**17** The Options Approach to Corporate Securities

## Answers to Questions and Problems

1. Explain why common stock is itself like a call option. In the option analysis of common stock, what plays the role of the exercise price and what plays the role of the underlying stock?

Common stock is like a call option on the entire firm. To see how this can be the case, consider a firm with a single bond issue outstanding and assume that the bond is a pure discount bond. When the bond matures, the common stockholders have a choice: They can pay the bondholders the promised payment, or they can surrender the firm to the bondholders. If the firm is worth more than the amount due to the bondholders, the stock owners will pay the bondholders and keep the excess. If the firm is worth less than the amount due to the bondholders, the stock owners will abandon the firm to the bond owners.

In this situation, the amount due to the bond owners plays the role of the exercise price. The maturity date of the bond is the expiration date of the call option represented by the common stock. The common stock is like a call option. At expiration, the stock owners can exercise their call option by paying the claim of the bondholders (the exercise price). Upon exercising, the stockholders receive the underlying asset (the entire firm).

2. Consider a firm that issues a pure discount bond that matures in one year and has a face value of \$1,000,000. Analyze the payoffs that the bondholders will receive in option pricing terms, assuming the only other security in the firm is common stock.

When the bond matures, the stock owners decide whether to pay the bonds or surrender the firm to the bondholders in lieu of payment. If the value of the firm exceeds the amount owed to the bond owners, \$1,000,000, the bondholders receive full payment and the stock owners retain the excess. If the firm's value is less than the promised payment, the stock owners abandon the firm and the bondholders receive a payment equal to the value of the entire firm. However, by hypothesis, this is less than the promised payment of \$1,000,000. This pattern of payment is like the payments on a short put position with an exercise price that equals the face value of the bond. However, a short position in a put can give a payoff at expiration that is negative. This is not true of a bond. The worst payoff for the bond is zero. Therefore, the payoff has the same pattern as a short position in a put with an exercise price that equals the face value of the bond plus a long position in a riskless bond.

3. Consider a firm with common stock and a pure discount bond as its financing. The total value of the firm is \$1,000,000. There are 10,000 shares of common stock priced at \$70 per share. The bond matures in ten years

and has a total face value of \$500,000. What is the interest rate on the bond, assuming annual compounding? Would the interest rate become higher or lower if the volatility of the firm's cash flows increases?

The \$1,000,000 value of the firm equals the sum of the stock and bond values. As the outstanding stock is worth \$700,000, the bonds must be worth \$300,000. Therefore, the interest rate is 5.24 percent. If the volatility of the firm's cash flows increases, the total value of the firm will not change. However, because the common stock can be analyzed as a call option on the firm, the value of the common stock must increase. This means that the value of the bonds must decrease. If the bond value decreases, its yield must increase. This makes sense, because the bonds should be worth less if the firm's cash flows become more risky.

4. A firm has a capital structure consisting of common stock and a single bond. The managers of the firm are considering a major capital investment that will be financed from internally generated funds. The project can be initiated in two ways, one with a high fixed cost component and the other with a low fixed cost component. Although both technologies have the same expected value, the high fixed cost approach has the potential for greater payoffs. (If the product is successful, the high fixed cost approach gives much lower total costs for large production levels.) What does option theory suggest about the choice the managers should make? Explain.

Assuming that the managers perform in the interest of their shareholders, they must make the decision that increases the value of the stock. As the stock represents a call option on the total firm value, the managers should prefer the higher operating leverage/higher operating risk strategy.

5. In a firm with common stock, senior debt, and subordinated debt, assume that both debt instruments mature at the same time. What is the necessary condition on the value of the firm at maturity for each security holder to receive at least some payment? With two classes of debt, does option theory counsel managers to increase the riskiness of the firm's operations? Would there be any difference on this point between a firm with a single debt issue and two debt issues? Which bondholders would tend to be more risk-averse as far as choosing a risk level for the firm's operations? Explain.

For the senior debtholders to receive some payment, the value of the firm must exceed zero. For the subordinated debtholders to receive some payment, the value of the firm must exceed the total owed to the senior debtholders. For the common stockholders to receive any payment, the value of the firm must exceed the amount owed on both classes of debt. If the managers perform in the interest of the stockholders, the mere presence of two classes of debt does not suggest a change in operating policy. The stockholders get paid only after all the bondholders are paid, so it does not matter to the stockholders how the debt is split up, but only how much the total amount of debt payments is. Given that the junior debtholders have already purchased the junior debt, they are (by revealed preference) more risk-tolerant than the holders of the senior debt. However, increasing operating risk transfers wealth away from bondholders to stockholders. Thus, the junior debtholders would probably prefer a low-risk operating strategy if funds would be certain to sufficiently cover their holdings. However, consider an operating policy that would only generate enough cash to pay the senior debtholders. In this situation, it is clear that the junior debtholders would prefer a more risky operating policy that might give sufficient payoffs to repay their obligations.

6. Consider a firm financed solely by common stock and a single callable bond issue. Assume that the bond is a pure discount bond. Is there any circumstance in which the firm should call the bond before the maturity date? Would such an exercise of the firm's call option discard the time premium? Explain.

The stockholders should wait until the maturity date. The stockholders' situation here is analogous to a call on a nondividend stock. Early payment of the bond discards the time premium inherent in the option they hold.

7. Consider a firm financed only by common stock and a convertible bond issue. When should the bondholders exercise? Explain. If the common shares pay a dividend, could it make sense for the bondholders to exercise before the bond matures? Explain by relating your answer to our discussion of the exercise of American calls on dividend-paying stocks. If the common stock pays no dividend, the bondholders should not exercise until the last possible date. However, if the stock pays a sufficiently large dividend, it might pay the bondholders to convert earlier. The bondholder holds a call option on the firm's shares. If those shares pay dividends, then they are leaking value. The bondholders must decide whether it is worthwhile to discard the time premium in favor of securing the dividend. This is exactly analogous to the problem faced by the holder of an American call option on a dividend paying stock.

8. Warrants are often used to compensate top executives in firms. Often these warrants cannot be exercised until a distant expiration date. This form of compensation is used to align the manager's incentives with the maximization of the shareholders' wealth. Explain how the manager's receiving warrants might thwart the efforts to change his or her incentives.

If a manager holds warrants, and the value of these warrants is large relative to other forms of compensation, the manager will focus on maximizing the value of the firm at the expiration date of the warrants. This incentive might be incompatible with making decisions that will increase the value of the firm at other dates. For example, if markets are not perfect, then the value of the shares might not fully reflect a good decision to make a large capital budgeting outlay. Therefore, the manager might forego the investment in order to enhance the share price on the critical date for the manager.

9. In preparation for the CFA exam, you have been watching *Trading Places*. During your most recent viewing of the movie, you were struck by the notion that creating a call option on frozen concentrated orange juice would be possible. Describe the process of creating a synthetic call option on frozen concentrated orange juice using the frozen concentrated orange juice futures contract. Be sure to discuss the information necessary to create the synthetic option.

To create a synthetic call option on frozen concentrated orange juice, we must model the dynamics of the spot market price of orange juice. We could do this using either a binomial process or a stochastic process. Once we have modeled the dynamics of the spot price of orange juice, we can determine the appropriate hedge ratio for an initial position in the futures contract on frozen concentrated orange juice. That is, once we have determined the values of the five parameters necessary to value a call option—the strike price, the time until expiration, the risk-free interest rate, the spot market price, and the volatility of the spot market price—we can determine the dynamics of our position in the futures contract on frozen concentrated orange juice. With this information we will be able to determine our position in a Treasury bill. We will alter our position in the frozen concentrated orange juice futures contract and Treasury bill position as the spot price of orange juice changes. We will increase our position in the futures on frozen concentrated orange juice as the spot price of orange juice increases, and we will decrease our position in the futures on frozen concentrated orange juice as the spot price of orange juice decreases.

- 10. In automobile lease arrangements, the lessee has the right to buy the car from the manufacturer for a fixed price at the expiration of the lease. Assume that the lease in question matures in three years, and there are no tax advantages to leasing the car.
- A. Describe the positions of the automobile manufacturer and the car owner.

The car owner decides whether to purchase the car at the end of the contract. Therefore, the consumer is long the call option. Thus, the manufacturer has written a call option to the "purchaser" of the car.

B. Explain how such an option could be valued. Explain how you might estimate the parameters necessary to value this option. Be sure to discuss the factors complicating the valuation of this option.

The right to purchase the car at the end of the lease period is a long-term European call option. The purchase price for the car is the strike price of the option, and the option expires in three years. At the end of the lease the lessee will decide whether to purchase the car or return it to the auto dealer. If the purchase price of the car is less than the market price for an equivalent automobile, that is, the option is in-the-money, then the lessee will purchase the car.

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To value this option we need to know the strike price on the option, the time until expiration of the option, the relevant risk-free rate of interest, the spot price of the auto, and the volatility of the price of the auto. The strike price of the option and the expiration date of the option are clearly specified in the lease agreement. If we assume that we can create a riskless hedge between a synthetic call and the call attached to the lease, then we can use the appropriate three-year Treasury security rate as the risk-free interest rate in the pricing of the option. If we are not able to construct this riskless position, then we should not use a pricing model that assumes that it is possible to price the asset in a risk-neutral economy, that is, the Black–Scholes model. In this case we must use a risk-adjusted pricing model where we would value the option as the discounted value of the expected payoffs associated with the contract. To do this we would have to assess the probability of the set of possible payoffs associated with the option, calculate the expected payoffs, and discount the expected payoffs using an appropriate risk-adjusted return. Determination of the appropriate risk-adjusted rate of return would be the most difficult aspect of this problem. An appropriate proxy would be the market rate on three-year auto loans for an individual of the same risk class as the purchaser of the car.

The contract gives the "car buyer" the right to purchase a three-year-old automobile at the end of three years. Determining the spot price of the equivalent three-year-old automobile will be difficult, particularly for a consumer. The auto manufacturer will have access to information about the market for autos nation-wide, while consumers may have access to information about the local automobile market. We need to know the market price of an auto with the same characteristics as the leased car. This value may not exist if the car in question is a new model, as there are no three-year-old versions of this car in the market. If there are autos that are perceived to be close substitutes for the car in question in the market, we can use the price of used versions of this car as a proxy for the spot price of the used car. The decision to purchase a particular auto is a consumption decision, and individual consumption preferences change over time as one's wealth and tastes change. The existence of cars perceived as close substitutes will be influenced by the tastes of consumers. Once the appropriate price series has been created, the price series can be used to calculate the historical volatility in the price of three-year-old automobiles. We implicitly assume that consumer tastes and demands will not change over the three-year life of the option. Determination of implied volatility would be difficult, as there is no market for options written on autos.

C. Explain why automobile manufacturers would bundle this right with the automobile lease.

Consider an alternative lease contract that requires the car "owner" to return the car to the manufacturer at the end of the lease period. In this contract, the car "owner" knows that the asset must be returned to the manufacturer in three years. Essentially the car owner has a long position in an in-the-money put option. The car "owner" has the right to return, put, the car to the manufacturer in three years whatever the condition of the car. This right is most valuable to the car "owner" when the car is returned very poor condition.

With the purchase option, the incentives of the car "owner" change. With the purchase option, the car "owner" has a stake in the condition of the car. Assume that the car is still desired or demanded by consumers at the end of the lease. The lessee influences/controls the quality of the car via his driving and maintenance habits over the life of the lease. If the lessee has an ownership stake in the car via the right to purchase the car, then the lessee is less likely to engage in moral hazard and purposely run down the value of the car. The lessee knows that his behaviors will influence the moneyness of the option contract. If the lessee does not choose to purchase the car, the condition of a car returned to the manufacturer in an environment that did not permit the purchase of the car. In addition, the right to purchase a car at a fixed price at the end of the lease provides a price benchmark for the used car at the end of the lease. This price benchmark should decrease the impact of depreciation on the market value of all similar cars regardless of whether the car was leased or purchased. This right increases the value of all similar cars regardless of whether the car was leased or purchased. This right increases the value of all similar cars regardless of whether the car was leased or purchased. This right increases the value of the car to potential purchasers and lessors and increases the probability of selling/leasing cars initially.

D. Does the presence of the right to purchase the car at the expiration of the lease increase the price of the lease? Explain.

If we assume that the auto manufacturer is in the business of selling new cars, not used cars, then the manufacturer has an incentive to set the purchase price of the car at a level that increases the probability, at the margin, that the lessee will purchase the car at the end of the lease. The existence of the right to purchase the auto at the end of the lease increases the probability that the condition of cars returned to the manufacturer is higher than the condition of cars returned to the manufacturer when such a purchase option is not available. Thus, if a manufacturer has a car returned, it will be of higher quality and easier to dispose of. The manufacturer clearly benefits from the existence of this right. The key issue is, does the consumer have to pay for the right to purchase the car at the end of the lease? The answer depends on the car in question and the market environment at the time of the sale of the auto. Does the manufacturer need this added benefit to sell the car initially? If economic conditions, consumer preferences, and competitive conditions are such that the manufacturer must provide a nonprice inducement to attract customers to the car, then the consumer is not likely to have to pay for this right. That is, if a consumer perceives two cars as equivalent and the manufacturers of the cars are offering the same lease terms with the exception that one is offering the right to purchase, then the consumer is likely to be induced to lease the car with the right to purchase the car at the end of the lease.

11. A developer has purchased 60 acres of rural property just north of Augusta, Georgia, to develop a golf course. The golf course development will also include a housing development. To generate operating capital, the developer is selling rights. The rights give the holder of the contract the right to purchase lots in the housing development for a fixed price. Each lot in the housing development is half an acre. The agreements expire six months after they are signed. The developer is offering the following inducement. A potential homeowner can purchase a lot for \$25,000 at the end of six months if the homeowner enters the contract this week. The purchase price for a lot increases to \$40,000 on all contracts signed after this week. The developer has asked you to price the rights to purchase property in the development. Explain how you would value these options. Discuss the factors that make the valuation of this contract difficult.

Real estate is a fixed asset. It is not transportable. The desirable characteristics of the asset cannot be transferred to another asset or location. The value of a particular piece of property is determined by its location and the demand for the property. The supply of property is fixed and controlled by the owner of the property. The value of the property will be influenced by the perception and tastes of potential home buyers, and by the perception of the existence of comparable substitute housing locations. Thus, we have the problem of pricing an asset that is in limited supply where the demand for the asset is strongly influenced by consumer preferences.

Assuming that we can create a riskless hedge between a synthetic call option and the call option being offered by the developer would not be appropriate. Thus, we should not use a pricing model that assumes that it is possible to price the asset in a risk-neutral economy, that is, the Black–Scholes model or the binomial model as we have developed it in the text. To price this option we must use a risk-adjusted pricing model where the value of the option is the present value of the expected payoffs associated with the contract. To do this we must assess the probability of the set of possible payoffs associated with the option, calculate the expected payoffs, and discount the expected payoffs using an appropriate risk-adjusted return. An appropriate proxy for the discount rate would be the six-month rate on consumer credit from a bank. The payoff on the option would be the difference between the market value of the property and the purchase price of the property. If consumers perceive that there is comparable real estate in the area, then the market price for this property can be used in evaluating the payoffs associated with the option. If consumers perceive that there is no comparable real estate in the property, then one must estimate the premium that must be paid to purchase this property to evaluate the payoffs associated with the option.

12. Kevin is employed by Farm State Insurance. It is Kevin's job to develop a pricing model to price automobile insurance. Farm State Insurance will offer accident insurance policies to drivers of all ages, in all states.

The insurance policies will be renewable semiannually. The policies only cover accidents and do not cover the theft of the vehicle. Several different deductibles will be offered to prospective policyholders. Model the auto insurance as an option. Discuss the pricing of this type of insurance policy and the construction of the insurance policies offered to drivers.

The insured has the right to make a claim against the insurance company anytime during the life of the contract, which in this case is six months. If there is an accident involving the driver, then the insurance company makes a payment. The amount of the payment is the difference between the dollar amount of the deductible and the dollar value of the claim against the insurance company. Since the insurance company is making a payment, the insurance company has effectively written a put option to the insured. This option is different from a stock option in that in order to make a claim against the insurance company, the insured must be involved in an accident. Assuming the insured does not intend to file a fraudulent claim against the firm, most policyholders have an incentive to avoid accidents. Being involved in an accident puts an individual at risk of serious injury.

Kevin's job is to determine the semiannual premium on the different insurance policies offered to drivers. Assuming that we can create a riskless hedge between a synthetic put option and the put option being offered by Farm State would not be appropriate. Thus, we should not use a pricing model that assumes that it is possible to price the asset in a risk-neutral economy, that is, the Black-Scholes model. To price this option, we must use a risk-adjusted pricing model where the value of the option is the present value of the expected payoffs associated with the contract. Kevin must determine the expected payouts for a particular insured group during a six-month contract period, and discount those expected payouts at the firm's cost of capital. To price these policies, Kevin will need historical information about the distribution of claims for firms providing automobile insurance in the same state and region, and for the industry in general. Kevin must know the amount that the firm will pay if the insured is involved in an accident. This will be influenced by the types of automobiles being insured, the age of the drivers being insured, whether the driver has taken driver's training, and the location of the insured. Kevin must assess the probability of making a payout for a particular group of policyholders. An important part of the classification system used in the pricing of the policies will be the driving history of the insured. A key right of the insurance company will be the right to refuse coverage to a particular individual. Another important consideration is the size of the deducible that the insured chooses. The deductible represents the amount of risk that the individual is willing to selfinsure, and can be viewed by the insurance company as a signal concerning the risk-taking preferences of the policyholder. Thus, the same policy with different deductibles will have different prices.

13. Your bank is thinking of offering a new product to small businesses. This product will allow a customer to borrow up to \$50,000 at a fixed rate of interest. This line of credit has a life span of two years. The customer can draw against the credit line as many times as he or she wants over the life of the contract. However, the minimum amount that may be borrowed is \$5,000. Once the customer has borrowed funds, he or she has up to one year to repay the loan. This contract has a fixed life and a fixed interest rate. The small business person gains access to the line of credit by paying an up-front fee. It is your job to price the contract and determine the amount of the up-front fee. Model the fixed rate line of credit as an option. Explain when an investor is likely to use this line of credit.

The small businessperson has the right to borrow anytime during a two-year period up to \$50,000. By exercising this right, the customer obtains cash. When the owner of a put option written on common stock exercises the put, he or she too receives cash. Thus, the bank has effectively written a put option. Not only does the businessperson have the right to borrow funds, he or she has the right to choose the timing of the borrowing. Thus, the small businessperson has a multiple option. Both these options need to be valued in the pricing of the line of credit. The customer will exercise this line of credit when the cost of funds associated with the line of credit is less than the cost of funds available from other sources. One characteristic of a "normal" small business is that the firm does not generally have the same access to the capital markets as a larger firm does. Thus, it is not likely that the firm could issue commercial paper or a long-term bond as an alternative source of funding. It is more likely that the small businessperson is going to draw on the line of credit. In addition, temporary fluctuations in the firm's cash flows are likely to have a significant impact on the borrowing activities of the small businessperson. 14. The local junior service league is organizing a fund-raiser for the local homeless shelter. The owner of the Hallmark card shop in town has donated the grand prize of four Beanie Babies. These are not just any Beanie Babies. They are Garcia, Peace, Erin, and Princess Bear, the most famous and valuable retired Beanie Babies. However, in your state, it is a felony to operate a raffle. So rather than raffling off the grand prize, the junior service league must sell rights to the public that permit the "winner" of the raffle to purchase the grand prize at a retail price of \$6.99 per baby. The "winner" will be randomly selected from among all entrants. It is your job to price the raffle tickets to be offered for sale. Explain how you would value these tickets.

One lucky individual is going to own a deep-in-the-money European call option. Each contestant is donating funds for the right to purchase a valuable asset at a below market price. Using the Black-Scholes model to price these rights would be appropriate if we can create a riskless hedge between a synthetic call option and the call option being offered in the raffle. However, that is not the case. Thus, we should not use a pricing model that assumes that it is possible to price the asset in a risk-neutral economy, that is, the Black-Scholes model. Valuation of the right can be determined as the present value of the expected payouts associated with the right. The underlying assets, the four Beanie Babies, are in fixed supply. There are a limited number of the Beanie Babies that are available in the market. The market for the Beanie Babies is an overthe-counter market. The market price of the Beanie Babies is determined by the consumer demand for the toys. The demand is driven by the preferences of a set of collectors who are willing to pay to buy the toys. The easiest way to determine the market value of the four Beanie Babies is to search the electronic auction markets that are part of the Internet. One can obtain from several of these markets estimates of the current value of the Beanie Babies. From this information, the payoff on a raffle ticket can be easily determined. The probability of winning is a function of the number of raffle tickets sold. The fewer the number of tickets sold, the higher the probability of winning and the higher the price of the raffle ticket. A short-term interest rate, with a maturity equal to the length of the time until the drawing for the raffle winner, should be used to discount the payoffs. Given the present value of the payoffs, one can determine the price of a raffle ticket.

15. Debt contracts represent fixed claims against the cash flows of a firm, while an equity contract entitles the shareholder to claim against the residual cash flows of the firm. The small firm in question has one shareholder, the entrepreneur who started and runs the firm. The firm's debt consists of loans from the local commercial bank. The firm's primary source of revenues is exports to Singapore. Because of the Asian financial crisis, the firm is facing considerable reduction in cash flows. The manager/entrepreneur has two investment projects. One is a safe project that will only generate sufficient cash flows to cover the firm's debt obligations. The other project is considerably more risky, but if successful will generate twice the firm's normal annual revenue. Which project do you expect the entrepreneur to undertake? Explain.

We can model the entrepreneur's position in the firm as a long position in an out-of-the-money European call option on his firm. The bank has effectively written the call option to the entrepreneur. The entrepreneur can purchase the firm from the bank by repaying his loans to the bank. If the entrepreneur defaults, the bank acquires the assets of the firm. The entrepreneur makes the operating decisions for the firm that affect both the riskiness and cash flows of the firm. The entrepreneur must choose between two projects. The safe project covers the entrepreneur's obligations to the bank, but the project leaves nothing for the entrepreneur. The risky project has the potential to generate large payoffs to the entrepreneur. The bank has a fixed claim against the assets of the firm, so if the risky project is successful, the bank will not share the gains from the project with the entrepreneur. However, the bank shares the additional risk with the entrepreneur has an undiversified portfolio and is bearing the full risk of ownership that comes from being the sole owner of the firm. Since the owner of the firm holds an out-of-the-money call and can affect the moneyness of the call by his choice of an investment project, the entrepreneur is likely to pick the high-risk project. In addition, by choosing the high-risk project, the entrepreneur can share risk with the bank without sharing the gains that may result from the investment project.

16. You have just been hired as CFO for a medium-sized manufacturing firm. The SEC requires your firm to report the value of the stock option contracts awarded to employees in your annual 10K report. Your firm has issued stock options to its executives. The options generally have a strike price that is slightly higher

than the firm's stock price when they are offered. The options can be exercised anytime during the life of the option. If the options are exercised, the firm issues new treasury stock. Executives often exercise these options well before the expiration date of the option. The options issued to executives cannot be sold to any other party, and the options automatically expire if the executive leaves the firm. The majority of the options awarded to executives have had a life of three years. It is your job to value the options awarded by your firm. Explain why the firm would choose to compensate its executives with options. Explain how you would value these options. Discuss the possible reasons why an executive might choose to exercise these options early.

A corporation is usually managed by professional managers. In many corporations, these professional managers do not hold any of the firm's shares. Or if the manager does own shares, it is not a significant percentage of the shares outstanding. In this situation there is a clear separation between the management and ownership of the firm. The managers of the firm make all the operating decisions for the firm. These operating decisions affect the firm's cash flows and the riskiness of the firm. The purpose of the stock options is to align the interests of the shareholders and the managers of the firm by making the managers co-owners of the firm. Giving managers an equity stake in the firm creates an environment where managers have incentive to make decisions that maximize the value of their shares. Maximizing the value of the managers' shares also increases the wealth of the other owners of the firm. The executive stock options are not marketable. Thus the managers cannot sell the options to capture the intrinsic value and time premium associated with the options. The only way to capture the gain associated with a stock price increase is to exercise the option. The manager, like an owner of an American option written on a dividend paying stock, may choose to exercise the option to capture the dividends associated with the stock. Because the manager is an insider and has access to proprietary firm-specific information, the manager may choose to exercise an option to take advantage of his or her knowledge. For example, suppose the manager has access to negative information about an investment project that has not reached the market and has not been incorporated in the firm's stock price. The manager has an incentive to exercise the call options and to sell the stock in the market to capitalize on the value of this information through the sale of the overvalued shares. Nominally the valuation of the stock options should be straightforward and can be accomplished using the traditional pricing models used to value traded options. However, the fact that the options are not a marketable asset should adversely affect the value of the contract. Not being able to sell the option should reduce the value of the option to the manager. The question remains as to the size of this reduction in value.

17. WCS has enjoyed massive growth in the last decade and is in the process of constructing a new eighty-story corporate headquarters building. This construction project is early in the planning stage. The management of WCS has a choice between two technologies for the heating and cooling plant for the building. The choice is between a heating and cooling plant that burns only oil and one that burns either oil or natural gas. That is, the latter heating and cooling plant can be converted from oil burning to a natural gas fueled facility after a fixed cost expenditure of \$50,000. Although the dual fuel plant has greater initial cost, it offers management greater flexibility in the future. In making the choice between the two heating and cooling plants, the firm's managers must assess the value of this operating option. Evaluate this investment decision facing the managers of WCS as an option. Assume that natural gas comes from domestic suppliers and heating oil is supplied in the global oil market.

The dual fuel heating and cooling plant has option-like characteristics. Anytime in the future the management of WCS can choose to convert the heating and cooling plant of its headquarters building from oil to natural gas. The fixed cost of conversion is \$50,000 and is equivalent to the strike price on an American option. Thus, by choosing to invest in this type of technology, the managers have a valuable right that may or may not be exercised in the future. When choosing the cheaper single fuel technology heating and cooling plant, the managers give up the right to convert the heating and cooling plant from oil to natural gas at a low cost in the future. If the single fuel technology is chosen, then in order to make the conversion from oil to natural gas, the entire heating and cooling plant must be replaced. The cost of the reengineering of the heating and cooling plant will be significantly greater than the fixed cost of conversion associated with the dual fuel technology.

The value of the right to convert the dual fuel plant from oil to natural gas will be dependent on the relative cost and volatility of the two fuels. The management of WCS must formulate expectations regarding the future prices of the two fuels as part of the valuation of the conversion right. To complete this task, WCS's

managers must consider the sources of supply for the two fuels. The decision to supply oil to the world market involves both an economic and political decision. The supply of oil is often constrained for political reasons. If the managers of WCS expect the supply of oil to be limited in the future, the value of the conversion right increases. Another set of issues that must be evaluated by the managers of WCS is environmental. If the natural gas technology is more environmentally friendly and the managers of WCS expect government regulation to impose tighter constraints on pollution in the future, then the value of the conversion right will increase.

18. You are evaluating DOG as a potential target for acquisition. DOG has capital structure that consists of common stock and a convertible bond. The bond matures in 10 years, and upon conversion by a bondholder, the firm must issue additional shares of stock. Describe the bondholders' position. Discuss the valuation of the convertible bond. Explain when the bondholders should exercise their option. If DOG pays a dividend, would it be rational for the bondholders to exercise their option before the bond matures? Explain by relating your answer to the decision to exercise an American call option on a dividend paying stock.

From the perspective of the bondholder, a long position in a convertible bond can be viewed as a position in a straight bond plus a position in an American call option. That is, it is the bondholder who has the right to convert the debt position to an equity position in the firm anytime over the life of the bond. The convertible bond can be valued as the value of a straight bond plus the value of an American call option. The American call option written on DOG shares can be valued using the standard American call option pricing methodologies.

When the value of the firm gets sufficiently high, the bondholder will exercise the option and convert his bond into an equity position in the firm. That is, the bondholder will convert the fixed payoff associated with the bond position into a variable payoff associated with the ownership of stock. If DOG does not pay dividends, then the bondholder should wait until the bond is about to mature to decide whether to convert the bond to an equity position in the firm. Exercising the option before this date results in the loss of the time premium of the option. However, if DOG becomes a target for acquisition and the stockholders are going to gain by receiving a premium as payment for their shares, then exercising their option would be rational for the bondholders. By exercising the option, the bondholder can share in the gains associated with the acquisition.

If DOG pays a dividend, then the decision to exercise the option early will be dependent on the size of the dividend paid. If the dividend is sufficiently large, then the bondholders can be induced to exercise early. Exercising the option entitles the bondholder to the stream of dividends paid by the firm. The decision to exercise early will be influenced by the size of the dividends, the timing of the dividends relative to the maturity of the bond, and the level of the market interest rates. The decision faced by the bondholder is the same as the decision faced by the owner of an American call option written on a dividend paying stock.

## Value of a Convertible Bond at Maturity



**Firm Value** 

Suppose the bond also has a call provision. The call provision gives the firm's managers the right to call the bond after five years at a premium to par. Discuss the impact of the introduction of the call provision to the bond contract on the decision by the owners of the bond to convert the bond to stock prior to expiration of the bond contract.

The right to call the bond is held by the firm. So the bondholder has written the call provision to the managers of the firm. That is, the managers of the firm decide whether to call the bond prior to the bond's maturity. This short call option position places a ceiling on the potential gains available to bondholders from converting from a debt position in the firm to an equity position in the firm. Without the call provision, bondholders have no incentive to exercise the bond early unless the dividend paid by the firm is sufficiently large. When interest rates fall and the value of the bond rises, bondholders have an incentive to wait until the bond's maturity to convert the bond. When the call feature is introduced, the bondholders bear the risk of waiting to convert the bond. In this low interest rate environment, the firm's managers have an incentive to call the bond prior to the bond prior to the bondholders' conversion of the bond, the bondholders lose the upside potential associated with equity ownership. Thus bondholders have an incentive to convert early if they expect the managers of the firm to call the bond. Again, if DOG becomes a target for acquisition and the stockholders are going to gain by receiving a premium as payment for their shares, then it would be rational for the bondholders to exercise their options and convert their debt to equity. Upon conversion, the bondholders can share in the gains associated with the acquisition.

## Value of a Callable Convertible Bond



**Firm Value**