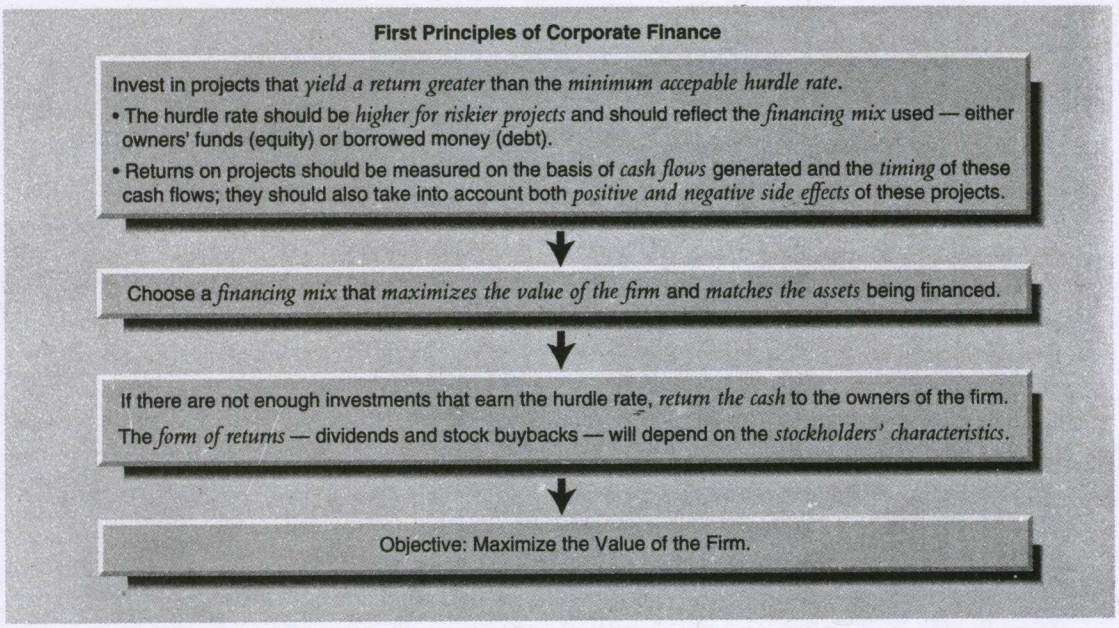
PART SIX

The Link Between Valuation and Corporate Finance Decisions



PART SIX

The Link Between Valuation and Corporate Finance Decisions

CHAPTER 27

Option Applications in Corporate Finance

IN OUR DISCUSSION of investment analysis, we argued that Boeing should invest in the Super Jumbo Jet since the net present value of the investment is positive. In our analysis of the optimal financing mix for The Home Depot, we noted that the firm has excess debt capacity and that using more debt would lower the cost of capital. In our examination of firm value, we estimated the value of Boeing, InfoSoft, and The Home Depot by discounting expected cash flows at the cost of capital. In all these cases, we used discounted cash flows to measure the impact of decisions on value.

In making investment, financing, and dividend decisions, however, firms may consider more than the expected cash flows from just those decisions. In deciding on whether to invest in the Super Jumbo, for instance, Boeing may consider the potential for expansion into new products or markets and the ease with which it can abandon the investment if not enough planes are sold. Similarly, The Home Depot may choose not to use its excess debt capacity because it values the financing flexibility generated by having this capacity. Although we have mentioned these considerations in earlier chapters and argued that they were options, we have neither valued them nor brought them explicitly into our analysis. In this chapter, we attempt to value these options and to lay out the conditions that need to be fulfilled for these options not only to exist but to have significant value.

We begin by introducing option pricing models in general. We then look at option applications in three parts. The first part includes options embedded in investments or projects, including the options to expand, delay, and abandon a project. Here we discuss strategic options, the value of research and development, and natural resource reserves. The second part of the analysis examines options in firm valuation. In particular, we look at the liquidation option that equity investors possess and at how much value it creates, especially in the context of highly levered, risky firms. The third part considers options in financing and dividend decisions. We consider the value of flexibility as an option and the use of options in the design of securities to reduce the cost of financing and default risk.

Basics of Option Pricing

In Chapter 5, we described options in terms of the cash flow payoffs we receive on them. The buyer of a call option gets the right to buy the underlying asset at a fixed price, whereas the buyer of a put option obtains the right to sell the underlying asset

at a fixed price. We considered the determinants of option value and introduced a model for pricing options, when the underlying asset's prices follow a binomial path. In this section, we expand this discussion to consider alternatives to the binomial model and extensions to value options with special features.

Alternatives to the Binomial Model

In the binomial option pricing model that we introduced in Chapter 5, we combined the underlying asset and risk-free lending or borrowing to create a portfolio that had the same cash flows as the option being valued; we called this portfolio the **replicating portfolio.** Although the binomial model provides an intuitive feel for the determinants of option value, it requires a large number of inputs in terms of expected future prices at each node. As we make time periods shorter in the binomial model, we can make one of two assumptions about asset prices. We can assume that price changes become smaller as periods get shorter; this leads to price changes becoming infinitesimally small as time periods approach zero, leading to a **continuous price process.** Alternatively, we can assume that price changes stay large even as the period gets shorter; this leads to a **jump price process,** whereby prices can jump in any period. In this section, we consider the option pricing models that emerge with each of these assumptions.

The Black-Scholes Model When the price process is continuous, that is, price changes become smaller as time periods get shorter, the binomial model for pricing options converges on the Black-Scholes model. The model, named after its co-creators, Fischer Black and Myron Scholes, allows us to estimate the value of any option using a small number of inputs, and it has been shown to be remarkably robust in valuing many listed options.

Although the derivation of the Black-Scholes model is far too complicated to present here, it is also based on the idea of creating a portfolio of the underlying asset and the riskless asset with the same cash flows, and hence the same cost, as the option being valued. The value of a call option in the Black-Scholes model can be written as a function of the five variables:

S = Current value of the underlying asset

K = Strike price of the option

t = Life to expiration of the option

r = Riskless interest rate corresponding to the life of the option

σ^2 = Variance in the *ln*(value) of the underlying asset

The value of a call is then:

$$\text{Value of call} = S\,N(d_1) - K\,e^{-rt}\,N(d_2)$$

where

$$d_1 = \frac{\ln\left(\frac{S}{K}\right) + \left(r + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

Note that e^{-rt} is the present value factor and reflects the fact that the exercise price on the call option does not have to be paid until expiration. $N(d_1)$ and $N(d_2)$ are probabilities, estimated by using a cumulative standardized normal distribution, and the values of d_1 and d_2 obtained for an option. The cumulative distribution is shown in Figure 27.1. In approximate terms, these probabilities yield the likelihood that an option will generate positive cash flows for its owner at exercise, that is, that $S > K$ in the case of a call option. The portfolio that replicates the call option is created by buying $N(d_1)$ units of the underlying asset and borrowing $Ke^{-rt}\ N(d_2)$. The portfolio will have the same cash flows as the call option and thus the same value as the option. $N(d_1)$, which is the number of units of the underlying asset that are needed to create the replicating portfolio, is called the **option delta.**

The Black-Scholes model was designed to value options that can be exercised only at maturity and on underlying assets that do not pay dividends. In addition, options are valued based on the assumption that option exercise does not affect the value of the underlying asset. In practice, assets do pay dividends, options sometimes get exercised early, and exercising an option can affect the value of the underlying asset. Adjustments exist, that while not perfect, provide partial corrections to the Black-Scholes model.

The Dividend Adjustment The payment of a dividend reduces the stock price; note that on the ex-dividend day, the stock price generally declines. Consequently, call options will become less valuable and put options will be more valuable as expected dividend payments increase. One approach to dealing with dividends is to estimate the present value of expected dividends that will be paid by the underlying asset during the option life and subtract it from the current value of the asset to use as S in the model. Since this becomes impractical as the option life becomes longer, we would suggest an alternative approach. If the dividend yield (y = dividends/current value of the asset) on the underlying asset is expected to remain unchanged during the life of the option, the Black-Scholes model can be modified to take dividends into account.

$$C = S\,e^{-yt}\,N(d_1) - K\,e^{-rt}\,N(d_2)$$

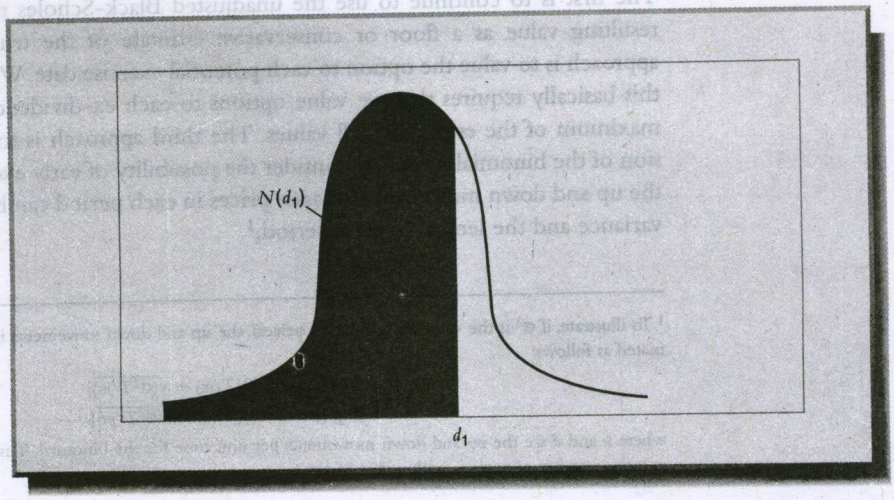


Figure 27.1
Cumulative Normal Distribution

where

$$d_1 = \frac{\ln\left(\frac{S}{K}\right) + \left(r - y + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

From an intuitive standpoint, the adjustments have two effects. First, the value of the asset is discounted back to the present at the dividend yield to take into account the expected drop in asset value resulting from dividend payments. Second, the interest rate is offset by the dividend yield to reflect the lower carrying cost from holding the asset (in the replicating portfolio). The net effect will be a reduction in the value of calls estimated using this model.

Early Exercise The Black-Scholes model was designed to value options that can be exercised only at expiration. Options with this characteristic are called **European options.** In contrast, most options that we encounter in practice can be exercised any time until expiration. These options are called **American options.** The possibility of early exercise makes American options more valuable than otherwise similar European options; it also makes them more difficult to value. In general, however, with traded options, it is almost always better to sell the option to someone else rather than exercise early, since options have a time premium, that is, they sell for more than their exercise value. There are two exceptions. One occurs when the underlying asset pays large dividends, thus reducing the value of the asset. In this case, call options may be exercised *just before an ex-dividend* date, if the time premium on the options is less than the expected decline in asset value as a consequence of the dividend payment. The other exception arises when an investor holds both the underlying asset and *deep in-the-money puts,* that is, puts with strike prices well above the current price of the underlying asset, on that asset at a time when interest rates are high. In this case, the time premium on the put may be less than the potential gain from exercising the put early and earning interest on the exercise price.

Three basic approaches can be used to deal with the possibility of early exercise. The first is to continue to use the unadjusted Black-Scholes model and regard the resulting value as a floor or conservative estimate of the true value. The second approach is to value the option to each potential exercise date. With options on stocks, this basically requires that we value options to each ex-dividend day and choose the maximum of the estimated call values. The third approach is to use a modified version of the binomial model to consider the possibility of early exercise. In this version, the up and down movements for asset prices in each period can be estimated from the variance and the length of each period.[1]

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[1] To illustrate, if σ^2 is the variance in *ln*(stock prices), the up and down movements in the binomial can be estimated as follows:

$$u = \text{Exp}\left[(r - \sigma^2/2)(T/m) + \sqrt{(\sigma^2 T/m)}\right]$$

$$d = \text{Exp}\left[(r - \sigma^2/2)(T/m) - \sqrt{(\sigma^2 T/m)}\right]$$

where u and d are the up and down movements per unit time for the binomial, T is the life of the option, and m is the number of periods within that lifetime.

Dilution The Black-Scholes model is based on the assumption that exercising an option does not affect the value of the underlying asset. This may be true for listed options on stocks, but it is not true for some types of options. For instance, the exercise of warrants increases the number of shares outstanding and brings fresh cash into the firm, both of which will affect the stock price.[2] The expected negative impact (dilution) of exercise will decrease the value of warrants, compared to otherwise similar call options. The adjustment for dilution in the Black-Scholes to the stock price is fairly simple. The stock price is adjusted for the expected dilution from the exercise of the options. In the case of warrants, for instance:

$$\text{Dilution-adjusted } S = \frac{S\,n_s + W\,n_w}{n_s + n_w}$$

where

S = Current value of the stock
W = Value of warrants outstanding
n_w = Number of warrants outstanding
n_s = Number of shares outstanding

Spreadsheet

***ltopt.xls* allows you to estimate the value of an option, when the underlying asset has a constant dividend yield.**

When the warrants are exercised, the number of shares outstanding will increase, reducing the stock price. The numerator reflects the market value of equity, including both stocks and warrants outstanding. The reduction in S will reduce the value of the call option.

There is an element of circularity in this analysis, since the value of the warrant is needed to estimate the dilution-adjusted S and the dilution-adjusted S is needed to estimate the value of the warrant. This problem can be resolved by starting the process off with an assumed value for the warrant (say, the exercise value or the current market price of the warrant). This will yield a value for the warrant, and this estimated value can then be used as an input to re-estimate the warrant's value until there is convergence.

Spreadsheet

***warrant.xls* allows you to estimate the value of an option, when there is a potential dilution from exercise.**

Put-call Parity The value of a put can be derived from the value of a call with the same strike price and the same expiration date:

$$C - P = S - K\,e^{-rt}$$

where C is the value of the call and P is the value of the put. This relationship between the call and put values is called **put-call parity,** and any deviations from parity can be used by investors to make riskless profits. To see why put-call parity holds, consider selling a call and buying a put with exercise price K and expiration date t, and simultaneously buying the underlying asset at the current price S. The payoff from this position is riskless and always yields K at expiration (t). To see this, assume that the stock price at expiration is S^*. The payoff on each of the positions in the portfolio can be written as follows:

Position	Payoffs at t if $S^*>K$	Payoffs at t if $S^*<K$
Sell call	$-(S^* - K)$	0
Buy put	0	$K - S^*$
Buy stock	S^*	S^*
Total	K	K

[2] Warrants are call options issued by firms, either as part of management compensation contracts or to raise equity. We discuss them in Ch

Since this position yields K with certainty, the cost of creating this position must be equal to the present value of K at the riskless rate ($K e^{-rt}$).

$$S + P - C = K e^{-rt}$$

$$C - P = S - K e^{-rt}$$

Substituting the Black-Scholes equation for the value of an equivalent call into this equation, we get:

$$\text{Value of put} = K e^{-rt}(1 - N(d_2)) - S e^{-yt}(1 - N(d_1))$$

where

$$d_1 = \frac{\ln\left(\frac{S}{K}\right) + \left(r - y + \frac{\sigma^2}{2}\right)t}{\sigma\sqrt{t}}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

Thus, the replicating portfolio for a put is created by selling short $(1 - N(d_1))$ shares of stock and investing $K e^{-rt}(1 - N(d_2))$ in the riskless asset.

Jump Process Option Pricing Models If price changes remain large as the time periods in the binomial are shortened, we can no longer assume that prices change continuously. When price changes remain large, a price process that allows for price jumps is much more realistic. Cox and Ross (1976) valued options when prices follow a *pure jump process,* where the jumps can only be positive. Thus, in the next interval, the stock price either will have a large positive jump with a specified probability or will drift downward at a given rate.

Merton (1976) considered a distribution in which there are price jumps superimposed on a continuous price process. He specified the rate at which jumps occur (λ) and the average jump size (k), measured as a percentage of the stock price. The model derived to value options with this process is called a *jump diffusion model.* In this model, the value of an option is determined by the five variables specified in the Black-Scholes model and the parameters of the jump process (λ, k). Unfortunately, the estimates of the jump process parameters are so noisy for most firms that they overwhelm any advantages that accrue from using a more realistic model. These models, therefore, have seen limited use in practice.

Extensions of Option Pricing

All the option pricing models we have described so far — the binomial, the Black-Scholes, and the jump process models — are designed to value options with clearly defined exercise prices and maturities, on underlying assets that are traded. The options we encounter in investment analysis or valuation are often on real assets rather than on financial assets, thus leading them to be categorized as **real options.** These options can take much more complicated forms. In this section, we will consider some of these variations.

Capped and Barrier Options With a simple call option, there is no specified upper limit on the profits that can be made by the buyer of the call. Asset prices, at

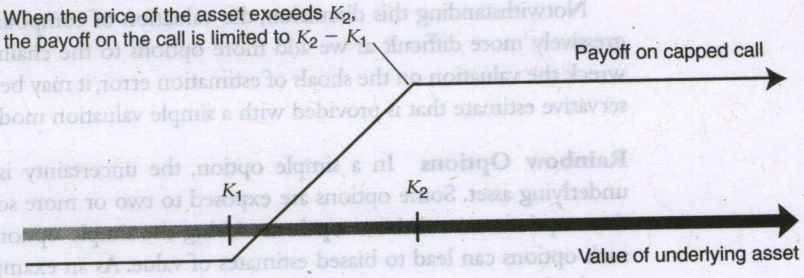


Figure 27.2 Payoff on Capped Call

least in theory, can keep going up, and the payoffs increase proportionately. In some call options, the buyer is entitled to profits up to a specified price but not above it. For instance, consider a call option with a strike price of K_1 on an asset. In an unrestricted call option, the payoff on this option will increase as the underlying asset's price increases above K_1. Assume, however, that if the price reaches K_2, the payoff is capped at $(K_2 - K_1)$. The payoff diagram on this option is shown in Figure 27.2.

This option is called a **capped call.** Notice, too, that once the price reaches K_2, there is no longer a time premium associated with the option, and the option will therefore be exercised. Capped calls are part of a family of options called **barrier options,** where in the payoff on, and the life of, the option are a function of whether the underlying asset price reaches a certain level during a specified period.

The value of a capped call will always be lower than the value of the same call without the payoff limit. A simple approximation of this value can be obtained by valuing the call twice, once with the given exercise price and once with the cap, and taking the difference in the two values. In the above example, then, the value of the call with an exercise price of K_1 and a cap at K_2 can be written as:

$$\text{Value of Capped Call} = \text{Value of call } (K = K_1) - \text{Value of call } (K = K_2)$$

Barrier options can take many forms. In a **knockout option,** an option ceases to exist if the underlying asset reaches a certain price. In the case of a call option, this knockout price is usually set below the strike price, and this option is called a **down-and-out option.** In the case of a put option, the knockout price will be set above the exercise price, and this option is called an **up-and-out option.** Like the capped call, these options will be worth less than their unrestricted counterparts. Many real options have limits on potential upside or knockout provisions, and ignoring these limits can result in the overstatement of the value of these options.

Compound Options Some options derive their value not from an underlying asset but from other options. These options are called **compound options.** Compound options can take any of four forms — a call on a call, a put on a put, a call on a put, and a put on a call. Geske (1979) developed the analytical formulation for valuing compound options by replacing the standard normal distribution used in a simple option model with a bivariate normal distribution in the calculation.

Consider, for instance, the option to expand a project that we will consider in the next section. Although we will value this option using a simple option pricing model, in reality there could be multiple stages in expansion, with each stage representing an option for the following stage. In this case, we will undervalue the option by considering it as a simple rather than a compound option.

Notwithstanding this discussion, the valuation of compound options becomes progressively more difficult as we add more options to the chain. In this case, rather than wreck the valuation on the shoals of estimation error, it may be better to accept the conservative estimate that is provided with a simple valuation model as a floor on the value.

Rainbow Options In a simple option, the uncertainty is about the price of the underlying asset. Some options are exposed to two or more sources of uncertainty, and these options are **rainbow options.** Using the simple option pricing model to value such options can lead to biased estimates of value. As an example, consider an undeveloped oil reserve as an option, where the firm that owns the reserve has the right to develop the reserve. Here, there are two sources of uncertainty. The first is obviously the price of oil, and the second is the quantity of oil that is in the reserve. To value this undeveloped reserve, we can make the simplifying assumption that we know the quantity of the reserves with certainty. In reality, however, uncertainty about the quantity will affect the value of this option and make the decision to exercise more difficult.[3]

Other Estimation Issues with Real Options We will confront several other estimation issues as we try to apply option pricing models to real options. First, the options being valued are often not on traded assets (such as stocks or commodities) but on nontraded assets such as projects and licenses. Consequently, neither the price of the underlying asset nor its variance is observable. The fact that we cannot observe the price of the underlying asset also implies that there is more uncertainty associated with valuing a real option than there is in valuing an option on a traded asset.

Second, real options are usually long term, stretching into years rather than months, making it more difficult to estimate inputs such as the variance in asset value. In particular, the assumption that the variance in the underlying asset's value is both known and constant over the option life may be more difficult to defend when valuing a 20-year option than a 6-month option.

Third, unlike listed options on stocks and other financial assets that are seldom exercised early, real options get their value from being exercised early and they usually are. Consequently, the difference between European and American option values will be much larger for real options than for traded short-term options. Furthermore, unlike the case of listed options, where exercise requires buying or selling stock and can be instantaneous, exercising a real option may require building a plant or constructing an oil rig, actions that do not happen in an instant. The fact that exercise takes time also implies that the true life of a real option is often less than the stated life.

In the applications that follow, we suggest adjustments that can be made to option pricing models to reflect these realities. Notwithstanding these adjustments, valuing real options will pose more estimation challenges and result in more estimation errors than valuing financial options on traded assets.

CT 27.1: Assume that you are valuing options on stock in a private firm. How would you estimate the value of the options? Why might you view the value you obtain from an option pricing model more cautiously than if the firm were public?

[3] The analogy to a listed option on a stock is the case where you do not know what the stock price is with certainty when you exercise the option. The more uncertain you are about the stock price, the more margin for error you have to give yourself when you exercise the option, to ensure that you are in fact earning a profit.

Options in Investment Analysis

In traditional investment analysis, a project or new investment should be accepted only if the returns on the project exceed the hurdle rate. In the context of cash flows and discount rates, this translates into investing in projects with positive net present values. The limitation of this view of the world, which analyzes projects on the basis of expected cash flows and discount rates, is that it fails to consider fully the options that are usually associated with many investments. In this section, we analyze three options that are often embedded in projects. The first is the option to delay a project, especially when the firm has exclusive rights to the project. The second is the option to expand an investment to produce new products or sell in new markets some time in the future. The third is the option to abandon a project if the cash flows do not measure up to expectations.

The Option to Delay a Project

Projects are typically analyzed based on their expected cash flows and discount rates at the time of the analysis; the net present value computed on that basis is a measure of its value and acceptability at that time. Expected cash flows and discount rates change over time, however, and so does the net present value. Thus, a project that has a negative net present value now may have a positive net present value in the future. In a competitive environment in which individual firms have no special advantages over their competitors in taking projects, the fact that net present values can be positive in the future may not be significant. In an environment in which a project can be taken by only one firm because of legal restrictions or other barriers to entry to competitors, however, the changes in the project's value over time give it the characteristics of a call option.

The Payoff on the Option to Delay Assume that a project requires an initial upfront investment of X and that the present value of expected cash inflows from investing in the project, computed today, is V. The net present value of this project is the difference between the two:

$$NPV = V - X$$

Now assume that the firm has exclusive rights to this project for the next n years and that the present value of the cash inflows may change over that time because of changes in either the cash flows or the discount rate. Thus, the project may have a negative net present value right now, but it may still be a good project if the firm waits. Defining V again as the present value of the cash flows (which can change over time), the firm's decision rule on this project can be summarized as follows:

If $V > X$ Invest in the project: Project has positive net present value.

$V < X$ Do not invest in the project: Project has negative net present value.

If the firm does not invest in the project over its life, it incurs no additional cash flows, though it will lose what it invested to get exclusive rights to the project. This relationship can be presented in a payoff diagram of cash flows on this project, as shown

In Practice 27.1: Valuing the Option to Delay a Project

Assume that you are interested in acquiring the exclusive rights to market a new product that will make it easier for people to access their e-mail on the road. If you do acquire the rights to the product, you estimate that it will cost you $50 million up-front to set up the infrastructure needed to provide the service. Based on your current projections, you believe that the service will generate only $10 million in after-tax cash flows each year. In addition, you expect to operate without serious competition for the next five years.

From a static standpoint, the net present value of this project can be computed by taking the present value of the expected cash flows over the next five years. Assuming a discount rate of 15% (based on the riskiness of this project), we obtain the following net present value for the project:

NPV of project = – 50 million + $10 million (PV of annuity, 15%, 5 years)

= – 50 million + $33.5 million = – $16.5 million

This project has a negative net present value.

The biggest source of uncertainty about this project is the number of people who will be interested in the product. Although current market tests indicate that you will capture a relatively small number of business travelers as your customers, they also indicate the possibility that the potential market could get much larger over time. In fact, a simulation of the project's cash flows yields a standard deviation of 42% in the present value of the cash flows, with an expected value of $33.5 million.

To value the exclusive rights to this project, we first define the inputs to the option pricing model:

Value of the Underlying Asset (S) = PV of Cash Flows from Project if introduced now = $33.5 million

Strike Price (K) = Initial Investment needed to introduce the product = $50.0 million

Variance in Underlying Asset's Value = $0.42^2 = 0.1764$

Time to expiration = Period of exclusive rights to product = 5 years

Dividend Yield = 1/Life of the right = 1/5 = 0.20

Assume that the five-year riskless rate is 5%. The value of the option can be estimated as follows:

$$\text{Call Value} = 33.5 \exp^{(-0.2)(5)} (0.2250) - 50.0 \exp^{(-0.05)(5)} (0.0451) = \$1.019 \text{ million}$$

The rights to this product, which has a negative net present value if introduced today, are worth $1.018 million. Note, however, as measured by $N(d_1)$ and $N(d_2)$, that the likelihood is low that this project will become viable before expiration.

Spreadsheet

***delay.xls* allows you to estimate the value of an option to delay an investment.**

Problems in Valuing the Option to Delay Although the option to delay is embedded in many projects, several problems are associated with the use of option pricing models to value these options. First, the underlying asset in this option, which is the project, is not traded, making it difficult to estimate its value and variance. We have argued that the value can be estimated from the expected cash flows and the discount rate for the project, albeit with error. The variance is more difficult to estimate, however, since we are attempting to estimate a variance in project value over time.

Second, the behavior of prices over time may not conform to the price path assumed by the option pricing models. In particular, the assumption that value follows a continuous process and that the variance in value remains unchanged over

time may be difficult to justify in the context of a project. For instance, a sudden technological change may dramatically change the value of a project, either positively or negatively.

Third, there may be no specific period for which the firm has rights to the project. Unlike the case of a patent, for instance, in which the firm has exclusive rights to produce the patented product for a specified period, the firm's rights often are less clearly defined in terms of both exclusivity and time. For instance, a firm may have significant advantages over its competitors, which may, in turn, provide it with the virtually exclusive rights to a project for a period of time. An example would be a company with strong brand-name recognition in retailing or consumer products. The rights are not legal restrictions, however, and will erode over time. In such cases, the expected life of the project itself is uncertain and only an estimate. In the valuation of the rights to the product, in the previous section, we used a life of five years for the option, but competitors could in fact enter sooner than we anticipated. Alternatively, the barriers to entry may turn out to be greater than expected and allow the firm to earn excess returns for longer than five years. Ironically, uncertainty about the expected life of the option can increase the variance in present value, and through it, the expected value of the rights to the project.

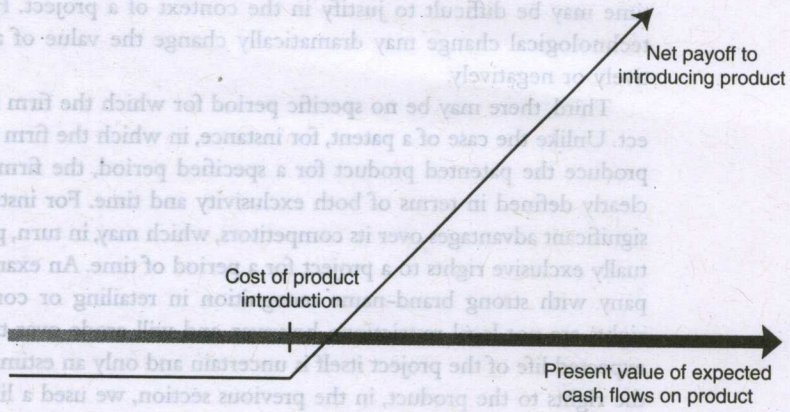
Implications and Extensions of Delay Options Several interesting implications emerge from the analysis of the option to delay a project. First, a project may have a negative net present value currently based on expected cash flows, but the rights to it may still be valuable because of the option characteristics.

Second, a project may have a positive net present value but still not be accepted right away. This can happen because the firm may gain by waiting and accepting the project in a future period, for the same reasons that investors do not always exercise an option that is in the money. A firm is more likely to wait if it has the rights to the project for a long time and the variance in project inflows is high. To illustrate, assume that a firm has the exclusive rights to produce a new type of disk drive for computer systems and that building a new plant will yield a positive net present value today. If the technology for manufacturing the disk drive is in flux, however, the firm may delay investing in the project in the hopes that the improved technology will increase the expected cash flows and consequently the value of the project. It has to weigh this benefit against the cost of delaying the project, which will be the cash flows that will be forsaken by not investing in it.

Third, factors that can make a project less attractive in a static analysis can actually make the rights to the project more valuable. As an example, consider the effect of uncertainty about the size of the potential market and the magnitude of excess returns. In a static analysis, increasing this uncertainty increases the riskiness of the project and may make it less attractive. When the project is viewed as an option, an increase in the uncertainty may make the option more valuable, not less. We will consider two cases, product patents and natural resource reserves, in which we believe that the project delay option allows us to estimate value more precisely.

Case 1: Valuing a Patent. A product patent provides a firm with the right to develop and market a product. The firm will do so only if the present value of the expected cash flows from the product sales exceeds the cost of development, as shown in Figure 27.4. If this does not occur, the firm can shelve the patent and not incur any further

Figure 27.4 Payoff to Introducing Product



costs. If I is the present value of the costs of commercially developing the patent and V is the present value of the expected cash flows from development, then:

$$\text{Payoff from owning a product patent} = V - I \quad \text{if } V > I$$
$$= 0 \quad \text{if } V \leq I$$

Thus, a product patent can be viewed as a call option, where the product is the underlying asset.

In Practice 27.2: Valuing a Patent: Avonex in 1997

Biogen is a biotechnology firm with a patent on a drug called Avonex, which has received FDA approval for use in treating multiple sclerosis. Assume that you are trying to value the patent and that you have the following estimates for use in the option pricing model:

- An internal analysis of the financial viability of the drug today, based on the potential market and the price that the firm can expect to charge for the drug, yields a present value of cash flows of $3.422 billion, prior to considering the initial development cost.
- The initial cost of developing the drug for commercial use is estimated to be $2.875 billion, if the drug is introduced today.
- The firm has the patent on the drug for the next 17 years, and the current long-term treasury bond rate is 6.7%.
- The average variance in firm value for publicly traded biotechnology firms is 0.224.

We assume that the potential for excess returns exists only during the patent life and that competition will eliminate excess returns beyond that period. Thus, any delay in introducing the drug, will cost the firm one year of patent-protected returns. (For the analysis, the cost of delay will be 1/17, next year it will be 1/16, the year after 1/15, and so on.) Based on these assumptions, we obtain the following inputs to the option pricing model.

Present Value of Cash Flows from Introducing the Drug Now = S = $3.422 billion
Initial Cost of Developing Drug for Commercial Use (today) = K = $2.875 billion
Patent Life = t = 17 years
Riskless Rate = r = 6.7% (17-year Treasury Bond rate)
Variance in Expected Present Values = σ^2 = 0.224
Expected Cost of Delay = y = 1/17 = 5.89%

These yield the following estimates for d and $N(d)$:

$d_1 = 1.1362$ $N(d_1) = 0.8720$

$d_2 = -0.8512$ $N(d_2) = 0.2076$

Plugging back into the dividend-adjusted Black-Scholes option pricing model, we get:

Value of the patent = 3,422 exp(–0.0589)(17) (0.8720) – 2,875 (exp(–0.067)(17) (0.2076)

= $907 million

Spreadsheet

***product.xls* allows you to estimate the value of a patent.**

To provide a contrast, the net present value of this project is only $547 million:

NPV = $3,422 million – $2,875 million = $547 million

The time premium of $360 million on this option ($907 – $547) suggests that the firm will be better off waiting rather than developing the drug immediately, the cost of delay notwithstanding. However, the cost of delay will increase over time and will make exercise (development) more likely in future years.

Case 2: Valuing Natural Resource Options. In a natural resource investment, the underlying asset is the natural resource, and the value of the asset is based on the estimated quantity and price of the resource. Thus, in a gold mine, the underlying asset is the value of the estimated gold reserves in the mine, based on the price of gold. In most such investments, an initial cost is associated with developing the resource; the difference between the value of the estimated reserves and the cost of the development is the profit to the owner of the resource (see Figure 27.5). Defining the cost of development as X and the estimated value of the resource as V makes the potential payoffs on a natural resource option the following:

$$\text{Payoff on natural resource investment} = V - X \quad \text{if } V > X$$

$$= 0 \quad \text{if } V \leq X$$

Thus, the investment in a natural resource option has a payoff function similar to a call option.

To value a natural resource investment as an option, we need to make certain assumptions about a number of variables:

1. *Available reserves of the resource:* Since this is not known with certainty at the outset, it has to be estimated. In an oil tract, for instance, geologists can provide reasonably accurate estimates of the quantity of oil available in the tract.

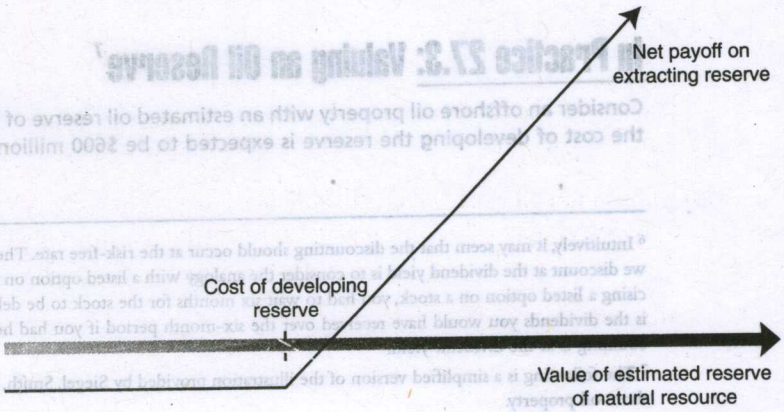


Figure 27.5 Payoff from Developing Natural Resource Reserves

2. *Estimated cost of developing the resource:* The estimated cost of developing the resource reserve is the exercise price of the option. In an oil reserve, this would be the cost of installing the rigs to extract oil from the reserve. Since oil companies have done this hundreds of times before in a variety of settings, they can use their experience to come up with a reasonable measure of development cost.
3. *Time to expiration of the option:* The life of a natural resource option can be defined in one of two ways. First, if the ownership of the investment has to be relinquished at the end of a fixed period of time, that period will be the life of the option. In many offshore oil leases, for instance, the oil tracts are leased to the oil company for a fixed period. The second approach is based on the inventory of the resource and the capacity output rate, as well as estimates of the number of years it would take to exhaust the inventory. Thus, a gold mine with a mine inventory of 3 million ounces and a capacity output rate of 150,000 ounces a year will be exhausted in 20 years, which is defined as the life of the natural resource option.
4. *Variance in value of the underlying asset:* The variance in the value of the underlying asset is determined by the variability in the price of the resource and the variability in the estimate of available reserves. In the special case where the quantity of the reserve is known with certainty, the variance in the underlying asset's value will depend entirely on the variance in the price of the natural resource.
5. *Cost of delay:* The net production revenue is the annual cash flow that will be generated, once a resource reserve has been developed, as a percentage of the market value of the reserve. This is the equivalent of the dividend yield and is treated the same way in calculating option values. An alternative way of thinking about this cost is in terms of a cost of delay. Once a natural resource option is in the money (Value of the reserves > Cost of developing these reserves), by not developing the reserve the firm is costing itself the production revenue it could have generated by doing so.

An important issue in using option pricing models to value natural resource options is the effect of development lags on the value of these options. Since oil or gold or any other natural resource reserve cannot be developed instantaneously, a time lag has to be allowed between the decision to extract the resources and the actual extraction. A simple adjustment for this lag is to reduce the value of the developed reserve for the loss of cash flows during the development period. Thus, if there is a one-year lag in development, the current value of the developed reserve will be discounted back one year at the net production revenue/asset value ratio[6] (which we also called the dividend yield above).

In Practice 27.3: Valuing an Oil Reserve[7]

Consider an offshore oil property with an estimated oil reserve of 50 million barrels of oil; the cost of developing the reserve is expected to be $600 million, and the development

[6] Intuitively, it may seem that the discounting should occur at the risk-free rate. The simplest way to explain why we discount at the dividend yield is to consider the analogy with a listed option on a stock. Assume that on exercising a listed option on a stock, you had to wait six months for the stock to be delivered to you. What you lose is the dividends you would have received over the six-month period if you had held the stock. Hence, the discounting is at the dividend yield.

[7] The following is a simplified version of the illustration provided by Siegel, Smith, and Paddock to value an offshore oil property.

lag is two years. Exxon has the rights to exploit this reserve for the next 20 years, and the marginal value (price per barrel – marginal cost per barrel) per barrel of oil is currently $12.[8] Once developed, the net production revenue each year will be 5% of the value of the reserves. The riskless rate is 8%, and the variance in oil prices is 0.03.

Given this information, the inputs to the Black-Scholes can be estimated as follows:

Current Value of the asset = S = Value of the developed reserve discounted back the length of the development lag at the dividend yield = $\$12 \times 50/(1.05)^2 = \$544.22$

Exercise Price = Cost of developing reserve = $600 million

Time to expiration on the option = 20 years

Variance in the value of the underlying asset[9] = 0.03

Riskless rate = 8%

Dividend Yield = Net production revenue/Value of reserve = 5%

Based on these inputs, the Black-Scholes model provides the following call value:

$$d_1 = 1.0359 \quad N(d_1) = 0.8498$$
$$d_2 = 0.2613 \quad N(d_2) = 0.6030$$

$$\text{Call Value} = 544.22 \exp^{(-0.05)(20)} (0.8498) - 600 \exp^{(-0.08)(20)} (0.6030) = \$97.08 \text{ million}$$

This oil reserve, though not viable at current prices, is still valuable because of its potential to create value if oil prices go up.

Spreadsheet

***natres.xls* allows you to estimate the value of an undeveloped natural resource reserve.**

✔ ***CC 27.2:* Assume that oil prices increase by $5 per barrel today and drop back by $5 tomorrow. Will these changes affect the value of the oil reserve? Why or why not?**

The Option to Expand a Project

Firms sometimes invest in projects because the investments allow them either to make further investments or to enter other markets in the future. In such cases, we can view the initial projects as options allowing the firm to invest in other projects, and we should therefore be willing to pay a price for such options. Put another way, a firm may accept a negative net present value on the initial project because of the possibility of high positive net present values on future projects.

The Payoff on the Option to Expand The option to expand can be evaluated at the time the initial project is analyzed. Assume that this initial project will give the firm the right to expand and invest in a new project in the future. Assessed today, the expected present value of the cash flows from investing in the future project is V, and the total investment needed for this project is X. The firm has a fixed time horizon, at the end of which it has to make the final decision on whether or not to make the

[8] For simplicity, we will assume that, while this marginal value per barrel of oil will grow over time, the present value of the marginal value will remain unchanged at $12 per barrel. If we do not make this assumption, we will have to estimate the present value of the oil that will be extracted over the extraction period.

[9] In this example, we assume that the only uncertainty is in the price of oil, and the variance therefore becomes the variance in *ln*(oil prices).

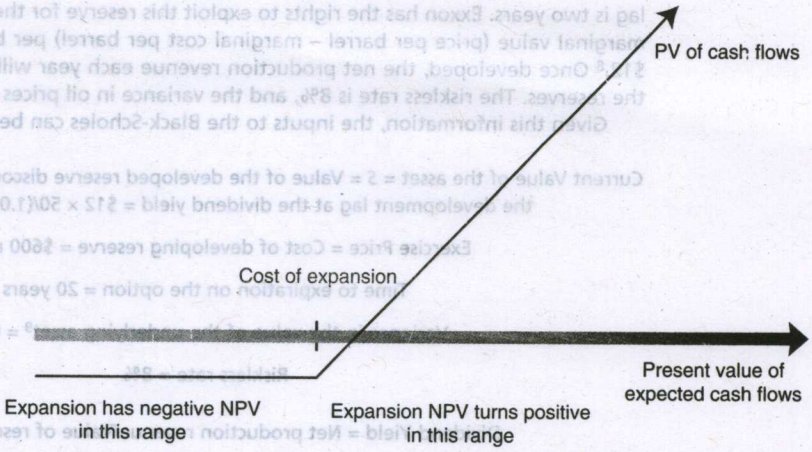


Figure 27.6 The Option to Expand a Project

future investment. Finally, the firm cannot move forward on this future investment if it does not take the initial project. This scenario implies the option payoffs shown in Figure 27.6

As you can see, at the expiration of the fixed time horizon, the firm will expand into the new project if the present value of the expected cash flows at that point in time exceeds the cost of expansion.

In Practice 27.4: Valuing an Option to Expand: The Home Depot, France

Assume that The Home Depot is considering opening a small store in France. The store will cost 100 million French francs (FF) to build, and the present value of the expected cash flows from the store is 120 million FF. Thus, by itself, the store has a negative NPV of 20 million FF.

Assume, however, that by opening this store, The Home Depot will acquire the option to expand its operations any time over the next five years. The cost of expansion will be 200 million FF, and it will be undertaken only if the present value of the expected cash flows from expansion exceeds 200 million FF. At the moment, this present value is believed to be only 150 million FF. The Home Depot still does not know much about the market for home-improvement products in France, and there is considerable uncertainty about this estimate. The variance in the estimate is 0.08.

The value of the option to expand can now be estimated, using the inputs to the option pricing model:

Value of the Underlying Asset (S) = PV of Cash Flows from Expansion, if done now = 150 million FF

Strike Price (K) = Cost of Expansion = 200 million FF

Variance in Underlying Asset's Value = 0.08

Time to expiration = Period for which expansion option applies = 5 years

Assume that the five-year riskless rate is 6%. The value of the option can be estimated as follows:

$$\text{Call Value} = 150\,(0.6314) - 200\exp^{(-0.06)(20)}\,(0.3833) = 37.91 \text{ million FF}$$

This value can be added on to the net present value of the original project under consideration.

NPV of Store = 80 million FF – 100 million FF = –20 million
Value of Option to Expand = 37.91 million FF
NPV of store with option to expand = –20 million + 37.91 million = 17.91 mil FF

The Home Depot should open the new store in France, even though it has a negative net present value, because it acquires an option of much greater value as a consequence.

Spreadsheet

***expand.xls* allows you to estimate the value of the option to expand a project to cover new markets or new products.**

Problems in Valuing the Option to Expand The practical considerations associated with estimating the value of the option to expand are similar to those associated with valuing the option to delay. In most cases, firms with options to expand have no specific time horizon by which they have to make an expansion decision, making these open-ended options, or, at best, options with arbitrary lives. Even when a life can be estimated for the option, neither the size nor the potential market for the product may be known, and estimating either can be problematic. To illustrate, consider The Home Depot example discussed earlier. Although we adopted a period of five years, at the end of which The Home Depot has to decide one way or another on its future expansion in France, it is entirely possible that this time frame is not specified at the time the store is opened. Futhermore, we have assumed that both the cost and the present value of expansion are known at the time of the initial investment. In reality, the firm may not have good estimates for either input before opening the first store, since it does not have much information on the underlying market.

Extensions and Implications of Expansion Options Firms can use the option to expand to rationalize investing in projects that have negative net present values but provide significant opportunities to enter new markets or to sell new products. The option pricing approach adds rigor to this argument by estimating the value of this option, and it also provides insight into those occasions when it is most valuable. The option to expand is more valuable for more volatile businesses with higher returns on projects (such as biotechnology or computer software) than it is for stable businesses with lower returns (such as automobile production). We will consider three cases where the expansion option may yield useful insights — strategic considerations in acquisitions, research and development expenses, and multistage projects.

Strategic Considerations in Acquisitions. In many acquisitions or investments, the acquiring firm believes that the transaction will give it competitive advantages in the future. These competitive advantages include:

- *Entry into a large or growing market:* An investment or acquisition may allow the firm to enter a large or potentially large market much sooner than it otherwise would have been able to do so. A good example is the acquisition of a Mexican retail firm by a U.S. firm, with the intent of expanding into the Mexican market.
- *Technological expertise:* In some cases, the acquisition is motivated by the desire to acquire a proprietary technology, which will allow the acquirer to either expand its existing market or enter a new market.
- *Brand name:* Firms sometime pay large premiums over market price to acquire firms with valuable brand names because they believe that these brand names can be used for expansion into new markets in the future.

Although all of these potential advantages may be used to justify large acquisition premiums, not all of them create valuable options. Even if these advantages can be viewed

as valuable expansion options, the value has to be greater than the acquisition premium for stockholders to gain.

Research, Development, and Test Market Expenses. Firms that spend considerable amounts of money on research and development and test marketing are often stymied when they try to evaluate these expenses, since the payoffs are in terms of future projects. At the same time, there is the very real possibility that after the money has been spent, the products or projects may not turn out to be viable. Consequently, the expenditure must be treated as a sunk cost. In fact, R&D has the characteristics of a call option — the amount spent on the R&D is the cost of the call option, and the projects or products that might emerge from the research provide the payoffs on the options. If these products are viable (i.e., the present value of the cash inflows exceeds the needed investment), the payoff is the difference between the two. If not, the project will not be accepted, and the payoff will be zero.

Several logical implications emerge from this view of R&D. First, research expenditures should provide much higher value for firms that are in volatile businesses, since the variance in product or project cash flows is positively correlated with the value of the call option. Thus, Minnesota Mining and Manufacturing (3M), which expends a substantial amount on R&D on basic office products, such as the Post-it pad, should receive less value[10] for its research than does Amgen, whose research primarily concerns biotechnology products. Second, the value of research and the optimal amount to be spent on research will change over time as businesses mature. The best example is the pharmaceutical industry. Pharmaceutical companies spent most of the 1980s investing substantial amounts in research and earning high returns on new products, as health care costs expanded. In the 1990s, however, as health care costs started leveling off and the business matured, many of these companies found that they were not getting the same payoffs on research and started cutting back. Some companies moved research dollars from conventional drugs to biotechnology products, where uncertainty about future cash flows remains high.

✔ ***CC 27.3:*** **This option-based approach presupposes that the research is applied and directed toward finding commercial products. Would the same arguments apply for basic research (such as the research done at universities) which are not directed toward commercial products? Why or why not?**

Multistage Projects/Investments. When entering new businesses or taking new investments, firms sometimes have the option to move in stages. While doing so may reduce potential upside, it also protects the firm against downside risk by allowing it at each stage to gauge demand and decide whether to go on to the next stage. In other words, a standard project can be recast as a series of options to expand, with each option being dependent on the previous one. Two propositions follow:

- Some projects that are unattractive on a full investment basis may be value creating if the firm can invest in stages.

[10] This statement is based on the assumption that the quality of research is the same at both firms, though the research is in different businesses, and that the only difference is in the volatility of the underlying businesses.

- Some projects that look attractive on a full investment basis may become even more attractive if taken in stages.

The gain in value from the options created by multistage investments has to be weighed against the cost. Taking investments in stages may allow competitors who decide to enter the market on a full scale to capture the market. It may also lead to higher costs at each stage, since the firm is not taking full advantage of economies of scale.

Several implications emerge from viewing this choice between multistage and one-time investments in an option framework. The projects in which the gains will be largest from making the investment in multiple stages include:

- Projects in which there are *significant barriers to entry to competitors* entering the market and taking advantage of delays in full-scale production: Thus, a firm with a patent on a product or other legal protection against competition pays a much smaller price for starting small and expanding as it learns more about the market.
- Projects in which there is *uncertainty about the size of the market* and the eventual success of the project. Here, starting small and expanding in stages allow the firm to reduce its losses if the product does not sell as well as anticipated and to learn more about the market at each stage. This information can be useful in both product design and marketing in subsequent stages.
- Projects in which there is a *substantial investment needed in infrastructure* and high operating leverage (fixed costs). Since the savings from doing a project in multiple stages can be traced to the investments needed at each stage, the benefit is likely to be greater in firms where those costs are large. Capital-intensive projects as well as projects that require large initial marketing expenses (a new brand-name product for a consumer product company), for example, will gain more from the options created by investing in the projects in multiple stages.

When Are Delay and Expansion Options Valuable?

The argument that some or many investments have valuable strategic or expansion options embedded in them has great allure, but a danger arises that this argument can be used to justify poor investments. In fact, acquirers have long justified huge premiums on acquisitions on synergistic and strategic grounds. We need to be more rigorous in our measurement of the value of real options and in our use of real options as justification for paying high prices or making poor investments.

Quantitative Estimation When real options are used to justify a decision, the justification has to be in more than qualitative terms. In other words, managers who favor investing in a project with poor returns or paying a premium on an acquisition on the basis of the real options generated by this investment should be required to value these real options and show that the economic benefits exceed the costs. Two arguments are often made against this requirement. The first is that real options cannot be easily valued, since the inputs are difficult to obtain and often noisy. The second is that the inputs to option pricing models can be easily manipulated to back up whatever the conclusion might be. Although both arguments have some basis, an estimate is better than no estimate at all, and the process of trying to estimate the value of a real option is the first step to understanding what drives its value.

Tests for Expansion Option to Have Value Not all investments have options embedded in them, and not all options, even if they do exist, have value. To assess whether an investment creates valuable options that need to be analyzed and valued, we need to answer three key questions.

1. *Is the first investment a prerequisite for the later investment/expansion? If not, how necessary is the first investment for the later investment/expansion?* Consider our earlier analysis of the value of a patent or the value of an undeveloped oil reserve as options. A firm cannot generate patents without investing in research or paying another firm for the patents, and it cannot get rights to an undeveloped oil reserve without bidding on it at a government auction or buying it from another oil company. Clearly, the initial investment here (spending on R&D, bidding at the auction) is required for the firm to have the second investment. Now consider The Home Depot investment in a French store and the option to expand into the French market later. The initial store investment provides The Home Depot with information about market potential, without which presumably it is unwilling to expand into the larger market. Unlike the patent and undeveloped reserves examples, the initial investment is not a prerequisite for the second, though management might view it as such. The connection gets even weaker, and the option value lower, when we look at one firm acquiring another to have the option to be able to enter a large market. Acquiring an Internet service provider to have a foothold in the Internet retailing market or buying a Brazilian brewery to preserve the option to enter the Brazilian beer market would be examples.
2. *Does the firm have an exclusive right to the later investment/expansion? If not, does the initial investment provide the firm with significant competitive advantages on subsequent investments?* The value of the option ultimately derives not from the cash flows generated by the second and subsequent investments but from the excess returns generated by these cash flows. The greater the potential for excess returns on the second investment, the greater the value of the expansion option in the first investment. The potential for excess returns is closely tied to how much of a competitive advantage the first investment provides the firm when it takes subsequent investments. At one extreme, again, consider investing in research and development to acquire a patent. The patent gives the firm that owns it the exclusive right to produce that product and, if the market potential is large, the right to the excess returns from the project. At the other extreme, the firm might get no competitive advantages on subsequent investments, in which case it is questionable as to whether there can be any excess returns on these investments. In reality, most investments will fall in the continuum between these two extremes, with greater competitive advantages being associated with higher excess returns and larger option values.
3. *How sustainable are the competitive advantages?* In a competitive marketplace, excess returns attract competitors, and competition drives out excess returns. The more sustainable the competitive advantages possessed by a firm, the greater will be the value of the options embedded in the initial investment. The sustainability of competitive advantages is a function of two forces. The first is the *nature of the competition;* other things remaining equal, competitive advantages fade much more quickly in sectors where there are aggressive competitors. The second is the *nature of the competitive advantage.* If the resource controlled by the firm is finite and scarce (as is the case with natural resource reserves and vacant land), the competitive advantage is likely to be sustainable for longer periods. Alternatively, if the competitive advantage comes from being the first mover in a market or from having technological expertise, it will come under assault far sooner. The most direct way of reflecting

this competitive advantage in the value of the option is its life; the life of the option can be set to the period of competitive advantage, and only the excess returns earned over this period counts towards the value of the option.

If the first investment is necessary to get to the second investment and there are large and sustainable returns, then the option to expand can be valuable.

The Option to Abandon a Project

When investing in new projects, firms worry about the risk that the investment will not pay off and that actual cash flows will not measure up to expectations. Having the option to abandon a project that does not pay off can be valuable, especially on projects with a significant potential for losses. In this section, we examine the value of the option to abandon and its determinants.

The Payoff on the Option to Abandon The option pricing approach provides a general way of estimating and building in the value of abandonment. To illustrate, assume that V is the remaining value on a project if it continues to the end of its life, and L is the liquidation or abandonment value for the same project at the same point in time. If the project has a remaining life of n years, the value of continuing the project can be compared to the liquidation (abandonment) value. If the value from continuing is higher, the project should be continued; if the value of abandonment is higher, the holder of the abandonment option can consider abandoning the project. The payoffs can be written as:

$$\begin{aligned} \text{Payoff from owning an abandonment option} &= 0 && \text{if } V > L \\ &= L - V && \text{if } V \leq L \end{aligned}$$

These payoffs are graphed in Figure 27.7, as a function of the expected stock price. Unlike the prior two cases, the option to abandon takes on the characteristics of a put option.

In Practice 27.5: Valuing an Option to Abandon

Assume that The Home Depot is considering a new store that requires a net initial investment of $9.5 million and generates cash flows with a present value of $8.563 million. The net present value of –$937,287 would lead us to reject this project. To illustrate the effect

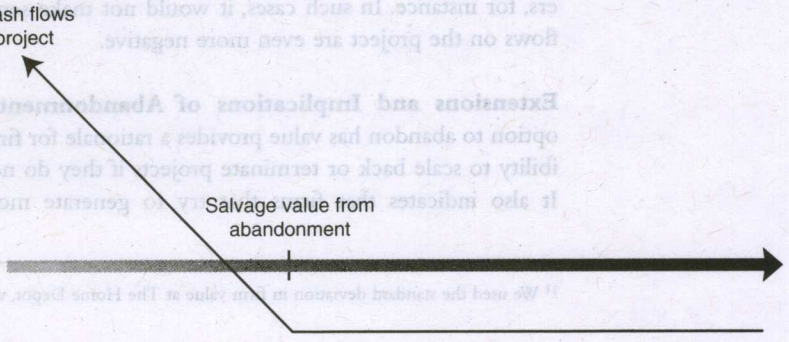


Figure 27.7 The Option to Abandon a Project

of the option to abandon, assume that The Home Depot has the option to close the store any time over the next 10 years and sell the land back to the original owner for $5 million. In addition, assume that the standard deviation[11] in the present value of the cash flows is 22%.

The value of the abandonment option can be estimated by determining the characteristics of the put option:

Value of the Underlying Asset (*S*) = PV of Cash Flows from Project
= $ 8,562,713

Strike Price (*K*) = Salvage Value from Abandonment = $5 million

Variance in Underlying Asset's Value = $0.22^2 = 0.0484$

Time to expiration = Life of the Project = 10 years

Dividend Yield = 1/Life of the Project = 1/10 = 0.10 (We are assuming that the project's present value will drop by roughly 1/*n* each year into the project.)

Assume that the ten-year riskless rate is 5%. The value of the put option can be estimated as follows:

$$\text{Value of Put} = 5{,}000{,}000 \exp^{(-0.05)(10)} (1 - 0.4977) - 8{,}562{,}713 \exp^{(-0.10)(10)} (1 - 0.7548)$$
$$= \$474{,}831$$

The value of this abandonment option has to be added to the net present value of the project of –$937,287, yielding a total net present value that remains negative.

NPV without abandonment option = –$937,287

Value of abandonment option = +$474,831

NPV with abandonment option = –$462,456

Although the abandonment option has value, it does not compensate for the negative net present value of the investment.

Spreadsheet

***abandon.xls* allows you to estimate the value of the option to abandon an investment.**

Problems in Valuing the Option to Abandon In In Practice 27.5 we assumed, rather unrealistically, that the abandonment value was clearly specified and did not change during the life of the project. This may be true in some very specific cases in which an abandonment option is built into the contract. More often, however, the firm has the option to abandon, and the salvage value from abaondoning can only be estimated. Furthermore, the abandonment value may change over the life of the project, making it difficult to apply traditional option pricing techniques. Finally, it is entirely possible that abandoning a project may not bring in a liquidation value but may create costs instead. A manufacturing firm may have to pay severance to its workers, for instance. In such cases, it would not make sense to abandon, unless the cash flows on the project are even more negative.

Extensions and Implications of Abandonment Option The fact that the option to abandon has value provides a rationale for firms to build the operating flexibility to scale back or terminate projects if they do not measure up to expectations. It also indicates that firms that try to generate more revenues by offering their

[11] We used the standard deviation in firm value at The Home Depot, which was 22% between 1993 and 1998.

customers the option to walk away from commitments will have to weigh the higher revenues against the cost of the options that have been granted to these customers.

The first and most direct way of creating an abandonment option is to build operating flexibility contractually with other parties that are involved in a project. Thus, contracts with suppliers may be written on an annual basis rather than be long term, and employees may be hired on a temporary basis rather than permanently. The physical plant used for a project may be leased on a short-term basis rather than bought, and the financial investment may be made in stages rather than as an initial lump sum. Although there is a cost to building in this flexibility, the gains may be much larger, especially in volatile businesses.

On the other side of the transaction, offering abandonment options to customers and partners in joint ventures can have a negative impact on value. As an example, assume that a firm that sells its products on a multiyear contract basis offers customers the option to cancel the contract at any time. While this system may increase sales, the cost is likely to be substantial. In the event of a recession, firms that are unable to meet their obligations are likely to cancel their contracts. Any benefits gained by the initial sale (obtained by offering the inducement of cancellation by the buyer) may be offset by the cost of the option provided to customers.

CT 27.2: A firm that is considering a new project with a net present value of –$100 million decides to invest in it because is provides it with expansion options. Under what conditions do you think this is reasonable? When is it not?

Option Applications in Valuation

In traditional discounted cash flow models, a firm is valued by estimating cash flows over a long time horizon (often an infinite period) and discounting the cash flows back at a discount rate that reflects the riskiness of the cash flows. The value of equity is obtained by subtracting the value of debt from firm value. There are at least three scenarios in which the discounted cash flow approach will underestimate the value of equity in a firm. The first occurs when a firm gets a significant portion of its value from patents or licenses; as we noted in the earlier section, a patent can be viewed as an option on the underlying product. The second occurs when a natural resource firm has undeveloped reserves; if an individual gold or oil reserve can be viewed as an option on the underlying resource, a firm's collective undeveloped reserves will be worth more than its discounted cash flow value. In the third scenario, a firm has negative earnings and large liabilities. The option to liquidate the firm possessed by equity investors, in conjunction with limited liability, can give equity value to troubled firms that exceeds their discounted cash flow value.

Valuing Firms with Patents or Licenses

In the last section, we valued a patent as an option. By extension, then, a firm that derives a large proportion of its value from patents or licenses can be valued, at least partially, using option pricing models. Telecommunication firms like Lucent and Cisco, pharmaceutical firms such as Merck and Pfizer, and biotechnology firms like Amgen are good examples. To use option pricing to value such firms, we have to value them in three parts:

- *Patents that have already been commercially developed and are producing cash flows for the firm currently:* These patents are not options and should be valued based on their expected cash flows and discounted present value.
- *Patents the firm owns but has not commercially developed yet:* These patents are options and should be valued as such. The option value will be greater than the present value of the expected cash flows from developing these patents today.
- *Patents the firm expects to generate in the future:* This is the most difficult part of the valuation. Firms have ongoing research and can expect to generate patents in the future. To the extent that these future patents will have value in excess of the cost of generating these patents (the cost of R&D), they will add to the value of the firm.

In summary, the value of a firm with patents can be estimated as the sum of the three components:

Value of Firm = Discounted Cash Flow Value of developed patents
+ Option Value of patents owned but not developed yet
+ (Option Value of patents that will be generated in the future
– R&D Cost of developing these patents)

The first of these components can be valued fairly easily by looking at the current cash flows generated, and the second can be valued with some access to information about potential markets and likely costs. The third component, however, will be difficult to measure. If we assume that the cost of generating the patents will be equal to the value created by them, we can ignore it. Firms such as Pfizer and Cisco that have a track record of efficient research, where efficiency is defined as the capacity to generate value in excess of costs, can gain substantial value from the third component. On the other hand, firms that spend significant amounts on R&D and generate few or no valuable patents from the research can destroy value.

In practice, firms are seldom valued using this approach. Instead, they are valued using either discounted cash flow models or relative to other firms in the same business. Does that imply that they are undervalued because the option value of patents is not being explicitly considered? Not necessarily. In discounted cash flows models, we often compensate by allowing firms with valuable patents and efficient research operations to maintain higher growth and earn larger excess returns than their competitors and, in relative valuation, by allowing these firms to command higher multiples of earnings and revenues. If we decide to incorporate the option value of patents into value, we have to make sure that we do not continue to assume high growth and excess returns since that would be double counting the value of patents.

Valuing Natural Resource Firms

We valued a gold reserve and an oil reserve in the last section as options. A natural resource firm with substantial undeveloped reserves can be valued using the same principle. Like firms with patents, natural resource firms can be evaluated in three parts:

- We can estimate the value of the developed reserves based on the expected cash flows from these reserves. Since developed reserves are usually finite, the expected cash flows from this component will also last for a limited period.

- We can value the undeveloped reserves owned by the firm today, on the other hand, as options. To value these reserves precisely, we should value each reserve separately and aggregate the values. A shortcut that will deliver an approximate value[12] is to value the undeveloped reserves collectively as one option.
- The exploration costs incurred by natural resource firms can be expected to generate more reserves in the future. The value of these expected future reserves has to be offset by the cost of generating these reserves.

We can write the value of a natural resource firm as:

$$\begin{aligned}\text{Value of Firm} = {} & \text{Discounted Cash Flow Value of Developed Reserves} \\ & + \text{Option Value of Undeveloped Reserves} \\ & + (\text{Option Value of Expected Future Reserves} - \text{Cost of} \\ & \quad \text{Exploration to generate these reserves})\end{aligned}$$

Firms that are efficient in generating new reserves, where efficiency indicates that the value of the reserves generated exceeds the exploration cost, will get value from the third component. If the cost of generating the reserves is equal to the value of the reserves, the third component will have no effect on value. If the firm expends more on exploration than it receives in value from generated reserves, the third component can destroy value.

Valuing Equity in Troubled Firms

In most publicly traded firms, equity has two features. The first is that the equity investors run the firm and can choose to liquidate its assets and pay off other claim holders at any time. The second is that the liability of equity investors in some private firms and almost all publicly traded firms is restricted to their equity investments in these firms. This combination of the option to liquidate and limited liability allows equity to have the features of a call option. In firms with substantial liabilities and negative earnings, the option value of equity may be in excess of the discounted cash flow value.

The Payoff on Equity as an Option The equity in a firm is a residual claim; that is, equity holders lay claim to all cash flows left after other financial claim holders (debt, preferred stock, etc.) have been satisfied. If a firm is liquidated, the same principle applies; equity investors receive the cash that is left in the firm after all outstanding debt and other financial claims have been paid off. With limited liability, if the value of the firm is less than the value of the outstanding debt, equity investors cannot lose more than their investment in the firm. The payoff to equity investors on liquidation can therefore be written as:

$$\begin{aligned}\text{Payoff to equity on liquidation} &= V - D \qquad \text{if } V > D \\ &= 0 \qquad\qquad\quad \text{if } V \leq D\end{aligned}$$

[12] It is approximate because an option on a portfolio of assets is worth less than a portfolio of options on the same assets. In other words, an option on the S&P 500 will be worth less than a portfolio of equivalent options on each of the 500 stocks.

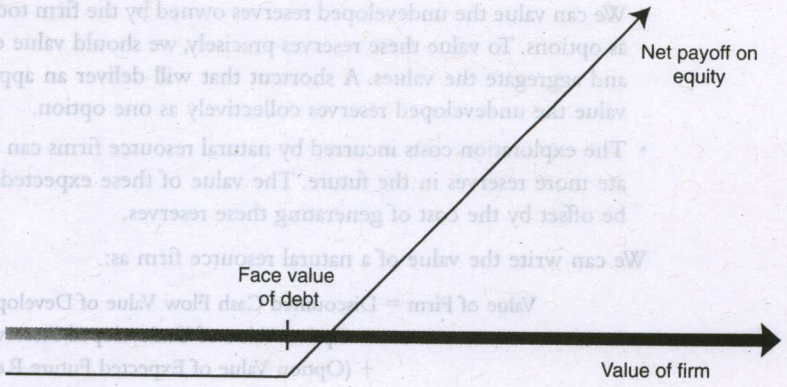


Figure 27.8 Payoff on Equity as Option on a Firm

where

V = Liquidation Value of the firm

D = Face Value of the outstanding debt and other external claims

Equity can thus be viewed as a call option on the firm, where exercising the option requires that the firm be liquidated and the face value of the debt (which corresponds to the exercise price) be paid off. The firm is the underlying asset, and the option expires when the debt comes due. The payoffs are shown in Figure 27.8.

In Practice 27.6: Valuing Equity as an Option

Assume that you are valuing the equity in a firm whose assets are currently valued at $100 million; the standard deviation in this asset value is 40%. The face value of debt is $80 million. (It is zero-coupon debt with 10 years left to maturity.) The 10-year treasury bond rate is 10%. We can value equity as a call option on the firm, using the following inputs for the option pricing model:

Value of the underlying assets = S = Value of the firm = $100 million

Exercise price = K = Face value of outstanding debt = $80 million

Life of the option = t = Life of zero-coupon debt = 10 years

Variance in the value of the underlying asset = σ^2 = Variance in firm value = 0.16

Riskless rate = r = Treasury bond rate corresponding to option life = 10%

Based on these inputs, the Black-Scholes model provides the following value for the call:

$d_1 = 1.5994$ $N(d_1) = 0.9451$

$d_2 = 0.3345$ $N(d_2) = 0.6310$

Value of the call = $100 (0.9451) - 80 \exp^{(-0.10)(10)} (0.6310) = \$75.94$ million

Since the call value represents the value of equity and the firm value is $100 million, the estimated value of the outstanding debt is:

Value of the outstanding debt = $100 - $75.94 = $24.06 million

The debt is a 10-year zero-coupon bond, and the market interest rate on the bond is:

Interest rate on debt = $(\$80/\$24.06)^{1/10} - 1 = 12.77\%$

Thus, the default spread on this bond should be 2.77%.

Implications of Viewing Equity as an Option The first implication of viewing equity as a call option is that equity will have value, even if the value of the firm falls well below the face value of the outstanding debt. Although the firm will be viewed as troubled by investors, accountants, and analysts, its equity is not worthless. Just as deep out-of-the-money traded options command value because of the possibility that the value of the underlying asset may increase above the strike price in the remaining lifetime of the option, equity commands value because of the time premium on the option (the time until the bonds mature and come due) and the possibility that the value of the assets may increase above the face value of the bonds before they come due.

Revisiting the preceding example, assume that the value of the firm drops to $50 million, below the face value of the outstanding debt ($80 million). Assume that all the other inputs remain unchanged. The parameters of equity as a call option are as follows:

Value of the underlying asset = S = Value of the firm = $50 million
Exercise price = K = Face value of outstanding debt = $80 million
Life of the option = t = Life of zero-coupon debt = 10 years
Variance in the value of the underlying asset = σ^2 = Variance in firm value = 0.16
Riskless rate = r = Treasury bond rate corresponding to option life = 10%

Based on these inputs, the Black-Scholes model provides the following value for the call:

$$d_1 = 1.0515 \qquad N(d_1) = 0.8534$$

$$d_2 = -0.2135 \qquad N(d_2) = 0.4155$$

$$\text{Value of the call (equity)} = 50\ (0.8534) - 80\ \exp^{(-0.10)(10)}\ (0.4155) = \$30.44 \text{ million}$$

$$\text{Value of the bond} = \$50 - \$30.44 = \$19.56 \text{ million}$$

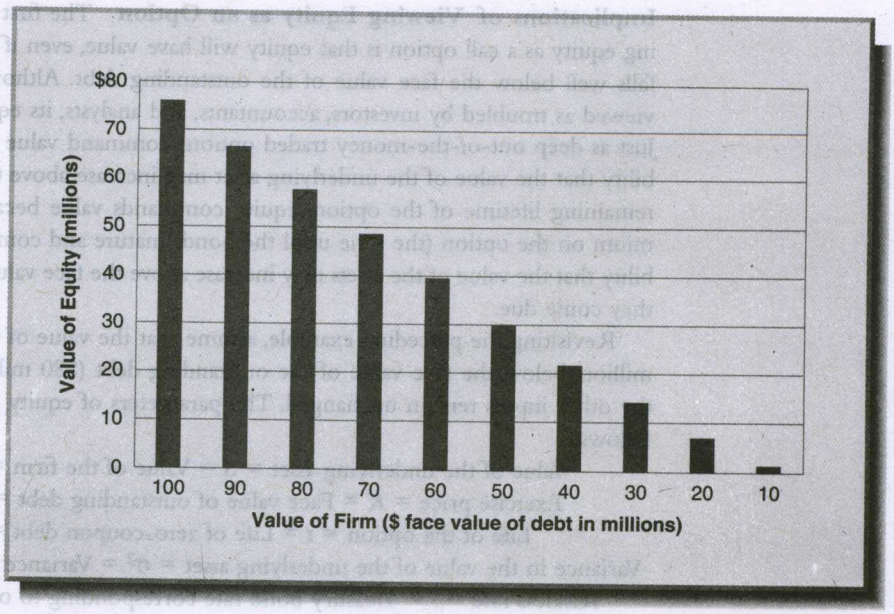
As you can see, the equity in this firm retains value because of the option characteristics of equity. Equity continues to have value in this example even if the firm value drops to $10 million or below, as shown in Figure 27.9.

Estimating the Value of Equity as an Option The examples we have used thus far to illustrate the application of option pricing to value equity have included some simplifying assumptions. Among them are the following:

1. There are only two claim holders in the firm — debt and equity.
2. There is only one issue of debt outstanding, and it can be retired at face value.
3. The debt has a zero coupon and no special features (convertibility, put clauses etc.).
4. The value of the firm and the variance in that value can be estimated.

Each of these assumptions is made for a reason. First, by restricting the claim holders to just debt and equity, we make the problem more tractable; introducing other claim holders such as preferred stock makes it more difficult to arrive at a result, though not impossible. Second, by assuming only one zero-coupon debt issue that can be retired at face value any time prior to maturity, we align the features of the debt more closely to the features of the strike price on a standard option. Third, if the debt is coupon debt, or more than one debt issue is outstanding, the equity investors can be forced to

Figure 27.9 Value of Equity as Firm Value Changes



exercise (liquidate the firm) at these earlier coupon dates if they do not have the cash flows to meet their coupon obligations.

Finally, knowing the value of the firm and the variance in that value makes the option pricing possible, but it also raises an interesting question about the usefulness of option pricing in equity valuation. If the bonds of the firm are publicly traded, the market value of the debt can be subtracted from the value of the firm to obtain the value of equity much more directly. The option pricing approach does have its advantages, however. Specifically, when the debt of a firm is not publicly traded, option pricing theory can provide an estimate of value for the equity in the firm. Even when the debt is publicly traded, the bonds may not be correctly valued, and the option pricing framework can be useful in evaluating the values of debt and equity. Finally, relating the values of debt and equity to the variance in firm value provides some insight into the redistributive effects of the firm's actions.

✔ ***CC 27.4:*** **In In Practice 27.6, the debt outstanding took the form of 10-year zero-coupon bonds. Would the value of equity as an option increase or decrease if the bonds had been 10-year coupon bonds?**

Inputs for Valuing Equity as an Option Since most firms do not fall into the neat framework developed above (such as having only one zero-coupon bond outstanding), we have to make some compromises to use this model in valuation.

We can obtain the value of the firm in one of three ways. In the first, we cumulate the market values of outstanding debt and equity, assuming that all debt and equity are traded, to obtain firm value. The option pricing model then reallocates the firm value between debt and equity. This approach, though simple, is internally inconsistent. We start with one set of market values for debt and equity, and, using the option pricing model, we end up with entirely different values for each.

In the second, we estimate the market values of the firm's assets by discounting expected cash flows at the cost of capital. The one consideration that we need to keep in mind is that the value of the firm in an option pricing model should be the value obtained on liquidation. This may be less than the total firm value, which includes expected future investments, and it may also be reduced to reflect the cost of liquidation. If we estimate the firm value using a discounted cash flow model, this would suggest that we should consider only existing investments[13] while estimating firm value.

We can use the third approach for firms that have separable assets that are individually traded. For example, we can value a troubled real estate firm that owns five properties by valuing each property separately and then aggregating the values.

We can obtain the variance in firm value directly if both stocks and bonds in the firm are traded. Defining σ_e^2 as the variance in the stock price and σ_d^2 as the variance in the bond price, w_e as the market value weight of equity, and w_d as the market value weight of debt, we can write the variance in firm value as[14]

$$\sigma^2_{\text{firm}} = w_e^2 \sigma_e^2 + w_d^2 \sigma_d^2 + 2 w_e w_d \rho_{ed} \sigma_e \sigma_d$$

where ρ_{ed} is the correlation between the stock and the bond prices. When the bonds of the firm are not traded, we can use the variance of similarly rated bonds as the estimate of σ_d^2 and the correlation between similarly rated bonds and the firm's stock as the estimate of ρ_{ed}.

When companies get into financial trouble, this approach can yield misleading results as both its stock prices and its bond prices become more volatile. An alternative that often yields more reliable estimates is to use the average variance in firm value for other firms in the sector. Thus, the value of equity in a deeply troubled steel company can be estimated using the average variance in firm value of all traded steel companies.

Most firms have more than one debt issue on their books, and much of the debt comes with coupons. Since the option pricing model permit only one input for the time to expiration, we have to convert these multiple bonds issues and coupon payments into one equivalent zero-coupon bond. One solution, which takes into account both the coupon payments and the maturity of the bonds, is to estimate the duration of each debt issue and calculate a face-value-weighted average of the duration of the different issues. This value-weighted duration is then used as a measure of the time to expiration of the option.

When firms have more than one debt issue on their books, the face value of debt that is used has to include all the principal outstanding on the debt. To stay consistent with the notion of converting all debt into the equivalent of a zero-coupon bond, it makes sense to cumulate expected nominal coupon (or interest) payments[15] on the debt over its lifetime and add the sum to the face value of debt.

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[13] Technically, this can be done by putting the firm into stable growth and valuing it as a stable-growth firm, where reinvestments are used to either preserve or augment existing assets.

[14] This is an extension of the variance formula for a two-asset portfolio, introduced in Chapter 6.

[15] If we do not cumulate the coupons and add them to the face value, we will tend to understate the value of the debt.

In Practice 27.7: Valuing Equity as an Option — Eurotunnel

Eurotunnel was the firm that was created to build and ultimately profit from the tunnel under the English Channel, linking England and France. Although the tunnel was readied for operations in the early 1990s, it was never a commercial success and reported significant losses each year after opening. In early 1998, Eurotunnel had a book value of equity of –£117 million, and in 1997, the firm had reported earnings before interest and taxes of –£56 million and net income of –£685 million. By any measure, it was a firm in financial trouble.

Much of the financing for the tunnel had come from debt, and at the end of 1997 Eurotunnel had debt obligations in excess of £8,000 million, including expected coupon payments. The following table summarizes the outstanding debt at the firm, with our estimates of the expected duration for each class of debt:

Table 27.1 Debt Breakdown for Eurotunnel

Debt Type	Face Value (including cumulated coupons)[a]	Duration (years)
Short term	£935	0.50
10 year	£2435	6.7
20 year	£3555	12.6
Longer	£1940	18.2
Total	£8,865	10.93

[a] In millions.

The firm's only significant asset is its ownership of the tunnel, and we estimated the value of this asset from its expected cash flows and the appropriate cost of capital. The assumptions we made were as follows:

1. Revenues will grow 5% a year in perpetuity.
2. The cost of goods sold (COGS), which was 85% of revenues in 1997, will drop to 65% of revenues by 2002 and stay at that level.
3. Capital spending and depreciation will grow 5% a year in perpetuity.
4. There are no working capital requirements.
5. The debt ratio, which was 95.35% at the end of 1997, will drop to 70% by 2002. The cost of debt is 10% for the next five years and 8% after that.
6. The beta for the stock will be 1.10 for the next five years and drop to 0.8 thereafter (as the leverage decreases).

The long-term bond rate at the time of the valuation was 6% and the risk permium used is 5.5%. Based on these assumptions, we estimated the cash flows in Table 27.2. (For simplicity, we assumed that the firm would get a tax credit from its operaing losses. In reality, these would be carried forward into the future.)

Table 27.2 Estimated FCFF: Eurotunnel

	1	2	3	4	5
Revenues	470	494	519	545	572
– COGS	400	395	389	381	372
– Depreciation	141	145	150	154	159
EBIT	(71)	(47)	(20)	9	41
– EBIT*t	(25)	(16)	(7)	3	14
EBIT (1 – *t*)	(46)	(30)	(13)	6	27
+ Depreciation	141	145	150	154	159
– Capital Spending	46	48	49	51	52
– Chg. Working Capital	0	0	0	0	0
Free CF to Firm	49	67	87	110	133
Terminal Value					2,710
Present Value	46	59	72	84	2,051

The value of the assets of the firm is £2,312 million.

The final input we estimated was the standard deviation in firm value. Since there are no directly comparable firms, we estimated the standard deviations in Eurotunnel stock and debt using the data over the previous years:

Standard deviation in Eurotunnel stock price (*ln*) = 41%

Standard deviation in Eurotunnel bond price (*ln*) = 17%

We also estimated a correlation of 0.50 between Eurotunnel stock and bond prices, and the average market debt to capital ratio during the two-year period was 85%. Combining these inputs, we estimated the standard deviation in firm value to be:

$$\sigma_{firm}^2 = (0.15)^2 (0.41)^2 + (0.85)^2 (0.17)^2 + 2 (0.15) (0.85)(0.5)(0.41)(0.17) = 0.0335$$

In summary, the inputs to the option pricing model were as follows:

Value of the underlying asset = S = Value of the firm = £2,312 million

Exercise price = K = Face value of outstanding debt = £8,865 mil

Life of the option = t = Weighted average duration of debt = 10.93 years

Variance in the value of the underlying asset = σ^2 = Variance in firm value = 0.0335

Riskless rate = r = Treasury bond rate corresponding to option life = 6%

Based on these inputs, we estimate the following value for the call:

$$d_1 = -0.8337 \quad N(d_1) = 0.2023$$
$$d_2 = -1.4392 \quad N(d_2) = 0.0751$$

$$\text{Value of the call} = 2{,}312\ (0.2023) - 8{,}865\ \exp^{(-0.06)(10.93)}\ (0.0751) = £122 \text{ million}$$

Eurotunnel's equity was trading at £150 million in 1997.

Spreadsheet

***equity.xls* allows you to estimate the value the equity in a troubled firm as an option.**

The option pricing framework, in addition to yielding a value for Eurotunnel equity, also yields some valuable insight into the drivers of value for this equity. While it is certainly important that the firm try to bring costs under control and increase operating margins, the two most critical variables determining equity value are the duration of the debt and the variance in firm value. Any action that increases (decreases) the debt duration will have a positive (negative) effect on equity value. For instance, when the French government put pressure on the bankers who had lent money to Eurotunnel to ease restrictions and allow the firm more time to repay its debt, equity investors benefited as their options became more long term. Similarly, an action that increases the volatility of expected firm value will increase the value of the option.

CT 27.3: Assume that you are valuing the equity in two firms with high leverage and negative earnings. One has very long-term debt, and the other has short-term debt. Which one would you expect to have more valuable equity? Why?

Option Pricing in Capital Structure and Dividend Policy Decisions

Option pricing theory can be applied to financing and dividend decisions in a number of ways. One is to illustrate the conflict between stockholders and bondholders when it comes to investment analysis and conglomerate mergers. A second is in the design and valuation of securities. A third is to examine the value of financial flexibility, a reason cited by firms that have excess debt capacity and large cash balances.

The Conflict between Bondholders and Stockholders

Stockholders and bondholders have different objective functions, and this can lead to agency problems whereby stockholders expropriate wealth from bondholders. The conflict can manifest itself in a number of ways. For instance, stockholders have an incentive to invest in riskier projects than bondholders and to pay more out in dividends than bondholders would like them to. The conflict between bondholders and stockholders can be illustrated dramatically using the option pricing methodology developed in the previous section.

Investing in Risky Projects Since equity is a call option on the value of the firm, other things remaining equal, an increase in the variance in the firm value will lead to an increase in the value of equity. It is therefore conceivable that stockholders can invest in risky projects with negative net present values, which, while making them better off, may make the bonds and the firm less valuable. To illustrate, consider the firm in In Practice 27.6 with a value of assets of \$100 million, a face value of zero-coupon 10-year debt of \$80 million, and a standard deviation in the value of the firm of 40%, which we valued in the earlier illustration. The equity and debt in this firm were valued as follows:

Value of Equity = \$75.94 million

Value of Debt = \$24.06 million

Value of Firm = \$100 million

Now assume that the stockholders have the opportunity to invest in a project with a net present value of –\$2 million; the project is a very risky one that will push up the standard deviation in firm value to 50%. The equity as a call option can then be valued using the following inputs:

Value of the underlying asset = S = Value of the firm = \$100 million – \$2 million = \$98 million (The value of the firm is lowered because of the negative net present value project.)

Exercise price = K = Face value of outstanding debt = \$80 million

Life of the option = t = Life of zero-coupon debt = 10 years

Variance in the value of the underlying asset = σ^2 = Variance in firm value = 0.25

Riskless rate = r = Treasury bond rate corresponding to option life = 10%

Based on these inputs, the Black-Scholes model provides the following value for the equity and debt in this firm.

Value of Equity = \$77.71

Value of Debt = \$20.29

Value of Firm = \$98.00

The value of equity rises from \$75.94 million to \$77.71 million, even though the firm value declines by \$2 million. The increase in equity value comes at the expense of bondholders, who find their wealth decline from \$24.06 million to \$20.19 million.

✔ ***CC 27.5:*** **Given this conflict between stockholder and bondholder interests, what type of covenants or restrictions would you put on the managers of firms in financial distress? What else would you try to do to reduce your exposure to a loss of wealth?**

Conglomerate Mergers Bondholders and stockholders may also be affected differently by conglomerate mergers, where the variance in earnings and cash flows of the combined firm can be expected to decline because the merging firms have earning streams that are not perfectly correlated. In these mergers, the value of the combined equity in the firm will decrease after the merger because of the decline in variance; consequently, bondholders will gain. Stockholders can reclaim some or all of this lost wealth by utilizing their higher debt capacity and issuing new debt. To illustrate, suppose you are provided with the following information on two firms, Lube & Auto (auto service) and Gianni Cosmetics (a cosmetics manufacturer), which hope to merge.

	Lube & Auto	*Gianni Cosmetics*	
Value of the firm	$100 million	$150 million	
Face value of debt	$80 million	$50 million	(Zero-coupon debt)
Maturity of debt	10 years	10 years	
Std. dev. in firm value	40 %	50 %	
Correlation between firm cash flows	0.4		

The 10-year bond rate is 10%.

We calculate the variance in the value of the firm after the acquisition as follows:

$$\begin{aligned}\text{Variance in combined firm value} &= w_1^2\,\sigma_1^2 + w_2^2\,\sigma_2^2 + 2\,w_1\,w_2\,\rho_{12}\,\sigma_1\,\sigma_2\\ &= (0.4)^2\,(0.16) + (0.6)^2\,(0.25) + 2\,(0.4)\,(0.6)\,(0.4)\,(0.4)\,(0.5)\\ &= 0.154\end{aligned}$$

We estimate the values of equity and debt in the individual firms and the combined firm using the option pricing model:

	Lube & Auto	*Gianni*	*Combined Firm*
Value of equity in the firm	$75.94	$134.47	$207.43
Value of debt in the firm	$24.06	$15.53	$42.57
Value of the firm	$100.00	$150.00	$250.00

The combined value of the equity prior to the merger is $210.41 million; it declines to $207.43 million after that. The wealth of the bondholders increases by an equal amount. As a consequence of the merger, there is a transfer of wealth from stockholders to bondholders. Thus, conglomerate mergers that are not followed by increases in leverage are likely to result in a wealth transfer from stockholders to bondholders.

Security Design and Valuation

In Chapter 20, we proposed that firms should try to match the cash flows on their financing as closely as possible to the cash flows on their assets. By doing so, they

reduce the likelihood of default risk and increase debt capacity. Combining options with straight bonds can sometimes allow a firm to accomplish this matching, as in the following cases:

- A **convertible bond** is a combination of a conversion option and a straight bond. Convertible bonds allow firms with high-growth potential, high volatility in earnings and cash flows, and low cash flows to borrow without exposing themselves to significant default risk.
- A **commodity bond,** which is a bond whose coupon rate is tied to commodity prices, is a combination of an option on a commodity (such as gold or oil) and a straight bond. Commodity firms whose earnings tend to move with commodity prices can gain by using these bonds
- A **catastrophe bond** allows for the suspension of coupon payments and/or the reduction of principal in the event of a specified catastrophe. For insurance companies, which are often exposed to large liabilities in the event of a catastrophe (such as an earthquake or a hurricane), it provides a relatively default risk-free approach to borrowing.

In each of these cases, options allow us to create customized securities and to value them.

Value of Financial Flexibility

When making financial decisions, managers consider the effects of such decisions on their capacity to make new investments or meet unanticipated contingencies in future periods. Practically, this translates into firms maintaining excess debt capacity or larger cash balances than are warranted by current needs to meet unexpected future requirements. While maintaining this financing flexibility has value to firms, it also has a cost; the large cash balances might earn below-market returns, and excess debt capacity implies that the firm is giving up some value and has a higher cost of capital.

Determinants of the Value of Financial Flexibility One reason that a firm maintains large cash balances and excess debt capacity is to have the option to take unexpected projects with high returns in the future. To value financial flexibility as an option, assume that a firm has expectations about how much it will need to reinvest in future periods, based on its own past history and current conditions in the industry. Assume also that a firm has expectations about how much it can raise from internal funds and its normal access to capital markets in future periods. There is uncertainty about future reinvestment needs. For simplicity, we will assume that the capacity to generate funds is known with certainty to the firm. The advantage (and value) of having excess debt capacity or large cash balances is that the firm can meet any reinvestment needs, in excess of funds available, using its debt capacity. The payoff from these projects, however, comes from the excess returns the firm expects to make on them. To value financial flexibility on an annualized basis, therefore, we will use the following measures:

Input to Model	Measure	Estimation Approach
S	Expected Annual Reinvestment Needs as percent of firm value	Use historical average of (Net Capital Expenditure + Change in Noncash Working Capital)/Market Value of Firm
K	Annual Reinvestment Needs as percent of firm value that can be raised without financing flexibility	If firm does not want to or cannot use external financing use (Net Income − Dividend + Depreciation)/Market Value of Firm If firm uses external capital (bank debt, bonds or equity) regularly use (Net Income + Depreciation + Net External Financing)/Market Value of Firm
σ^2	Variance in reinvestment needs	Variance in the reinvestment as percent of firm value (using historical data)
t	1 year	To get an annual estimate of the value of flexibility

In Practice 27.8: Valuing Financial Flexibility at The Home Depot

We estimated these inputs for The Home Depot, starting with the reinvestments as a percentage of firm value. The following table summarizes these numbers from 1989 to 1998:

Year	Reinvestment Needs	Firm Value	Reinvestment Needs as Percent of Firm Value	*ln*(Reinvestment Needs)
1989	$175	$2,758	6.35	−2.7563329
1990	374	3,815	9.80	−2.3224401
1991	427	5,137	8.31	−2.4874405
1992	456	7,148	6.38	−2.7520951
1993	927	9,239	10.03	−2.2992354
1994	1,176	12,477	9.43	−2.3617681
1995	1,344	15,470	8.69	−2.4432524
1996	1,086	19,535	5.56	−2.8897065
1997	1,589	24,156	6.58	−2.7214279
1998	1,817	30,219	6.01	−2.8112841

Average Reinvestment needs as % of Firm Value = 7.71%

Standard Deviation in *ln*(Reinvestment Needs) = 22.36%

We followed up by estimating internal funds as a percentage of firm value, using the sum of net income and depreciation as a measure of internal funds:

Year	Net Income	Depreciation	Firm Value	Internal Funds/Value (%)
1989	$112	$21	$2,758	4.82
1990	163	34	3,815	5.16
1991	249	52	5,137	5.86
1992	363	70	7,148	6.06
1993	457	90	9,239	5.92
1994	605	130	12,477	5.89
1995	732	181	15,470	5.90
1996	938	232	19,535	5.99
1997	1,160	283	24,156	5.97
1998	1,614	373	30,219	6.58

Spreadsheet

***finflex.xls* allows you to estimate the value of financial flexibility as an option.**

Internal funds, on average, were 5.82% of firm value between 1989 and 1998. Since the firm uses almost no external debt, the firm made up the difference between its reinvestment needs (7.71%) and internal fund generation (5.82%) by issuing equity. We will assume, looking forward, that The Home Depot will no longer issue new equity.

The Home Depot's current debt ratio is 4.55%, and its current cost of capital is 9.51%. From Chapter 19, we estimated its optimal debt ratio to be 20%, and its cost of capital at that debt level is 9.17%. Finally, The Home Depot in 1998 earned a return on capital of 16.37%; we will assume that this is the expected return on new projects as well.

S = Expected Reinvestment Needs as percent of Firm Value = 7.71%

K = Reinvestment needs that can be financed without flexibility = 5.82%

t = 1 year

σ^2 = Variance in *ln*(Net Capital Expenditures) = $(0.2237)^2$ = 0.05

With a risk-free rate of 6%, the option value that we estimate using these inputs is 0.02277. We then converted this option value into a measure of the value of financing flexibility by multiplying the value by the annual excess return on the new project and then assuming that the firm foregoes these excess returns forever[16]:

$$\text{Value of Flexibility} = 0.02277\ (\text{Return on Capital} - \text{Cost of Capital})/\text{Cost of Capital}$$
$$= 0.02277\ (0.1637 - 0.0951)/0.0951 = 1.6425\%$$

On an annual basis, the flexibility generated by the excess debt capacity is worth 1.6425% of firm value at The Home Depot, which is well in excess of the savings (9.51% – 9.17% = 0.34%) in the cost of capital that would be accomplished, if it used up the excess debt capacity.

The one final consideration here is that this estimate does not consider the fact that The Home Depot does not have unlimited financial flexibility. In fact, assume that excess debt capacity of The Home Depot (which is 15.45%, the difference between the optimal debt ratio and the current debt ratio) is the upside limit on financial flexibility. We can value the effect of this limit by valuing a call with the same parameters as the call described above, but with a strike price of 21.27% (15.45% + 5.82%) and subtracting this value from the value estimated above. In this case, the effect of imposing this constraint on the value of flexibility is negligible.

Implications of Financial Flexibility Option Looking at financial flexibility as an option yields valuable insights on when financial flexibility is most valuable. Using the approach developed above, for instance, we would argue that:

[16] We are assuming that the project that a firm is unable to take because it lacks financial flexibility is lost forever and that the excess returns on this project would also have lasted forever. Both assumptions are strong and may result in overstatement of the lost value.

- Other things remaining equal, firms operating in businesses where projects earn substantially higher returns than their hurdle rates should value flexibility more than those that operate in stable businesses where excess returns are small. This would imply that firms such as Microsoft and Dell, which earn large excess returns on their projects, can use the need for financial flexibility as justification for holding large cash balances and maintaining excess debt capacity.
- Since a firm's ability to fund these reinvestment needs is determined by its capacity to generate internal funds, other things remaining equal, financial flexibility should be worth less to firms with large and stable earnings, as a percentage of firm value. Firms that have small or negative earnings, and therefore much lower capacity to generate internal funds, will value flexibility more.
- Firms with limited internal funds can still get away with little or no financial flexibility if they can tap external markets for capital — bank debt, bonds, and new equity issues. Other things remaining equal, the greater the capacity (and the willingness) of a firm to raise funds from external capital markets, the less should be the value of flexibility. This may explain why private or small firms, which have far less access to capital, will value financial flexibility more than larger firms. The existence of corporate bond markets can also make a difference in how much flexibility is valued. In markets where firms cannot issue bonds and have to depend entirely on banks for financing, there is less access to capital and a greater need to maintain financial flexibility. In The Home Depot example above, a willingness to tap external funds — debt or equity — would reduce the value of flexibility substantially.
- The need for and the value of flexibility is a function of how uncertain a firm is about future reinvestment needs. Firms with predictable reinvestment needs should value flexibility less than firms in businesses where reinvestment needs are volatile on a period-to-period basis.

CT 27.4: What types of firms are likely to face significant constraints in raising external capital? What implications would you draw for the value of financing flexibility at these firms?

Summary

Option pricing theory has wide applicability in corporate finance, and we have explored a range of these applications in this chapter. We began with a discussion of some of the measurement issues that make the pricing of real options more difficult than the pricing of options on financial assets. We then considered three options embedded in investment projects — the option to expand a project, the option to abandon a project, and the option to delay a project. The option to expand an investment has value because the value of the cash flows from expanding are uncertain and may have high value under some scenarios. The option to delay an investment implies that the rights to an investment with negative net present value today may still be valuable because the variability in cash flows may make it a positive net present value investment in the future. In fact, patents, undeveloped natural resource reserves, and research and development can all be viewed as options to delay. Finally, the option to abandon an investment protects a firm from potential downside if the cash flows turn

out to be negative, and it makes the investment more attractive. In all these cases, the underlying asset is the project, and the options add value to the firm. The value of these options should be incorporated into investment analysis and may result in the acceptance of otherwise unacceptable investments.

In capital structure, option pricing can be used to value financial flexibility. In particular, firms maintain excess debt capacity or large cash balances so as to be able to invest in attractive projects that may show up unexpectedly — acquisition opportunities, for instance. The value of flexibility as an option will be greater for firms with uncertain investment needs, with the potential for large and sustainable excess returns on new investments.

In valuation, the value of equity in deeply troubled firms — firms with negative earnings and high leverage — can be viewed as a call option. The option rests in the hands of equity investors who can choose to liquidate the firm and claim the difference between firm value and debt oustanding. With limited liability, they do not have to make up the difference if firm value falls below the value of the outstanding debt. The equity will retain value even when the value of the firm's assets is lower than the debt outstanding because of the time premium on the option.

Questions

1. Assume that you price a deep out-of-the-money option using the Black-Scholes model, and then revalue it with a jump process model. Which model will give you a higher value and why?
2. You have been offered the rights to a technology for the next 10 years. The technology is not financially viable now but could be valuable in the future. What are some of the variables that will determine how much you would be willing to pay for this technology?
3. A consumer product firm is considering making a major investment in China. The investment is expected to cost $2 billion, and the present value of the expected cash flows on the investment is only $1.5 billion. However, the firm believes that there are substantial expansion opportunities in China. Would that justify investing the $2 billion? Why or why not?
4. Answer true or false to the following statements:
   a. The right to pursue a project will not be valuable if there is a great deal of uncertainty about the viability of the project.
   b. A project can be viewed as an option only if there are some barriers to entry which prevent competitors from replicating it.
   c. A company that has valuable patents that do not yet generate cash flows and earnings will be undervalued using traditional discounted cash flow valuation.
   d. A company should take on a project as soon as it becomes financially viable (i.e., when its NPV exceeds zero).
   e. The value of the rights to a project will increase as the volatility of the industry and the technology underlying the project increase.
5. You are comparing two investments with the same net present value. However, you have a partner on one of the investments who is willing to buy out your stake in the investment any time over the next 10 years for half of what you paid for it. Would that make a difference in your choice? Why or why not?
6. Firms that require their initial ventures in new markets to carry their own weight (i.e., have positive net present values) are much less likely to enter these markets. Comment.
7. We have argued that equity in firms with negative earnings and significant leverage can be viewed as options. Would this argument apply if you were looking at a private business, with negative earnings, significant leverage, and an owner with unlimited liability?
8. Assume that you value a pharmaceutical firm, using a traditional discounted cash flow model. You assume that the firm's earnings will grow 25% a year for the next 10 years because it has a number of valuable patents that it has not commercially developed yet. Given the view of patents as options, would you under- or overestimate the value of the firm?

9. In investment analysis, we argued that investments with negative net present value should never be accepted. Why might a firm with significant leverage and negative earnings accept such an investment?
10. GenSee Corporation is a large, diversified firm with large, stable earnings and easy access to capital markets. The firm has significant excess debt capacity and argues that it needs the financial flexibility provided by the debt capacity. Would you agree with this argument? Why or why not?

Problems

In the problems below, you can use a market risk premium of 5.5% and a tax rate of 40% where none is specified.

1. Merck has asked you to assess the value of a patent on a drug for treating Parkinson's disease that it would like to acquire from Genzyme, a small biotechnology firm. The patent was obtained three years ago and had a 17-year life when it was granted. The drug has been approved by the FDA, and the current assessment is that it would cost $1 billion to develop it for commercial production. Based on the potential market and competition, it is believed that the after-tax cash flows on the drug would be $100 million, growing at 5% a year until the patent expires. In addition, you are provided with all of the following information (some of which might be redundant or useless). You can also assume that this is the only product that Genzyme has as a firm.

	Merck	*Genzyme*
Cost of equity	12%	15%
After-tax Cost of debt	4%	4%
Debt/Capital Ratio	10%	10%
Std Dev in firm value	25%	50%

The treasury bond rate is 5%. Estimate the value of this patent as an option.

2. A company is considering delaying a project with after-tax cash flows of $25 million but that costs $300 million to take. (The life of the project is 20 years, and the cost of capital is 16%.) A simulation of the cash flows leads you to conclude that the standard deviation in the present value of cash inflows is 20%. If you can acquire the rights to the project for the next 10 years, what are the inputs for the option pricing model? (The six-month T.bill rate is 8%, the 10-year bond rate is 12%, and the 20-year bond rate is 14%.)
3. You are valuing the compensation package of an executive for your company. He has been guaranteed $500,000 next year, and he will also receive $10,000 for every dollar above $50 the stock price rises over the next year. The bonus package will be capped off at $250,000 (i.e., the executive will receive no additional bonuses if the stock price exceeds $75). The current stock price is $45. This company has only put options traded on it on the options exchange. The prices of the traded put options are as follows:

Strike price	*3-month*	*6-month*	*1 year*
45	1.00	2.25	3.00
50	7.00	9.00	12.00
75	30.25	30.50	31.00

The riskless interest rate is 10%. Value this package.

4. You have been approached by a real estate conglomerate with a deal: You can buy 100,000 square feet of space in a mall at $50/square foot. Over the next 10 years, you expect to make an after-tax cash inflow of $500,000 a year. At the end of 10 years, you expect to be able to sell the space back at $5 million to other investors.
   a. From a standard capital budgeting analysis, would you take this project if your discount rate were 15%?
   b. Assume that as an inducement, the promoters offer to give you the option to buy another 100,000 square feet at today's price anytime over the next five years. The five-year bond rate is 6%, and the prices per square foot for the last six years have been as follows:

Year	*Price/Square Foot*
–6	$20
–5	$30
–4	$55
–3	$70
–2	$55
–1	$50

What is the value of this option?

5. Designate the following statements as true or false:
   a. Equity can be viewed as an option because equity investors have limited liability (limited to their equity investment in the firm).
   b. Equity investors will sometimes take bad projects (with negative net present value) because they can add to the value of the firm.

c. Investing in a good project (with positive NPV) — which is less risky than the average risk of the firm — can negatively impact equity investors.

d. The value of equity in a firm is an increasing function of the duration of the debt in the firm (i.e., equity will be more valuable in a firm with longer term debt than an otherwise similar firm with short-term debt).

e. In a merger in which two risky firms merge and do not borrow more money, equity can become less valuable because existing debt will become less risky.

6. XYZ Corporation has $500 million in zero-coupon debt outstanding, due in five years. The firm had earnings before interest and taxes of $40 million in the most recent year (the tax rate is 40%). These earnings are expected to grow 5% a year in perpetuity, and the firm paid no dividends. The firm had a cost of equity of 12% and a cost of capital of 10%. The annualized standard deviation in firm values of comparable firms is 12.5%. The five-year bond rate is 5%. (ROC = Cost of capital.)

a. Estimate the value of the firm.

b. Estimate the value of equity, using an option pricing model.

c. Estimate the market value of debt and the appropriate interest rate on the debt.

7. McCaw Cellular Communications reported earnings before interest and taxes of $850 million in 1993 and had a depreciation allowance of $400 million in that year (which was offset by capital spending of an equivalent amount). The earnings before interest and taxes are expected to grow 20% a year for the next five years and 5% a year after that. The cost of capital is 10%. The firm has $10 billion in debt outstanding with the following characteristics: (Tax rate = 40%)

Duration	*Debt*
1 year	$2 billion
2 years	$4 billion
5 years	$4 billion

The annualized standard deviation in the firm's stock price is 35%, while the annualized standard deviation in the traded bonds is 15%. The correlation between stock and bond prices has been 0.5. The firm has a debt/equity ratio of 50%, and the after-tax cost of debt is 6%. (The beta of the stock is 1.50; the 30-year treasury bond rate is 7%.) The three-year bond rate is 5%.

a. Estimate the value of the firm.

b. Estimate the value of the equity.

c. The stock was trading at $60, and there were 210 million shares outstanding in January 1994. Estimate the implied standard deviation in firm value.

d. Estimate the market value of the debt.

8. You are examining the financial viability of investing in some abandoned copper mines in Chile, which still have significant copper deposits. A geologist survey suggests that there might still be 10 million pounds of copper in the mines and that the cost of opening up the mines will be $3 million (in present value dollars). The capacity output rate is 400,000 pounds a year, and the price of copper is expected to increase 4% a year. The Chilean government is willing to grant a 25-year lease on the mine. The average production cost is expected to be 40 cents a pound, and the current price per pound of copper is 85 cents. (The production cost is expected to grow 3% a year, once initiated.) The annualized standard deviation in copper prices is 25%, and the 25-year bond rate is 7%.

a. Estimate the value of the mine using traditional capital budgeting techniques.

b. Estimate the value of the mine based on an option pricing model.

c. How would you explain the difference between the two values?

9. You have been asked to analyze the value of an oil company with substantial oil reserves. The estimated reserves amount to 10 million barrels, and the estimated present value of the development cost for each barrel is $12. The current price of oil is $20 per barrel, and the average production cost is estimated to be $6 per barrel. The company has the rights to these reserves for the next 20 years, and the 20-year bond rate is 7%. The company also proposes to extract 4% of its reserves each year to meet cash flow needs. The annualized standard deviation in the price of the oil is 20%. What is the value of this oil company?

10. You are analyzing a capital budgeting project that is expected to have a PV of cash inflows of $250 million and will cost $200 million (in present value dollars) initially. A simulation of the project cash flows yields a variance in present value of cash inflows of 0.04. You have to pay $12.5 million a year to retain the project rights for the next five years. The five-year treasury bond rate is 8%.

a. What is the value of project, based on traditional NPV?

b. What is the value of the project as an option?

c. Why are the two values different? What factor (or factors) determine the magnitude of this difference?

11. Cyclops, Inc., a high-technology company specializing in state-of-the-art visual technology, is considering going public. Although the company has no revenues or profits yet on its products, it has a 10-year patent to a product that will enable contact lens users to obtain maintenance-free lenses that will last for years. The product is technically viable, but it is exorbitantly expensive to manufacture, and its immediate potential market will be relatively small. (A cash flow analysis of the project suggests that the present value of the cash inflows on the project, if adopted now, would be $250 million, while the cost of the project would be $500 million.) The technology is evolving rapidly, and a simulation of alternative scenarios yields a wide range of present values, with an annualized standard deviation of 60%. To move toward this adoption, the company will have to continue to invest $10 million a year in research. The 10-year bond rate is 6%.

a. Estimate the value of this company.

b. How sensitive is this value estimate to the variance in project cash flows? What broader lessons would you draw from this analysis?

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Related Web Sites

http://www.wiley.com/college/damodaran

CHAPTER 28

Back to First Principles

WE BEGAN THE BOOK by stating the three principles we believe comprise the core of corporate finance: the investment principle, the financing principle, and the dividend principle. We have spent most of the last 27 chapters applying these principles to firms in general and to Boeing, The Home Depot, and InfoSoft, in particular.

In this chapter, we revisit the basic principles of corporate finance and summarize them. We then look at the interrelationship between the principles and how a firm's investment policy can affect its financing and dividend policy, and vice versa. For instance, Boeing's trouble earning a return on its investments to match its cost of capital restricts its ability to retain cash for future investments and to raise new equity. The Home Depot's good track record of earning excess returns on its investments allows it to preserve its excess debt capacity and has implications for future dividend policy. InfoSoft's unwillingness to use debt can affect its capacity to invest in expansion.

We end the chapter with a listing of broad propositions that we believe represent the foundation for much of the corporate financial theory and most of the models that we have used in this book.

Back to First Principles

The investment principle states that firms should invest in assets only if they expect to earn a return greater than their minimum acceptable hurdle rate. The financing principle suggests that the mix of debt and equity firms use should be the one that maximizes firm value. The dividend principle proposes that firms that cannot find investments earning their hurdle rate should return the cash to the owners of the business. Throughout the chapters, we have essentially developed these principles.

The Investment Principle

Although there is little disagreement that firms should invest in assets that earn a return greater than the minimum acceptable hurdle rate, there is substantial disagreement about the best way to measure the minimum acceptable hurdle rate and the return on the investment. Let us consider the hurdle rate first. As laid out in Chapters 7 and 8, the hurdle rate should be a weighted average of the costs of the

different financing that a firm uses to fund investments. We categorize the different financing into debt and equity, estimate costs for each, and calculate weights based on market value to arrive at a cost of capital. This cost of capital represents the minimum acceptable hurdle rate for a project, when returns are measured prior to debt payments. Alternatively, the cost of equity can be used as the hurdle rate, when returns are measured after debt payments.

How do we measure returns? Although we consider different measures based on accounting earnings and cash flows, we conclude in Chapters 9 and 10 that the best measure of return on an investment is based on time-weighted cash flows. The process of discounting cash flows, we argue, represents time weighting, with earlier cash flows weighted more and later cash flows less. The side costs and side benefits that investments create for a firm should be incorporated either into the cash flows and returns, as noted in Chapter 12, or valued separately, if they are options (to expand, delay, or abandon the investment), as in Chapter 27.

The investment principle applies to all types of investments. In Chapter 11, we applied it to evaluate investments in foreign markets and high-inflation economies. The returns and hurdle rates for these investments can be defined in the local currency or the foreign currency and in nominal or real terms. When measured consistently, our conclusions on these investments are unchanged. Investments in cash and marketable securities (in Chapter 14) and investments in short-term assets such as inventory and accounts receivable (in Chapter 13) are governed by the same principle. Our analysis of acquisitions in Chapter 26 follows the same blueprint, with the cash flows and returns on acquisitions, with synergy and control benefits built into the cash flows, being compared to the cost of capital for these acquisitions.

The Financing Principle

Ultimately, a firm can raise funds from only one of two sources—debt or equity. There are three primary differences between the two sources. First, debt gets both a fixed and a prior claim on cash flows of the firm, while equity has a residual claim on these cash flows. Second, portions of the payments on debt (interest expenses) are tax deductible, whereas payments to equity are not. Third, equity investors usually get to control the operations of the firm while lenders have, at best, veto power over some decisions and often no control over how the firm is run. Within these broad categories of debt and equity lie a wide range of financing choices, both for private firms and, even more so, for publicly traded firms. We examined these choices in Chapter 16, and we described how firms make the transition from one financing choice to another in Chapter 17.

The choice between debt and equity then becomes a tradeoff between the tax benefits and added discipline created by borrowing on the one hand, and the expected bankruptcy and agency costs generated by debt on the other. In Chapter 18, we consider the special case in which the costs are exactly offset by the benefits, leading to the result that the choice of financing mix does not affect value. In the more general case, where costs do not offset benefits, we argue that the optimal mix of debt and equity for a firm is that mix at which the value of the firm is maximized. We consider several ways of estimating this optimal mix in Chapter 19. If the operating cash flows of a firm are unaffected by its debt ratio, the optimal debt ratio is the one that

minimizes the cost of capital. Alternatively, the optimal debt ratio can be found by comparing the dollar tax benefits on borrowing to the expected bankruptcy cost created by the borrowing.

Having estimated an optimal financing mix for a firm, in Chapter 20 we consider whether and how firms should move to the optimal. Although some of the reasons for not shifting to an optimal debt ratio are inconsistent with value maximization, others may be. For instance, firms may highly value the financial flexibility offered by excess debt capacity and may choose not to use the capacity. In Chapter 27, we value financial flexibility as an option and compare it to the cost of maintaining excess debt capacity. In choosing between the different paths that are available to a firm to move from its existing debt ratio to an optimal debt ratio, we have to consider both the threat created by being suboptimally levered and the quality of investment opportunities.

As a final part of the financing principle, we argued that the optimal type of financing for a firm is the one that generates cash flows similar to those generated by the firm's assets. Thus, financing long-term assets with long-term debt and nondollar assets with nondollar debt can reduce default risk, increase borrowing capacity, and increase firm value.

The Dividend Principle

Generally speaking, firms that do not have sufficient investments generating returns higher than the hurdle rate should return the excess cash to the owners. Although dividends are the traditional way by which firms have done so, they tend to be sticky, lag earnings, and understate the true cash returned to stockholders. As we argue in Chapter 21, dividends also tend to create tax disadvantages for many.

In recent years, we have seen an increase in stock buybacks as an alternative to dividends, and we believe these should be viewed as part of cash returned to stockholders. When examining how much a firm returns to its stockholders in the form of dividends and stock buybacks, we contend, in Chapter 22, that we have to examine how much cash the firm could have returned. We estimated this by calculating the free cash flow to equity, which is the cash left over after reinvestment needs and debt payments. A firm with significant free cash flows to equity that fails to return cash to its owners will accumulate a large cash balance, whereas a firm with low or negative free cash flows to equity that pays large dividends or buys back stock will face a cash deficit.

Dividends and stock buybacks represent only two of many actions that affect stockholder wealth and stock prices. In Chapter 23, we look both at cosmetic changes such as stock splits and dividends that affect stock prices but may not affect value, and at real events such as spinoffs, equity carve-outs, and divestitures that can change the mix of assets owned by the firm and alter its value.

Interrelationships and Life Cycle Effects

In this book, we have introduced the three principles, and the decisions that flow from each, in sequential order. In reality, however, these decisions are seldom independent of each other, and we will begin this section by considering the interrelationships

between the three principles. We will also ask whether one principle will dominate in terms of value creation and, if so, whether this situation might change as a firm evolves.

Interrelationship between Principles

Consider again the investment decision. Assume that a firm has maintained an impeccable record of investing in assets that earn more than its cost of capital. This firm's investment record is likely to have effects on both its financing and investment decisions. On the financing decision, the quality of investments will influence how a firm reacts to excess debt capacity. With good projects, a firm is much more likely to use debt to invest in new assets. On the dividend decision, a firm with good investments will have far less in cash flows to distribute to its stockholders and far more leeway to accumulate cash balances, if it so desires.

Firms with poor investments will find their choices in terms of financing mix and dividend policy affected as well. A firm that has a history of investing in assets that earn less than the cost of capital is more likely to become the target of a hostile acquisition. If the firm has excess debt capacity, it will therefore have to move to its optimal debt ratio quickly. It will also be far more likely to use debt to buy back stock than invest in new assets. When it comes to dividend policy, this firm is likely to be tightly constrained. Stockholders will view any cash accumulation with suspicion, and the firm will therefore be under pressure to return the cash either in the form of dividends or stock buybacks.

One lesson emerges from these interrelationships: it is that managers who want the freedom to accumulate cash and invest in new projects and new businesses earn the right to do so by developing a track record as good stewards of stockholder wealth. On the other hand, managers who have abused the trust reposed in them by stockholders and who have invested poorly will (and should) find themselves limited in what they can do.

The Life Cycle Effect

Among the three principles, which is the dominant one? In general, the investment principle should be viewed as the most critical component in value creation. A firm with great investments can afford to have suboptimal financing and dividend policies and still have high value. In contrast, a firm with optimal financing and dividend policy cannot become valuable if its investment choices are abysmal.

Having said that, however, we should remember that the relative importance of the three principles in value creation will change as firms grow and mature. Returning to the life cycle of the firm that we introduced in Chapter 17, we would argue that in the early stages of growth and expansion, it is the investment principle that will dominate. As firms mature, and investment opportunities and returns diminish, the financing principle will move to the center. Finally, as firms decline, the dividend principle will emerge as the dominant principle. Figure 28.1 summarizes how investment, financing, and dividend opportunities evolve with a firm's life cycle.

While the need for funding may be substantial in both the start-up and expansion phases, finding investment concepts (in the start-up phase) and converting them into

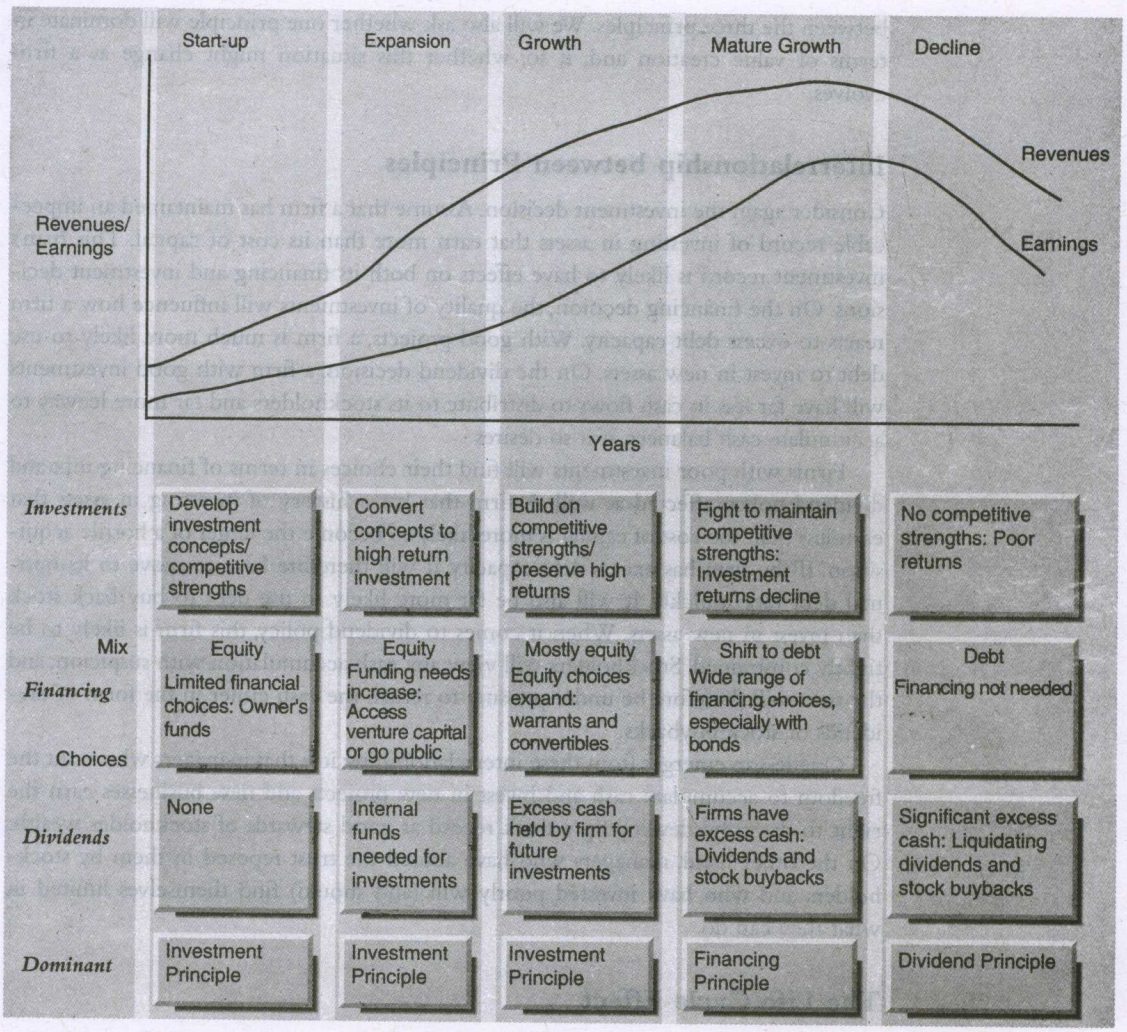

Figure 28.1 Life Cycle Analysis of Corporate Finance Principles

investment opportunities (in the expansion phase) are far more critical components of success than altering the financing mix. The choices in terms of financing are primarily equity and are usually restricted to the owner's wealth and venture capital. Since internal cash flows are consumed by the firm's investments, dividend policy plays little or no role in value enhancement.

As firms move into the growth phase, the investment principle still dominates, as investment returns remain high. Especially for those firms that go public, financing choices expand to include common stock, warrants, and even convertibles, but the financing mix remains almost entirely equity. The first priority of growth firms is to deliver high investment returns, and dividend policy remains on the back burner as long as significant investment opportunities exist. Even if internal funds exceed investment needs, growth firms are likely to accumulate cash to meet investment needs in future periods.

In the mature phase, investment opportunities and returns begin declining. This is the phase where both the financing mix and financing choices become much more critical. Firms may be able to continue delivering excess returns to their investors by using more debt in their capital structure and using innovative securities to reduce default risk. Internal funds exceed investment needs, and firms will be under far greater pressure to return the cash to their investors.

In the decline phase, there are few, if any, new investments and little need for funding. Thus, both the investment and financing principles recede into the background, and dividend policy takes precedence. Firms in decline have to liquidate their assets and return the cash to the owners, either by paying special dividends or by buying back stock.

Core Propositions/Beliefs

We have used a series of basic propositions and beliefs to develop the theory and models in this book. We would like to revisit them in this section.

Faith in Markets, but Not Blind Faith . . .

We began this book by stating in Chapter 1 that the objective function in corporate finance is to maximize firm value, but soon after, in Chapter 2, we noted the advantages of the narrower objective function of maximizing stock prices. Primary among them was the fact that stock prices are observable and constantly updated. We are not rabid efficient marketers. In fact, we believe that markets make mistakes, and large ones at that.

Given that markets make mistakes, why do we give their assessments so much weight? The answer lies in the reality that we need objective measures of how a firm is performing. Accountants do try to do that with financial statements, but their focus is on the past and on investments that the firm has already made. Even if their assessments are perfect, and we know that they are not, we would still have problems analyzing firms with high-growth potential using accounting information. Market prices are forward looking, and while we might disagree with these prices, they represent the collective wisdom and information of thousands of investors. They are also real, in the sense that stockholders can sell their stock and receive the market price; in contrast, a firm's accounting earnings may have little or no relationship to a firm's true earnings. Knowing the market's assessment not only of the value of a firm currently but of the impact of the firm's actions on that value is useful in any analysis. It is when we analyze private businesses that we realize how much we depend on market prices in our assessment of a firm's corporate financial policy.

We approach markets with a mixture of skepticism and trust, and this mindset is reflected in much of what we have done in this book. The trust shows, for instance, the way in which we compute the cost of capital for a firm. We use a weighted average of the cost of equity and debt, but the weights are market value weights, not book value weights. When assessing a firm's performance, we look at how well or badly its stock has done, relative to the market. Skepticism shows in the fact that we do look at accounting measures of performance as well, and we examine stock price performance over longer periods (say, three to five years) rather than short ones (a week or a month).

The tension between our trust that markets generally do their jobs well at assessing firm value, and the concern we feel about the mistakes they can make, is most visible in the chapters on valuation. After all, if we had complete faith in markets, the value of any firm would be its market value, and valuation would be an exercise in confirming this. When valuing firms, however, we estimated their intrinsic or true values, leaving open the possibility that the market value could be wrong. Even so, we have enough faith in markets to believe that they will recognize these intrinsic values, sooner or later, and that market prices will adjust to these values.

The Future, Not the Past

Almost all the information we use in corporate financial analysis is historical information, that is, information about what has happened in the past. At the same time, almost everything we would like to measure in corporate finance relates to the future.

This contrast was first drawn in Chapter 4, when we noted the differences between the questions accounting statements try to answer and the questions raised in financial analysis. Many of the adjustments we make to accounting earnings, such as the capitalization of research and development expenses, are motivated by our desire to forecast the future. In the investment analysis section, in Chapters 7 and 8, one reason we argue for using bottom-up betas for firms and new investments, rather than betas based on historical data, is that the risk looking forward may be very different from the risk looking back. In analyzing a firm's financial mix, we consider expected changes in investment opportunities and risk in making a judgment about whether firms should borrow more or less money in Chapter 20. In Chapter 22 expectations about the future also help us determine how much firms should return to their owners.

Finally, when valuing firms in Chapters 24 and 25, we observe that the value of a firm is based not on what it paid for its assets, or whether they are tangible or intangible, but on the expected cash flows from its investments. In fact, a significant portion of a firm's value comes from investments that it has not made yet but is expected to make in the future.

Show Me the Money

There are two basic dimensions for measuring returns in corporate finance. The first is that it is the cash flows generated by an investment, not the accounting earnings or revenues, that will determine its value. This contrast was drawn in Chapter 9, where we examined alternative approaches to measuring returns. The second dimension is that it matters when the cash flows occur, with earlier cash flows having higher value than later cash flows. We introduced this concept early in Chapter 3, when we considered the time value of money, but we returned to it repeatedly in every section of the book.

In the investment analysis section, in Chapter 10, we maintained that the value of a project was best estimated by looking at the cumulative present value of all the cash flows that it would generate over its lifetime. This net present value, we noted, represents

surplus value created for the firm. In discussing optimal debt ratios in Chapter 19, we measured the increase in value from moving to the optimal by estimating the present value of tax benefits over time and comparing this to the expected bankruptcy costs, measured in the same terms. In evaluating whether a firm should divest assets in Chapter 23, we compared the divestiture value to the present value of the cash flows that would be generated by the assets for the firm over time. When we looked at the value of the firm, we computed the value of a firm as the present value of the cash flows that it would generate to its claim holders.

Although project returns come from cash flows, the analysis becomes much richer when we consider the determinants, often qualitative, of these cash flows. Thus, while we spend Chapters 8 through 14 examining different ways of evaluating projects, we examine the much broader and more fundamental question of where good projects come from in Chapter 15. In a similar vein, we consider ways of coming up with an optimal debt ratio for a firm in Chapter 19, and in Chapter 20 we examine why firms may not move to the optimal because of their need for financing flexibility. While we develop models to value firms in Chapter 24, we consider qualitative factors like brand name and corporate strategy as value enhancers in Chapter 25, and synergy and control in Chapter 26. Although we were not averse to discussing the qualitative factors in any of these decisions, we did try, to the limits of our capacity, to convert qualitative factors to quantitative ones. Ultimately, we argue that qualitative factors matter only because they affect expected cash flows, growth rates, discount rates, and value. Thus, brand names matter because they allow firms to increase operating margins and value. Synergy has value because it leads to cost savings or higher growth.

Manage for the Marginal Investor

Corporate finance takes the unique, and sometimes disconcerting, perspective that we should look at corporate financial decisions through the eyes not of the firm or its managers, but the marginal investor in the firm. We define the marginal investor as the investor who is most likely to be involved in the next trade on the firm's stock, and we note that this investor is likely to be a diversified institution for most large U.S. companies. Even for companies with substantial insider holdings, we argue that institutional investors are likely to be the marginal investors.

Why do we do this? If the objective in corporate finance is to maximize the stock price, and consequently firm value, it is the marginal investors who matter because it is they who determine stock prices by trading on the stock. Our focus on the marginal investor has the greatest consequences when we look at how we measure risk in both firms and in new investments. Since the marginal investor is generally well diversified, we maintain that the only risk that matters, when looking at an investment, is the risk that cannot be diversified away by such an investor. This, in turn, leads us to measure risk using a beta (in the CAPM) and betas (in multifactor models), and to estimate the costs of equity based on these risk measures. This is also why we argue that private and closely held firms, whose marginal investors are less likely to be diversified, will face much higher costs of equity than otherwise similar publicly traded firms. Because these costs of equity influence our choice of investments (through the cost of capital) as well as the optimal debt ratio and how much we should return to

stockholders, it can safely be said that much of our analysis would have been very different if we had taken a different perspective.

Summary

Corporate finance is central to everything firms do, because it provides consistent principles that can be used in decision making. The principles themselves are simple: Invest in assets only if they earn a return greater than the cost of capital, fund them with a mix of debt and equity that maximizes firm value, and return cash to the owners if you cannot find investments that earn excess returns. The principles are also universal, applying to all firms (small or large, private or public) and all decisions within these firms.

SOLUTIONS TO ODD-NUMBERED QUESTIONS AND PROBLEMS

CHAPTER 2

2-1 Annual Meeting: Stockholders may not show up at annual meetings or be provided with enough information to have effective oversight over incumbent management. In addition, the corporate charter is often tilted to provide incumbent managers with the advantage, if there is a contest at the annual meeting.

Board of Directors: Directors are often chosen by the incumbent managers (rather than by stockholders), own few shares, and lack the expertise/information to ask tough questions of incumbent managers.

2-3 The fact that markets are volatile does not, by itself, imply that they are not efficient. If the underlying value of the investments traded in the market is changing a lot from period to period, prices should be volatile. Even if the underlying value is not moving as much as prices are, the fact that markets make mistakes (which is what the noise is) does not imply that the prices are not unbiased estimates of value.

2-5 This strategy is likely to work if higher market share leads to higher profits and cash flows in the long term. If, on the other hand, the higher market share is obtained by cutting prices and sacrificing long-term profitability, the strategy is unlikely to work.

2-7 The ability to obtain equity capital without having to give up voting rights reduces the danger for managers that they will be called to account for bad actions. Obviously, this means that shareholders cannot effectively fulfill their roles as monitors.

2-9 I would be concerned at the limited extent of stockholder oversight of managerial actions. I would try to push management to convert non-voting shares to voting shares. I would also try to ensure that the Board of Directors is independent and active, so that they can perform some of the duties that activist shareholders could have performed if they had voting rights.

2-11 If a firm were large enough in the country's economy that socially irresponsible actions would also affect its share price, it would try to act socially responsibly. Also, if the company were majority-owned by the government, there would be a greater convergence between social goals and shareholder goals. Finally, if there are laws penalizing socially irresponsible actions, the firm will act responsibly in social matters as well.

2-13 The idea is that bondholders by converting their bonds into equity would be able to participate in the upside potential if stockholders attempted to increase the riskiness of the firm. This would decrease the incentive for stockholders to expropriate bondholders in this fashion.

2-15 First of all, it is not clear how destruction of a well-run firm would be desirable for a stockholder who has taken over the firm. However, even if this could happen, it is not clear that legislation preventing hostile takeovers is the solution. The reason for this is that such legislation would also unduly shield managers from market monitoring.

CHAPTER 3

3-1 a. Current Savings Needed = $\$500{,}000/1.1^{10} = \$192{,}772$

b. Solve the equation: $(x/0.1)[1 - (1/1.1)^{10}]/0.1 = \$500{,}000$ to get $x = \$31{,}373$.

3-3 Annual Percentage Rate = 8%

Monthly Rate = 8%/12 = 0.67%

Monthly Payment needed for 30 years is obtained as the solution to $(x/0.0067)[1-(1/1.0067)^{360}]/0.1 = \$200{,}000$. $x = \$1{,}473$

3-5 a. Year-end Annuity Needed to have $100 million available in 10 years = $6.58 [FV = $100, r = 9%, n = 10 years]

b. Year-beginning Annuity Needed to have $100 million in 10 years = $6.04

3-7 Annuity given current savings of \$250,000 and n = 25 = \$17,738.11 (r = 5%)

3-9 PV of deficit reduction can be computed as follows:

Year	Deficit Reduction	PV
1	\$25.00	\$23.15
2	\$30.00	\$25.72
3	\$35.00	\$27.78
4	\$40.00	\$29.40
5	\$45.00	\$30.63
6	\$55.00	\$34.66
7	\$60.00	\$35.01
8	\$65.00	\$35.12
9	\$70.00	\$35.02
10	\$75.00	\$34.74
Sum	\$500.00	\$311.22

The true deficit reduction is \$311.22 million.

3-11 a.

Year	Nominal	PV
0	\$5.50	\$5.50
1	\$4.00	\$3.74
2	\$4.00	\$3.49
3	\$4.00	\$3.27
4	\$4.00	\$3.05
5	\$7.00	\$4.99
Sum	\$28.50	\$24.04

b. Let the signup bonus be reduced by X. Then the cash flow in year 5 will have to be raised by X + 1.5 million to get the nominal value of the contract to be equal to \$30 million. Since the present value cannot change,

$X - (X + 1.5)/1.07^5 = 0$

$X\,(1.07^5 - 1) = 1.5$

$X = 1.5/(1.07^5 - 1) = \$3.73$ million

The signup bonus has to be reduced by \$3.73 million, and the final year's cash flow has to be increased by \$5.23 million, to arrive at a contract with a nominal value of \$30 million and a present value of \$24.04 million.

3-13 a. Monthly Payments at 10% on current loan = \$1,755.14 (Monthly rate used = (10/12)%)

b. Monthly Payments at 9% on refinanced mortgage = \$1,609.25 (Monthly rate = 0.75%)

Monthly Savings from refinancing = \$145.90

c. Present Value of Savings at 8% for 60 months = \$7,195.56 (Monthly rate = (8/12)%) Refinancing Cost = 3% of \$200,000 = \$6,000. You would refinance.

d. Annual Savings needed to cover \$6,000 in refinancing cost = \$121.66

Monthly Payment with Savings = \$1,755.14 – \$121.66 = \$1,633.48. Interest Rate at which Monthly Payment is \$1,633.48 = 9.17%

3-15 Assuming a discount rate of 10%, the present value of what you can pay the player is the present value of an annuity of \$1.5 m over three years, or $(1.5/0.1)[1 - 1/(1.1)^3]$ = \$3.7302 m. If the number of years can be extended, then the nominal value of a contract with a present value of no more than \$3.7302 m can still be \$5 m. For example, if the number of years can be 6, an annual payment of x will result in a present value of \$3.7302 m, where x solves $3.7302 = (x/0.1)[1 - 1/(1.1)^6]$. Solving this, we find x = 0.8565 m. The nominal value of the contract is, therefore, 6(0.8565 m) = \$5.1389 m > \$5 m.

3-17 a. Amount needed in the bank to withdraw \$80,000 each year for 25 years = \$1,127,516.

b. Future Value of Existing Savings in the Bank = \$407,224

Shortfall in Savings = \$1,127,516 – \$407,224 = \$720,292

Annual Savings needed to get FV of \$720,292 = \$57,267

c. If interest rates drop to 4% after the 10th year, Annuity based on interest rate of 4% and PV of \$1,127,516 = \$72,175

The decline in the amount of withdrawal = \$80,000 – \$72,175 = \$7,825

CHAPTER 4

4-1 a. Marketable securities are valued at book or market, whichever is lower. Hence, marketable securities are probably assessed at close to market value. Near-cash must also be close to market value. Cash, of course, by definition is at market value.

b. Fixed Assets are valued at historical cost. Hence, they were probably purchased for the

gross book value of fixed assets, that is, 5,486 + 199 = $5,685. From the value of $2,016 for accumulated depreciation, we see that about 36.75% of the value of the depreciable fixed assets has been written off in depreciation. Hence, if we can assume that Coca-Cola uses straight-line depreciation, about two-fifths of the estimated life of these assets is over. If we know the average life of assets in this industry, we can use that to estimate the age of these assets.

c. There are several reasons why current assets are more prominent in Coca-Cola's balance sheet than fixed assets. (1) There is a large amount of cash and near-cash: this might be due to impending expansion, perhaps investment in bottling operations. (2) The Other Assets item includes investment in other Coca-Cola companies, which are primarily manufacturing operations, such as bottlers. Hence, if the fixed assets and current assets parts of these investments were included, the ratio of fixed to current assets would probably be larger.

d. Even though the companies were sold off, Coca-Cola presumably still has some ownership stake in these companies. To the extent that Coca-Cola does not have a majority stake in these companies, they would not be consolidated into Coca-Cola's balance sheet. If these companies were primarily manufacturing companies, their relatively large fixed-asset structure would no longer appear on Coca-Cola's balance sheet.

4-3 Coca-Cola's brand-name value does not appear in its balance sheet. Even though there is an item called Nondepreciable Fixed Assets, it is too small, and it cannot represent the brand-name value; it's probably land. One way to adjust the balance sheet to reflect the value of this asset is for Coca-Cola to set up a separate subsidiary that would buy the rights to the brand name. The brand-name value would then show up as an asset for the subsidiary, which would then be reflected in Coca-Cola's balance sheet as well, even if the financial statements were consolidated.

4-5 Operating Income

	1997	1998
Revenues	18,868	18,813
Less COGS	6,105	5,562
Less Selling, G&A expenses	7,852	8,284
equals Operating Earnings	4,911	4,967

The difference seems to be mainly due to the much lower level of COGS in 1998. COGS as a percentage of Sales is 32.36% in 1997 versus 29.56% in 1998.

4-7 The effective tax rate in 1997 was 1,926/(4,911 − 258 + 1,312) = 32.28%, while the same quantity for 1998 was 1,665/(4,967 − 277 + 508) = 32.03%, which is almost the same. The differences may reflect differences between the tax and reporting books.

4-9 a. The return on equity is defined as Net Income/Book Value of Equity. Using beginning of 1998 value of equity, this was 3,533/7,274 = 48.57%

b. The pre-tax return on capital equals EBIT/Total capital = 4,967/(7,274 + 3,875) = 44.55%

c. The after-tax return on capital equals 44.55(1 − 0.3203) = 30.28%

4-11

Year	Operating Lease Expense	Present Value at 7%
1	90	84.11215
2	90	78.60949
3	85	69.38532
4	80	61.03162
5	80	57.03889
6–10	75	219.2538
	Sum of present values	569.4313

The debt value of operating leases is $569.4313 million. Including this amount in debt, the book value debt to equity ratio becomes 569/1,000 or 0.5694.

4-13 If the book value of capital is $1 billion and the reported debt to capital ratio is 10%, the book value of debt equals $100 million. If the present value of lease commitments is $750 million, the revised debt to capital ratio is (100 + 750)/(1,000 + 750) = 48.57%. The after-tax return on capital is 0.25 × 1,000/1,750 = 14.29%.

4-15 Capital Invested is $1,500 million. The value of the research asset is $1,000 million. Hence, the adjusted value of capital invested is $2,500 million. EBIT (1 − *t*) originally calculated was $1,500 million; adjusted EBIT (1 − *t*) equals approximately 1500 + 250 − 150 = 1,600; hence, Stellar Computer's adjusted return on capital is 1,600/2,500 = 64%.

CHAPTER 5

5-1 The rate of return is $(1{,}000/300)^{1/10}$ or 12.79%.

5-3 If the NV Technologies bond is trading at par, its yield is equal to its coupon rate of 8%. If GEV Technologies has the same rating, it should have a similar yield. Hence, we can write: $95 = (3.75/0.04)(1 - 1/1.04^n) + 100/1.04^n$, where $n/2$ is the maturity in years of the GEV bond. Solving, we find $n = 41$; hence, the maturity is 20.5 years.

5-5 The coupon solves $1{,}000c/0.03 = 636$, where c is the semiannual coupon rate; hence, the annual coupon rate equals 3.82%.

5-7 We solve $51.25 = 2.5(1.05)/(r - 0.05)$, where r is the expected rate of return. Solving, we get $r = 10.12\%$.

5-9 a. According to the Dividend Discount Model, the share price is $1.88(1.05)/(0.1 - 0.05) = \$39.48$.

b. According to the FCFE model, the price of the share is $2.4(1.05)/(0.1 - 0.05) = \$50.40$.

c. The difference in price could be due to the fact that the company is not following the optimal dividend policy. The FCFE value is probably more accurate since it assumes that the firm will follow an optimal dividend policy. However, if there is no market mechanism available to force the company's management to change its dividend policy, the market price will probably reflect the \$37.6 valuation rather than the truer underlying value of \$48.

5-11 a. The value of the entire firm is $650(1.045)/(0.085 - 0.045) = 16{,}981.25$ m.

b. The value of the equity can be estimated as 16.98125 b. – 3.88 b. = 13.10125 b.

c. This implies that the price per share should be $13{,}101.25/66.3 = \$197.01$; hence at a market price of \$32, the stock is undervalued by \$165.01.

5-13 The stock price would rise if the market's expected rate of increase was below the announced 50%; otherwise it would decrease if the actual increase was less than expected.

5-15 If investors receive the same information about assets, they can still disagree if their personal characteristics, such as degree of risk aversion and marginal tax rates, differ. They may also disagree on the implications of the information for asset value.

CHAPTER 6

6-1

Year	Price	Annual Return
1989	1.2	
1990	2.09	0.741667
1991	4.64	1.220096
1992	5.34	0.150862
1993	5.05	–0.05431
1994	7.64	0.512871
1995	10.97	0.435864
1996	20.66	0.883318
1997	32.31	0.563892
1998	69.34	1.146085
	average	0.622261

a. The average annual return is 62.23%.

b. The standard deviation is 42.49%. The variance is 0.1805.

c. No. The firm is changing its business mix, is under increasing assault for anti-trust practices, and is accumulating cash.

6-3

Year	Scientific Atlanta	AT&T
1989	80.95	58.26
1990	–47.37	–33.79
1991	31	29.88
1992	132.44	30.35
1993	32.02	2.94
1994	25.37	–4.29
1995	–28.57	28.86
1996	0	–6.36
1997	11.67	48.64
1998	36.19	23.55
average	27.37	17.804
s.d.	51.36	27.89
covariance	774.48	
correlation	0.54	

a. The average return over the ten years is 27.37% for Scientific Atlanta and 17.8% for

AT&T. The standard deviations are 51.36% and 27.89%, respectively.

b. The covariance is 774.48, while the correlation coefficient is 0.54.

c. The variance of a portfolio composed equally of the two investments equals $(0.5)^2(51.36)^2+(0.5)^2(27.89)^2+2(51.36)(27.89)(0.5)(0.5)(0.54) = 1240.68$; the standard deviation is 35.22%.

6-5 a. The average return on the portfolio equals $(0.6)25 + (0.4)12 = 19.8\%$.

The variance of returns equals $(0.6)^2(36)^2 +(0.4)^2(22^2) + 2(0.4)(0.6)(36)(22)(0.28) = 650.44$; the standard deviation of returns = 25.5%.

b. The minimum variance portfolio is given by $w_{CC} = [22^2 - (22)(36)(0.28)]/[22^2 + 36^2 - 2(22)(36)(0.28)] = 262.24/1,336.48 = 0.1962$; the weight in Texas Utilities is $1 - 0.1962 = 0.8038$.

6-7 The Portfolio variance equals
$(1/3)^2(23)^2 + (1/3)^2(27)^2 + (1/3)^2(50)^2 +$
$+2(1/3)(1/3)(23)(27)(-0.15) +$
$2(1/3)(1/3)(27)(50)(-0.25) +$
$2(1/3)(1/3)(23)(50)(0.2) = 360.97$
The standard deviation = 19%

6-9 The variance of a portfolio consisting of N securities can be estimated as $(1/N)$ (average variance) + $(1 - 1/N)$(average covariance) = $10 + (50 - 10)/N$.

Number of Securities in Portfolio (N)	Estimated Portfolio Variance
5	18
10	14
20	12
50	10.8
100	10.4

We must solve $10 + 40/N = 1.1(10) = 11$, or $N = 40$.

6-11 a. Invest everything in the riskless asset.

b. Solve $0.15 = w(0.3)$ to get $w >= 0.5$; *invest 50% in each asset.*

c. Invest everything in the market portfolio.

d. Solve $0.45\ w(0.3)$ to get $w = 1.5$; the investor should borrow 50% of his own outlay at the risk-free rate and invest the borrowing as well as his own outlay in the market portfolio.

e. Solve $w(15) + (1 - w)5 = 12$ to get $w = 0.7$; invest 70% in the market portfolio and the rest in the risk-free asset.

6-13 a. Solve $1.5 = \text{Covariance}(R_{UA}, R_{mkt})/22^2$. Hence, the covariance equals 726. The correlation between United Airlines and the market can be computed as $726/(22 \times 66) = 0.5$.

6-15 The expected return on Emerson Electric would be $6 + 0.5(1.8) + 1.4(0.6) + 1.2(1.5) + 1.8(4.2) = 17.1\%$.

CHAPTER 7

7-1 a. We use the CAPM: The Expected Return on the stock = $0.058 + 0.95(0.0876) = 0.1412 = 14.12\%$. Since the investor is a short-term investor, we use the T-bill rate and the arithmetic mean. Since the focus is short term, we don't need to take compounding into account.

b. For a long-term investor, we would use the T-bond rate and the geometric mean: The expected return = $0.064 + 0.95(0.0561) = 0.1173$ or 11.73%, where 5.61% is used as the estimate of the market risk premium since that is the geometric average of the market premium, using the long-term T-bond rate as the risk-free rate. If we use 5.5% as our estimate of the market premium, the expected return will be $0.064 + 0.95(0.055) = 0.1163$ or 11.63%.

c. The cost of equity for the company is more appropriately the long-term required rate of return since most projects for the company would be long-term.

7-3 a. The cost of equity equals $0.064 + 1.70(0.055) = 15.75\%$.

b. If long-term bond rates rise to 7.5%, the cost of equity will rise by a like amount to 16.85%.

c. Since Biogen had no debt, all of its risk is due to business risk.

7-5 a. Using the CAPM, we compute the expected return as 0.03 + 1.2(0.0876) = 13.51%. We use a T-bill rate because the focus is on the short-term expected return (the next year). For the same reason, we use the market premium over bills.

b. The cum-dividend price, one year from now, would be \$50 (1.1351) = 56.75. The ex-dividend price, assuming that the stock price goes down by the amount of the dividend, is 56.75 – 2.50 = \$54.25.

c. Over last year, the expected return would have been 15.51%, based on the then prevailing T-bill rate of 5%.

d. The actual returns were (–4 + 2)/54 = –3.70%.

e. The unlevered beta based on the current capital structure would be 1.2/(1 + (1 – 0.4)(50/100)) = 0.92. There is no debt in the new capital structure. Hence, the new beta would be 0.92.

7-7 a. The combined beta for Novell after the acquisition equals [2/(1 + 2)]1.5 + [1/(1 + 2)]1.3 = 1.43.

b. If Novell borrowed the \$1 m, we would lever this beta to get 1.43[1 + [1 – 0.4][1/2]] = 1.86.

7-9 a. The degree of operating leverage is computed as %Δ Operating Income/% Δ Revenue.

Firm	Degree of Operating Leverage	Beta
PharmaCorp	25/27 = 0.92	1.0
SynerCorp	32/25 = 1.28	1.15
BioMed	36/23 = 1.56	1.3
Safemed	40/21 = 1.90	1.4

b. There is a clear relationship between the degree of operating leverage and the beta. The greater the degree of operating leverage, the more responsive income (and presumably stock returns) will be to changes in revenue which are correlated with changes in market movements.

7-11 The volatility in commodity prices will be reflected in the beta only to the extent that commodity price movements are correlated with market movements. Commodity prices probably do not move closely with the rest of the market.

7-13 a. The required rate of return is 0.06 + 0.46(0.055) = 8.53%.

b. $(1 - R^2)$ = 95% of this firm's risk is diversifiable.

c. The current unlevered beta = 0.46/(1 + (1 – 0.36)(20/40)) = 0.35. The total firm is worth 60 m. The average beta of the divisions that will be kept must equal 0.35 = (1/3)0.20 + (2/3) β_{rem}. Solving, β_{rem} = 0.425. The new unlevered beta equals [40/90](0.425) + [50/90](0.80) = 0.63
The new levered beta = 0.63(1 + (1 – 0.36)(50/90)) = 0.85

7-15 a. The expected return over the next year = 0.048 + (1.65)(0.0876) = 19.25%.

b. In this case, we would use a geometric average estimate of the risk premium and a long-term T. bond rate to get 0.064 + (1.65)(0.055) = 15.48%.

c. The extent of the monthly overperformance = $(1.511)^{1/12} - 1$ = 3.5%. Hence, Intercept – $(1 - \beta)R_f$ = 0.035, using a value of 0.0328 for the intercept, R_f = 4.14%, after annualizing.

d. Its current unlevered beta = 1.65/(1 + (1 – 0.4)(0.03)) = 1.62. Taking into account the new leverage ratio of [2,000 + 0.03(265)(30)]/(265)(30) = 0.2816, the new levered beta becomes 1.62(1 + (1 – 0.4)(0.2816)) = 1.89.

7-17 a. The unlevered beta equals 1.61/(1 + (1 – 0.4)(10/10))=1.01.

b. If the debt ratio goes from 1 to 0.9 and then to 0.8, the levered beta will become 1.01 (1 + (1 – 0.4)(0.9)) = 1.5554 and 1.4948, respectively.

7-19

Firm	Beta	Debt	Equity	D/E	Unlevered beta
Black & Decker	1.4	2,500	3,000	0.833333	0.933333
Fedders	1.2	5	200	0.025	1.182266
Maytag	1.2	540	2250	0.24	1.048951
National Presto	0.7	8	300	0.026667	0.688976
Whirlpool	1.5	2,900	4,000	0.725	1.045296

The average unlevered beta = 0.9798. Using the private firm's leverage ratio of 25%, we can compute a levered beta of 0.9798(1 + (1 – 0.4)(0.25)) = 1.1268. If you use the average D/E ratio for the sector, average unlevered beta = 0.9820.

b. Given the range of unlevered betas for these publicly traded firms, it might be that there are differences among these firms and between these firms and the private firm that are not averaged out in the numbers. For example, the degree of operating leverage might be different. The private firm owner may not be diversified either.

7-21 The unlevered beta for the current business in 1995 would be 0.9/(1 + (1 –0.36)(1.0)) = 0.5488. The unlevered beta of comparable media business firms is 1.2/(1 + (1 – 0.36)(0.50)) = 0.9091. Hence, the unlevered beta of the new business (including the media division) in 1999 can be estimated as 0.3(0.9091) + 0.7(0.5488) = 0.6569. Leveraging it up, we get the levered beta estimate of 1.077. Southwestern's debt-to-capital ratio = $\frac{1}{2}$; if it decided to finance its media operations with a debt equity ratio of 50%, then the media division's debt-to-capital ratio would be $\frac{1}{3}$. Hence, Southwestern's overall debt-to-capital ratio would be 0.3(1/3) + 0.7(1/2) = 0.45; hence its debt to equity ratio would be 9/11. The levered beta would be 0.6569(1 + (1 – 0.36)(9/11)) = 1.00.

7-23 a. The levered beta using comparable firm data would be 1.15(1 + (1 – 0.4)(0.2)) = 1.288.

b. Using the regression, a range estimate with a likelihood of 95% that the true beta lies within it is –0.25 to 1.75.

c. Using the comparable firm beta, cost of equity = 6.5% + 1.29(5.5%) = 13.60%. Cost of capital = 13.6% (10/12) + 7.5%(1 – 0.4)(2/12) = 11.34%.

CHAPTER 8

8-1 a. Such estimation errors would be offset if the investor held other retail firms in the same industry.

b. Geographical diversification would help against such natural disasters.

c. Again, holding other stocks in the same industry would offset the losses to this firm.

d. Holding stock in other stock, such as that of the firm owning the manufacturing plant, would help diversify this risk.

e. This risk could not be diversified because it would be market risk.

f. If such an action is, in fact, suboptimal from the point of view of the economy, it would be a negative shock that the investor could not protect himself/herself against.

g. This risk cannot be diversified.

Hence, sources of risk *e*, *f*, and *g* would need to be considered as part of an investment analysis.

8-3 a. The Limited is a U.S. company, and the marginal investor is probably an American investor. Since the analysis is being done in U.S. dollars, the appropriate risk-free rate is the U.S. risk-free rate, which is the Treasury bond rate of 7%. It is not appropriate to adjust this rate by the premium earned on Brady bonds.

If we assume that country risk is diversifiable, the market risk premium is still 5.5%. The cost of equity, therefore, can be computed as 7% + 1.4(5.5%) = 14.7%. If the country risk is not diversifiable, you would use a risk premium of 7.5%

b. If the analysis were being done in the local currency, then we would need to compute the risk-free rate that would be appropriate for the local situation. If the marginal investor were in the South American country, again, the analysis would be different.

8-5 a. The levered beta for the multimedia business is 1.3; the average D/E ratio is 0.5, and the tax rate is 0.4. Hence, the unlevered beta is computed using the formula:
$\beta_{levered} = \beta_{unlevered}[1+ (1 - t)\ D/E]$ to obtain an unlevered beta of 1.

b. If the phone company uses the same debt/equity ratio as the rest of its business, that is, 1.0, it will have a levered beta of 1.6; hence, the cost of equity would be 7 + 1.6(5.5) = 15,8%.

c. If the debt/equity ratio used is 0.4, the levered beta is 1.24; hence, the cost of equity capital is 7 + 1.24(5.5) = 13.82.

8-7 a. The cost of equity would be 7.5 + 0.95(5.5) = 12.725 if the usual debt/equity ratio were used. However, it sounds as if Hershey believes that the current project would support a higher debt/equity ratio. In this case, we must compute a new cost of equity capital. First, we compute Hershey's unlevered beta, which works out to 0.8782. Using the new debt/equity ratio of 20/80, the modified levered beta is 1.01. Hence, the cost of equity is 7.5 + 1.01(5.5) = 13.055. The cost of capital is (0.8)(13.055) + (0.2)(1 – 0.4)(8) = 11.404%.

b No premium for exchange rate risk need be charged because it is possible to diversify away exchange rate risk.

c. No premium was charged for political risk, either, because we have assumed that it is diversifiable as well.

d. If Hershey had been held privately, the international risk might have been more difficult to diversify away, and it would have been appropriate to charge a risk premium.

8-9 a. b. The certainty equivalent factors and the equivalent riskless cash flows can be computed as $[(1 + \text{risk-free rate})/(1 + \text{risky rate})]^n$

Year	Flows (in million)	Certainty Equivalent Factor	Certainty Equivalents
0	–10	1	–10
1	3.5	0.921774	3.226209
2	4	0.849668	3.39867
3	4.5	0.783202	3.524407
4	5	0.721935	3.609674
5	5	0.665461	3.327304

8-11 a. I would use the same cost of capital at both stores. The cost of equity is 7 + 1.4(5.5) = 14.7. The debt/equity ratio is 70%; hence, the debt/capital ratio is 7/17. The cost of capital is (7/17)(5.5) + (10/17)(14.7) = 10.91%.

b. You would not charge a higher cost of capital for the New York store because estimation errors are diversifiable.

8-13 a. If Philip Morris desires to use its own debt ratio of 25% for all its business, then the computation of the levered beta to be used for its tobacco business is as follows: the unlevered beta for firms in the tobacco business is 0.982; lever up this using Philip Morris's debt equity ratio of 33% to get 1.784. Hence, the cost of equity is 7 + 1.1784(5.5) = 13.481. The cost of capital is (0.75)(13.481) + (0.25)8(1 – 0.4) = 11.31%.

b. The cost of capital for the food business is computed similarly. The unlevered beta for firms in the food business is 0.645; lever up this using Philip Morris's debt equity ratio of 33% to get 0.774. The cost of equity is 7 + 0.774(5.5) = 11.257%. The cost of capital is (0.75)(11.257) + (0.25)8(1 – 0.4) = 9.643%.

c. It would make no sense to compute Philip Morris's firm cost of capital, since it is an arbitrary mix of different businesses. However, we could compute the average cost of equity for Philip Morris as 7 + 0.95(5.5) = 12.225, and the cost of capital as (0.25)(8)(1 – 0.4) + (0.75)(12.225) = 10.369%.

8-15 a. If debt is allocated to the two divisions in proportion to their market values, the debt ratios for both divisions will be the same as Philip Morris (25%). The costs of debt may be different for the two divisions, resulting in different costs of capital.

b. $\beta_{tobacco} = 0.982(1 + (1 - 0.4)(25/37.5)) = 1.37$

$\beta_{food} = 0.645(1 + (1 - 0.4)(0)) = 0.645$

$\text{Cost of Equity}_{tobacco} = 7\% + 1.37(5.5\%) = 14.53\%$

$\text{Cost of Capital}_{tobacco} = 14.53\%(37.5/62.5) + 10\%\ (1 - 0.4)(25/62.5) = 11.12\%$

$\text{Cost of Equity}_{food} = 7\% + 0.645(5.5\%) = 10.55\%$ (also cost of capital).

CHAPTER 9

9-1 We assume that revenues and SG&A expenses will increase at the rate of inflation.

Year	Revenue	COGS	Depreciation	SG&A	Operating Income Tax	After-tax Operating Income
1	20.60	12.36	1.00	2.06	5.18	3.11
2	21.22	12.73	1.00	2.12	5.37	3.22
3	21.85	13.11	1.00	2.19	5.56	3.33
4	22.51	13.51	1.00	2.25	5.75	3.45
5	23.19	13.91	1.00	2.32	5.96	3.57

9-3 Net Income each year = $\$(5 - 0.07 \times 25)(1 - 0.4) = \$1.95$ m.

9-5 a. The after-tax operating cash flow is computed as

Revenues	$5.00
COGS (w/o depr.)	$1.50
Depreciation	$2.00
EBIT	$1.50
EBIT $(1-t)$	$0.90
+ Depreciation	$2.00
ATCF	$2.90

b. Using the annuity formula, we have $(2.9/0.11)\,[1 - 1/1.11^5] = 10.72$ as the present value of the operating cash flows. Deducting the initial investment of \$10 m, we get an NPV of \$0.72 m.

c. The yearly increment to cash flow due to depreciation is the savings in taxes, which is $2(0.4) - 0.8$ m. The PV of this flow = \$2.96 m.

9-7 With an interest rate of 7%, the annual interest expense would have been $25{,}000(0.07) = \$1{,}750$. Hence the net income per year would be $7{,}800 - (1 - 0.4)(1{,}750) = \$6{,}750$.

Cash flows to equity would be $6{,}750 + 5{,}000 = 11{,}750$ each year, with an outflow of \$32,500 when the project is initiated, and an outflow of \$19,000 (\$25,000 − \$6,000) at the end of the period.

9-9 The annual cash flows are

Revenues	1-m bottles at \$1 each	\$1,000,000
Variable costs	1-m bottles at 50 cents each	\$500,000
Fixed costs		\$200,000
Depreciation	550,000/5	\$110,000
Before-tax Income		\$190,000
After-tax Income	190,000(1 − 0.50)	\$95,000
Depreciation		\$110,000
Total after-tax cash flow	\$205,000	

Outflows at the beginning for the initial investment would be \$550,000. (We have assumed that licensing costs are capitalized and depreciated.)

9-11 The annual cash flows are:

	1	2	3	4	5
Revenues	600,000.00	679,800.00	770,213.40	872,651.78	988,714.47
Software specialists	250,000.00	257,500.00	265,225.00	273,181.75	281,377.20
Rent	50,000.00	51,500.00	53,045.00	54,636.35	56,275.44
Depreciation	20,000.00	20,000.00	20,000.00	20,000.00	20,000.00
Marketing and selling costs	100,000.00	103,000.00	106,090.00	109,272.70	112,550.88
Cost of materials	120,000.00	135,960.00	154,042.68	174,530.36	197,742.89
Net income	60,000.00	111,840.00	171,810.72	241,030.63	32,0768.05
After tax income	36,000.00	67,104.00	103,086.43	144,618.38	192,460.83
Depreciation	20,000.00	20,000.00	20,000.00	20,000.00	20,000.00
Working capital	60,000.00	67,980.00	77,021.34	87,265.18	98,871.45
Change in WC	−7,980.00	−9,041.34	−10,243.84	−11,606.27	11,606.27
Cash flows	48,020.00	78,062.66	112,842.59	153,012.11	224,067.10

There is an initial investment of \$100,000 plus an initial outlay of \$60,000 for working capital. Taking these into account, the NPV = 249,808.85.

The project has a positive NPV and should be accepted.

9-13 a. If \$5 m of the \$10 m required are borrowed, the equity holders will need to initially put in \$5 m plus the \$1 m necessary for beginning working capital, that is \$6 million in all.

b. In this case, the after-tax cash flows would have to be reduced by \$5(0.08)(1 – 0.4) = \$240,000, for a net cash flow of 3,400,000 – 240,000 = 3,160,000 a year. The cash flow at the end of the project would be – \$5 m (loan repayment) + \$463,193 (working capital recoupment) = \$4.536 m.

9-15 a. Using straight-line depreciation, the depreciation each year = (15 – 3)/10 = \$1.2 m. At a tax rate of 40%, this results in a tax saving of \$0.48 m a year, for a total nominal value of \$4.8 m. The present value can be computed using the annuity formula: $[0.48/0.12]\ [1 - 1/1.12^{10}] = \$2.712$ m.

b, c. Using double-declining balance depreciation, the nominal value does not change. However, the depreciation is higher in earlier years, and the present value increases.

Year	Depr	Nominal Tax Savings	PV	Double-declining Depreciation	Year-end Book Value	Nominal Tax Savings	PV
0					15.000		
1	1.200	0.480	0.429	3.000	12.000	1.200	1.071
2	1.200	0.480	0.383	2.400	9.600	0.960	0.765
3	1.200	0.480	0.342	1.920	7.680	0.768	0.547
4	1.200	0.480	0.305	1.536	6.144	0.614	0.390
5	1.200	0.480	0.272	1.229	4.915	0.492	0.279
6	1.200	0.480	0.243	0.983	3.932	0.393	0.199
7	1.200	0.480	0.217	0.786	3.146	0.315	0.142
8	1.200	0.480	0.194	0.146	3.000	0.058	0.024
9	1.200	0.480	0.173	0.000	3.000	0.000	0.000
10	1.200	0.480	0.155	0.000	3.000	0.000	0.000
		4.800	2.712			4.800	3.418

The present value is \$3.418 m.

9-17 a. The straight-line method produces the higher nominal tax savings.

b. The straight-line method provides a higher present value of tax benefits.

Year	Depr	Tax Rate	Tax Savings	PV	Double-declining Balance	Nominal Tax Savings	PV
1	2.000	0.200	0.400	0.357	4.000	0.800	0.508
2	2.000	0.250	0.500	0.399	2.400	0.600	0.457
3	2.000	0.300	0.600	0.427	1.440	0.432	0.367
4	2.000	0.350	0.700	0.445	1.08	0.378	0.240
5	2.000	0.400	0.800	0.454	1.08	0.432	0.245
			3.000	2.082		2.652	1.99

We switched to straight line in year 4 with double declining balance depreciation.

CHAPTER 10

10-1

Year	Beginning BV	Depreciation	Ending BV	Average BV	Revenues	COGS	EBIT
1	25	3	22	23.5	$ 20.00	$ 10.00	$7.00
2	22	3	19	20.5	$ 22.00	$ 11.00	$8.00
3	19	3	16	17.5	$ 24.20	$ 12.10	$9.10
4	16	3	13	14.5	$ 26.62	$ 13.31	$10.31
5	13	3	10	11.5	$ 29.28	$ 14.64	$11.64

a. Pre-tax Return on Capital

Year	Average BV	EBIT	Pre-tax ROC
1	23.5	$ 7.00	29.79%
2	20.5	$ 8.00	39.02%
3	17.5	$ 9.10	52.00%
4	14.5	$ 10.31	71.10%
5	11.5	$ 11.64	101.23%
Average			58.63%

b.

Year	Average BV	EBIT (1–*t*)	After-tax ROC
1	23.5	$ 4.20	17.87%
2	20.5	$ 4.80	23.41%
3	17.5	$5.46	31.20%
4	14.5	$ 6.19	42.66%
5	11.5	$ 6.98	60.74%
Average			35.18%

c. Since the return on capital is greater than the cost of capital, I would accept the project.

10-3

Year	Beg BV Equity	Depreciation	End BV Equity	Avg BV Equity	Revenues	COGS	Internal Exp	Net Income
1	$ 15.00	$ 3.00	$ 12.00	$ 13.50	$ 20.00	$ 10.00	$1.00	$3.60
2	$ 12.00	$ 3.00	$ 9.00	$ 10.50	$ 22.00	$ 11.00	$1.00	$4.20
3	$ 9.00	$ 3.00	$ 6.00	$ 7.50	$ 24.20	$ 12.10	$1.00	$4.86
4	$ 6.00	$ 3.00	$ 3.00	$ 4.50	$ 26.62	$ 13.31	$1.00	$5.59
5	$ 3.00	$ 3.00	$ –	$ 1.50	$ 29.28	$ 14.64	$1.00	$6.38

a.

Year	Avge BV Equity	Net Income	ROE
1	13.5	$ 3.60	26.67%
2	10.5	$ 4.20	40.00%
3	7.5	$ 4.86	64.80%
4	4.5	$ 5.59	124.13%
5	1.5	$ 6.38	425.64%
Average			136.25%

b. Since the return on equity is greater than the cost of equity, I would accept the project.

10-5

Year	0	1	2	3	4
Investment	15,000		2,000		
WC Investment	1,000				
Salvage					7,000
Revenues		$10,000	$ 11,000	$ 12,000	$ 13,000
–COGS		$ 4,000	$4,400	$ 4,800	$ 5,200
–Depreciation		$ 4,000	$ 3,000	$ 2,000	$ 1,000
EBIT		$ 2,000	$ 3,600	$ 5,200	$ 6,800
EBIT (1 – *t*)		$ 1,200	$ 2,160	$ 3,120	$ 4,080
+ Depreciation		$ 4,000	$ 3,000	$2,000	$ 1,000
– Change in WC		$ 100	$ 100	$ 100	$ (1,300)
FCFF	$ (16,000)	$ 5,100	$ 3,060	$5,020	$ 13,380

a. See above.

b. Payback

Cumulated FCFF	$ (16,000)	$ (10,900)	$ (7,840)	$ (2,820)	$ 10,560

Payback is early in the fourth year.

c. NPV of Project at 12% cost of capital

PV of Cash flow	$ (16,000)	$4,554	$ 2,439	$ 3,573	$ 8,503

NPV of Project = $ 3,069.35

d. IRR of Project 19.26%

10-7

Year	FCFF
0	$ (10,000,000)
1	$ 4,000,000
2	$ 5,000,000
3	$ 6,000,000

Discount Rate	NPV	Discount Rate	NPV
2%	$4,381,347	18%	$632,538
4%	$3,802,913	20%	$277,778
6%	$3,261,283	22%	($57,758)
8%	$2,753,391	24%	($375,449)
10%	$2,276,484	26%	($676,553)
12%	$1,828,079	28%	($962,219)
14%	$1,405,939	30%	($1,233,500)
16%	$1,008,036		

The internal rate of return of this project is about 21%. I would accept the project because its return is greater than the cost of capital. (The cost of equity does not apply.)

10-9

FV of year 1 cash flow = $4{,}000{,}000 \times 1.16^2 = 5{,}382{,}400$

FV of year 2 cash flow = $4{,}000{,}000 \times 1.16 = 4{,}640{,}000$

FV of year 3 cash flow = – 3,000,000

FV of years 1–3 cash flows = 7,022,400

Investment in year 0 = –4,750,000

Modified IRR = $(7{,}022{,}400/4{,}750{,}000)^{1/3} - 1 = 13.92\%$

I would still reject the project.

10-11 Generally not. Because you need a sign change (from negative to positive cash flows) for IRR to be estimated. It is possible that you could still get an operating cash flow that is negative in some years, but the IRR will be huge and meaningless.

10-13

Year		A	B	C	
0		–10,000	5,000	–15,000	
1		8,000	5,000	10,000	
2		7,000	–8,000	10,000	
a.	NPV	$2,723.21	$3,086.73	$1,900.51	! B is the best project on a NPV.
b.	IRR	32.74%	–13.99%	21.53%	! A is the best project.

c. The reasons can be partially attributed to differences in scale, and difference in reinvestment rate assumptions. The strange pattern of cash flows on B also throws off the IRR rule. The IRR rule is devised when cashflows go from negative to positive, not the other way around.

10-15 a. FCFF each year = 3 (1 – 0.4) + 0.5 = 2.30
NPV = –20 –5/1.125^{10} –5/1.125^{20} + 2.3 (PVA, 12.5%,30) + 15/1.125^{30} = –$3.71

b. IRR of this project

Discount Rate (%)	NPV
5	13.87328541
10	–0.129403014
12.50	–3.713174369
15	–6.213125943

10-17 Yes. When the cash flow pattern is reversed, that is, when cash flows are positive up front and negative late can be negative while the NPV is positive. (See problem 10–14.)

10-19 The average return on capital is overstated when accelerated depreciation is used because the book value drops quickly. The return on capital increases concurrently. The average return on capital is not time-weighted and overstates the true return on the project.

CHAPTER 11

11-1 a. The real cost of capital = (1.1/1.025) – 1 = 7.317%.

b, c. The real cash flows are obtained by discounting the nominal flows at the rate of inflation. The present values are obtained by discounting the real flows at the rate of 7.317% per year.

Year	Nominal Flows	Real Flows	Present Value
1	115	112.1951	104.5455
2	125	118.9768	103.3058
3	136	126.2895	102.1788
4	144	130.4569	98.35394
5	185	163.513	114.8704

The net present value is the sum of the present values, or $523.2544.

11-3 a. The depreciation each period is 250/25 = $10 m. Assuming a tax rate of 40%, the tax benefit is $4 m a year. The present value of this over 25 years is $98.226 m using the 9% cost of capital as a discount rate.

b. If the inflation rate jumps to 5%, the cost of capital will jump to 12%, but the nominal amount of yearly depreciation remains the same. The present value of this now drops to $78.431 m.

c. International Harvester could lease its plant; this would shift the risk of losing depreciation tax benefits to the lessor. Also, if depreciation is indexed to inflation, International Harvester would be protected.

11-5

Country	Inflation Rate	Expected Change	Actual Change
China	12.10%	8.30%	3.35%
Indonesia	20.60%	14.76%	4.96%
Malaysia	10.10%	6.63%	2.39%
Singapore	1.30%	–1.48%	–4.08%
S. Korea	2.40%	–0.39%	–3.39%
Japan	2.00%	–0.78%	–2.96%
Taiwan	2.90%	0.10%	0.41%
Thailand	6.60%	3.56%	2.10%
Philippines	11.00%	7.39%	8.71%
India	10.10%	6.63%	11.90%
United States	2.80%	0.00%	

There is a high correlation between the expected and actual change. The three countries that had currencies that strengthened against the dollar also had inflation rates lower than the United States.

11-7

Forward Rate = Spot Rate (1 + Domestic Rate)/(1 + Overseas Rate)

1.55 = 1.56 (1.05)/(1 + r)

Solve for r,

r = (1.55/1.56) × (1.05) – 1 = 4.33%

11-9 a.

Year	CF In DM	Expected $/DM	CF in $
0	–15,000	$ 0.6500	$ (9,750)
1	1,350	$ 0.6563	$ 886
2	1,485	$ 0.6626	$ 984
3	1,634	$ 0.6689	$ 1,093
4	1,797	$ 0.6754	$ 1,214
5	1,977	$ 0.6819	$ 1,348
6	2,174	$ 0.6884	$ 1,497
7	2,392	$ 0.6950	$ 1,663
8	2,631	$ 0.7017	$ 1,846
9	2,894	$ 0.7085	$ 2,050
10	3,183	$ 0.7153	$ 2,277

b. You might want to adjust this discount rate to reflect differences in inflation (if the analysis is done in the local currency) or differences in risk (exchange rate, political). I would not adjust the cost of capital for The Limited if I were doing the analysis in dollars, since I think that The Limited's investors are likely to be internationally diversified and can take care of exchange rate risk.

If I were doing the analysis in DM, I would use a cost of capital of approximately 11%: 1.12 × (1.04/1.05) – 1 = 10.93%.

c. NPV (in dollar terms, using 12% cost of capital) = ($2,132.11).

d. NPV (in DM terms, using 10.93% cost of capital) = (3,278 DM).

11-11 a.

Year	CF (Yuan)	$/Yuan	CF ($)
0	–1,600	$0.12	$(188.24)
1	–800	$0.11	$(86.55)
2	–1,000	$0.10	$(99.50)
3	150	$0.09	$13.73
4	300	$0.08	$25.25
5	500	$0.08	$38.69
6	650	$0.07	$46.26
7	800	$0.07	$52.36
8	900	$0.06	$54.17
9	1,000	$0.06	$55.35
10	1,100	$0.05	$56.00
11	1,210	$0.05	$56.65
12	1,331	$0.04	$57.30
13	1,464	$0.04	$57.97
14	1,611	$0.04	$58.66
15	1,772	$0.03	$59.34

b. We will assume that the country risk in China is significant enough to be considered in setting the discount rate.

China risk premium = 3.5% × 2 = 7%.

Cost of Equity ($) = 10% + 7% = 17%.

c. NPV (in dollar terms, at 17%) = (–180.72).

d. It should not matter. If the discount rate is also in yuan, the net present value should be the same.

CHAPTER 12

12-1

Project	Investment	NPV	PI	
A	$25	$10	0.40	
B	$30	$25	0.83	Accept
C	$40	$20	0.50	Accept
D	$10	$10	1.00	Accept
E	$15	$10	0.67	Accept
F	$60	$20	0.33	
G	$20	$10	0.50	Accept
H	$25	$20	0.80	Accept
I	$35	$10	0.29	
J	$15	$5	0.33	

b. Cost of Capital Rationing Constraint = NPV of rejected projects = $45 million

12-3 NPV(I) = – 12,000 – 500/0.1 = – 17,000

EAC(I) = – 17,000 × 0.1 = – 1,700

Remember that this is a perpetuity: PV = A/i; A = PV × i;

NPV(II) = – 5,000 – 1,000(1 – (1.1)^(–20))/0.1 = – 13,514 EAC(II) = – 1,587

NPV(III) = – 3,500 – 1,200(1 –(1.1)^(–15))/0.1 = –12,627 EAC(III) = – 1,660

CHOOSE OPTION II (GAS HEATING SYSTEM)

12-5 EAC for 1-year subscription = $20

EAC for 2-year subscription = $36 (APV,20%,2) = $23.56

EAC for 3-year subscription = \$45 (APV,20%,3) = \$21.36

Choose the 1-year subscription.

12-7 The existing machine has an annual depreciation tax advantage = 500,000(0.40)/5 = 40,000. The present value of this annuity equals $(40{,}000/0.1)[1\text{-}1/1.1^5]$ = 151,631.47.

The new machine has an annual depreciation tax advantage = 2,000,000(0.40)/10 = 80,000. The present value of this annuity equals $80{,}000/0.1[1\text{-}1/1.1^{10}]$ = 491,565.37.

However, it will be necessary to spend an additional 1.7 m to acquire the new machine.

Net Cost of the New Machine = –1,700,000 + 491,565 – 151,531 = \$1,360,066.

Solving, for the annual savings that we would need each year for the next 10 years, Annual Savings = \$ 1,360,066 (Annuity given PV, 10 years, 10%) = \$221,344. (I am assuming no capital gains taxes. If there are capital gains taxes, the initial investment will be net reduction because of capital losses from the sale of the old machine.)

12-9 NPV of less expensive lining = – 2,000 – 80 (AF, 20%, 3) = \$(2,169)

EAC of less expensive lining = –2,168.52/(AF, 20%, 3) = \$(1,029)

Key question: how long does the more expensive lining have to last to have an EAC < – 1,029.45?

NPV of more expensive lining = –4,000 – 160 (AF, 20%, *n* years)

EAC of more expensive lining = NPV/(AF, 20%, *n* years)

Try different lifetimes. You will find that the EAC declines as you increase the lifetime and that it becomes lower than 1,029.45 at 14 years.

12-11 NPV of Project A = –5,000,000 + 2,500,000 (PVA, 10%, 5) = \$4,476,967

Equivalent Annuity for Project A = 4,476,967 (APV, 10%, 5) = \$1,181,013

NPV of Project B = 1,000,000 (PVA, 10%, 10) + $2{,}000{,}000/1.1^{10}$ = \$6,915,654

Equivalent Annuity for Project B = 6,915,654 (APV, 10%, 10) = \$1,125,491

NPV of Project C = $2{,}500{,}000/0.1$ – $10{,}000{,}000 - 5{,}000{,}000/1.1^{10}$ = \$13,072,284

Equivalent Annuity for Project C = 13,072,284 × 0.1 = \$1,307,228

12-13 Annualized Cost of spending \$400,000 right now = \$400,000 (0.10) = \$40,000

Maximum Additional Cost that the town can bear = \$100,000 – \$40,000 = \$60,000

Annual expenditures will have to drop more than \$40,000 for the second option to be cheaper.

12-15

Project	Initial Investment	NPV	PI	IRR
I	5	3	0.60	21%
II	5	2.5	0.50	28%
III	15	4	0.27	19%
IV	10	4	0.40	24%
V	5	2	0.40	20%

a. The PI would suggest that the firm invest in projects II, IV, and V.

b. The IRR of project I is higher than the IRR of project V.

c. The differences arise because of the reinvestment rate assumptions; with the IRR, intermediate cash flows are reinvested at the IRR; with the PI, cash flows are reinvested at the cost of capital.

12-17 Initial Investment = – \$150,000

Annual Cash Flows from Babysitting Service

Additional Revenues \$1,000,000

ATCF = \$1,000,000 (0,10) – \$ 60,000 (1 – 0.4) = \$64,000

(I used a tax rate of 40%.)

NPV = – 150,000 + \$64,000 (PVA, 12%, 10 years) = \$211,614

Yes. I would open the service.

12-19 a. There is no cost in the first three years. The after-tax salary paid in the last two years is an opportunity cost = $80{,}000 \times 0.6/1.1^4 + 80{,}000 \times 0.6/1.1^5$ = \$62,589.

b. The opportunity cost is the difference in PV of investing in year 4 instead of year 8 = $250{,}000/1.1^4 - 250{,}000/1.1^8$ = \$54,126.

c. The present value of after-tax rental payments over five years is the opportunity cost = (3000 × 0.6)(PVA, 10%, 5 years) = \$6,823.

d. After-tax cash flow = (400,000 – 160,000) – (240,000 – 100,000) × 0.4 = \$184,000

e. NPV = –500,000 –62,589 – 54,126 – 6,823 + $184{,}000(1 - (.1.1)^{-5})/0.1$ = \$73,967

12-21

Year	Potential Sales	Lost Sales	Lost Profits	PV Lost Profits
1	27,500	0	$0	$0
2	30,250	250	$9,000	$7,438
3	33,275	3,275	$117,900	$88,580
4	36,603	6,603	$237,690	$162,345
5	40,263	10,263	$369,459	$229,405
6	44,289	14,289	$514,405	$290,368
7	48,718	18,718	$673,845	$345,789
8	50,000	20,000	$720,000	$335,885
9	50,000	20,000	$720,000	$305,350
10	50,000	20,000	$720,000	$277,591
Opportunity Cost				**$2,042,753**

CHAPTER 13

13-1 a. Net Working Capital equals 91,524 – 50,596 = 40,928.

b. Noncash working capital equals 40,928 – 19,927 + 36,240 = $57,241.

c. Ford's working capital is high because it has a high amount of receivables. If Ford Capital were consolidated into this balance sheet, then this would make sense since Ford Capital's business is to make short-term loans to enable consumers to purchase cars.

d. Noncash working capital as a percent of revenues for the 1994 year is 36.94% If I wanted to estimate noncash working capital for a future year, I could use this ratio along with an estimate of future revenues. Whether this is a good way of forecasting working capital in the future will depend upon how volatile this number is from period to period.

13-3 a., b. If inventory requirements dropped by 50%, there would have been an immediate reduction inventory of $54.2. In addition, each year, accretions to working capital would be 6% of this amount less than otherwise. This would increase cash flow by the same amount. The present value of this is 54.2 + 54.2 (0.06)/(0.11 – 0.06) = $119.24 m.

13-5 Free Cash Flow to Firm = After-tax Operating Income – Change in Working Capital = $5 million (1.05) – ($100 million) (0.05) (0.2) = $4.25

Value of Firm = $4.25/(0.12 – 0.05) = $60.71.

Increase in Current Cash Flow from cutting back inventory = $8 million

Firm value has to be at least $52.71 million to break even.

Let the revenues be X.

After-tax Operating Income = X (0.05)! After-tax Operating Margin is 5%.

Change in Working Capital = X (0.05) (0.12)! Working Capital is now 12% of revenues

Free Cash Flow to Firm = $X(0.05) - X(0.05)(0.12)$

Value of Firm = $52.71 = $X(0.05)(0.88)/(0.12 - 0.05)$

Solve for X,

X = $83.86

Revenues have to be at least $83.86 million for a firm to break even.

If revenues drop more than $16.14 million, the firm will be worse off.

13-7

Period	Current Assets	Current Liabilities	Revenues	Working Cap	Current Assets as % of Revenues
1990-Q1	$300	$150	$3,000	$150	10.00%
1990-Q2	325	160	3,220	165	10.09%
1990-Q3	350	180	3,450	170	10.14%
1990-Q4	650	300	6,300	350	10.32%
1991-Q1	370	170	3,550	200	10.42%
1991-Q2	400	200	4,100	200	9.76%
1991-Q3	420	220	4,350	200	9.66%
1991-Q4	755	380	7,750	375	9.74%
1992-Q1	450	220	4,500	230	10.00%
1992-Q2	480	240	4,750	240	10.11%
1992-Q3	515	265	5,200	250	9.90%
1992-Q4	880	460	9,000	420	9.78%
1993-Q1	550	260	5,400	290	10.19%
1993-Q2	565	285	5,600	280	10.09%
1993-Q3	585	300	5,900	285	9.92%
1993-Q4	1010	500	10,000	510	10.10%
1994-Q1	635	330	6,500	305	9.77%
1994-Q2	660	340	6,750	320	9.78%
1994-Q3	665	340	6,900	325	9.64%
				Average=	**9.97%**

a. See above

b. See above

c. The percent (working capital of revenues) should decline as revenues increase. There seems to be little evidence of that.

13-9 If sales were random, and the standard deviation of sales is 4,000 units, we'd have to decide on the acceptable probability of running out of inventory. If this is taken to be 1%, then we'd increase the safety inventory by 2(4,000) or 8,000 units to 9,500 units. Hence, the average inventory would increase to 9,712 units.

13-11 a.

Firm	Inventory	Revenues	Inventory/ Revenues
Apple	473	6,134	7.72%
Cisco	655	12,154	5.39%
Compaq	2,131	39,250	5.43%
Dell	374	25,600	1.46%
Gateway	172	8,650	1.99%
HP	2,637	42,370	6.22%
IBM	5,130	88,000	5.83%
Iomega	132	1,694	7.79%
Micron	223	1,438	15.51%
NCR	392	6,200	6.32%

b. Regressing Inventory on ln(Revenues), we find that

$$\text{Inventory/Revenue} = 0.2174 - 0.0164\ (\ln \text{Revenues})$$
$$(2.86) \quad (2.05)$$

$R^2 = 34.36\%$

c. According to the regression in part (b), Apple should have inventory of 0.2174 – 0.0164 [ln(6134)] = 0.0744 (7.44%). Its actual inventory (7.72%) is very close. IBM should have an inventory holding of 3.07%.

$R^2 = 38.60\%$

13-13 a. Implied Interest Rate = $(1 + 2/98)^{(365/40)-1}$ = 20.24%

b. Implied Interest Rate if customer takes 100 days = $(1 + 2/98)^{(365/90)-1}$ = 8.54%

CHAPTER 14

14-1 The optimal cash balance using the Baumol model is $\sqrt{2(500)100/0.06}$ = $1,291.

If selling securities is costless and without any lag, then the firm should hold all of its cash in the form of interest-bearing securities and simply sell them whenever cash is required.

14-3 If interest rates increase, I would expect the cost of holding non-interest bearing cash to increase, leading to a drop in optimal cash balances.

14-5 a. Spread between upper and lower cash limits = $120,498.

b. The average cash balance will be between $60,249: half of $120,498.

c. If there is a safety balance of $50,000,

Upper Limit = $50,000 + $120,498 = $170,498

Average Balance will increase to $110,249.

14-7 a. The initial outlay is (0.02)250 = $5. One year from now, the incremental outlay will be (0.02)(250)(0.06) = 0.3; the present value of the yearly incremental outlays is 0.3/(0.12 – 0.06) = $5. The total decrease in value is $5 + $5 = $10 less any value that the firm might obtain from having the cash balances.

b. If it is able to reduce its cash balance to 1% of revenues, the immediate decrease in the cash balance would be (0.01)(250) = $2.50;

the incremental outlay one year from now will be (0.01)(250)(0.06) = 0.15, for a present value of 0.15/(0.12 – 0.06) = \$2.5; hence, firm value will jump by \$5 million.

c. If the reduced cash balance makes the firm riskier, then the value of the firm will jump by less by \$10 million, and it might even decrease. This is because, first, the present value of the annual savings would be lower; and second, the present value of the other operating cash flows themselves would be lower due to the higher discount rate.

14-9 a. The annualized returns are:

(i) 3-month T-bill: The price of a T-bill with a face value of \$100 is 100(1 – 0.056/2) = 97.2; hence, the annualized return is $(100/97.2)^2$ or 5.844%

(ii) commercial paper: $(1.0298)^2 - 1$ or 6.0488%

(iii) repo agreement: $(1.0292)^2 - 1$ or 5.9253%

b. There is least risk in the T-bill; the commercial paper is riskiest because it is issued by private corporations with a nonnegligible default risk. The repo agreement has better security, but there is still the possibility of default. The returns on the three securities are consistent with their different riskinesses.

c. I would check to see if any of these were misvalued; if so, I would buy that security. Assuming that all of these securities were properly priced, I would look at the cost of converting them into cash. As a corporate treasurer, this is probably what is most important for me.

14-11 If Chimera invests its cash at 3%, then the value of its cash assets would be \$1(0.03)/(0.06) = \$0.5 billion. The value of the firm would be 7.936 + 0.5 = \$8.436 billion.

The firm's accounting return on equity would be [5,000(20) + 1,000(3)]/6,000 = 17.167% before the dividend payment, and [5,000(20) + 500(3)]/5,500 = 18.4545% after the dividend payment. The value of the firm would decrease by only 0.25 billion, even though \$0.5 billion would have been paid out.

14-13 a. Intel is paying a premium of 1.5/[(0.2)(5)] – 1 or 50% for its 20% stake.

b. Let x be the after-tax cashflow that Intel will earn on its invested \$1.5 billion. The net present value of the cashflows would be $x[1 - 1.12^{-5}]/0.12$ = \$0.5 billion. The after-tax cash flow (x) would have to be \$138.70 million.

CHAPTER 15

15-1 The Cash Flow Return on Investment (CFROI) is computed using the Gross Cash Flow and the Gross Investment. GI is defined as Net Asset Value + Cumulated Depreciation on Assets + Current Dollar Adjustment. This works out to (\$8,000 + \$3000) $(1.02)^4$ = \$11,906.754 million. The GCF = (1,300)(1 – 0.35) + 520 = 1365 m. Salvage value = (0.4)(11,907) = \$4,763.

The CFROI is the internal rate of return on an investment requiring an initial outlay of \$11,906.754, annual flows of \$1,365 every year for 15 years, and a salvage value of \$4,763. This works out to 9.50%.

The nominal cost of capital for Crown Cork and Seal is (0.5)(1 – 0.35)(0.08) + (0.5)(0.065 + 1.2(0.055)) = 9.15%, or 7.15% in real terms, after subtracting the inflation rate of 2%. This is lower than the CFROI of 9.50%. Hence, the current investments of the firm are value-increasing.

15-3 a. The cost of capital = (0.3)(1 – 0.35)(0.07) + (0.70)[0.065 + 1.1(0.055)] = 0.1015. EVA in 1998 = EBIT $(1 - t)$ – Cost of capital(Capital Invested) = 750(1 – 0.35) – (0.1015)(3,600) = \$122.1 million.

b. The levered beta appropriate to the battery business is 0.85[1 + (1 – 0.35)(3/7)] = 1.0868.

The cost of capital for the Eveready division is (0.3)(1 – 0.35)(0.07) + (0.70)[0.065 + 1.0868(0.055)] = 0.101.

The EVA of the Eveready division in 1998 is 0.34(750)(1 – 0.35) – (0.101)(3,600)(0.42) = 13.038 million.

15-5 Most utilities in the United States operate in businesses that are natural monopolies—that is, they are businesses where it is not possible to have competition. They are regulated to prevent them from reaping the spoils of their monopolistic position—higher prices and higher profits. If

the regulations were removed and they continued to be natural monopolies, they would increase their excess returns.

15-7 As a private firm, you might be more efficiently run than your competitors and have lower overhead expenses. You might also have the capacity to be more flexible than your competition. Your competitors, on the other hand, may have better access to funds and be less exposed to the kinds of firm-specific risk that you have to worry about.

15-9 a. Patents provide explicit protection against competition, allowing the firms that possess them to charge higher prices and earn higher returns.

b. If patent protection were weakened, I would expect excess returns in the pharmaceutical industry to drop.

c. If there is no patent protection, pharmaceutical firms will have to compete like all other consumer product firms—with advertising to create brand names—by reducing costs and establishing a cost advantage or by offering products tailored to market segments that are not being served. Firms with low-cost structures and good marketing teams are likely to be winners.

15-11 a. Given that the personal computer market is an intensely competitive one, with several large players, I would recommend a niche computer that would take advantage of her technical expertise and her capacity to keep overhead costs down.

b. She would need to convert her technical expertise—say, in graphics design—to produce a computer that served professional graphics designers better than the existing products. Furthermore, she would need to team up with a production specialist who could then produce these computers at low cost.

c. I think that a sophisticated niche offering, priced with higher margins, provides the best opportunity for a small firm with technical expertise.

15-13 a. McDonald's was the first fast-food chain. It offered a standardized menu at low prices at all its locations. As the first entrant to do this successfully with independent franchises, it reaped enormous gains.

b. McDonald's clearly has unparalleled brand-name recognition, especially overseas. I would foresee it taking advantage of this to grow internationally.

15-15

Year	Forecast CF	Actual CF
0	–100,000	–105,000
1	20,000	15,000
2	25,000	20,000
3	30,000	25,000
4	35,000	30,000
5	40,000	35,000

a. Forecast IRR 13.45%

b. Actual IRR 5.34%

c. The project did not add value to the firm since it earned only 5.34%.

15-17

	ROE	Cost of Equity	Peer Group ROE	Forecast ROE
Software firm	20.50%	13.60%	16.00%	22.00%
Auto firm	12.50%	14.70%	10.00%	10.50%

a. The software firm did better than its required rate of return, whereas the auto firm lagged its required return.

b. The software firm did better than its peer group, as did the auto firm.

c. The software firm did less well than the market expected it to, whereas the auto firm did better.

15-19 a.

Firm	ROE	Cost of Equity	Differential
Chrysler	14.00%	14.60%	–0.60%
Ford	16.00%	14.05%	1.95%
GM	11.50%	14.33%	–2.83%

b. I would conclude that Ford picked the best projects and GM the worst.

c. The return on equity is a flawed measure because it focuses on accounting income instead of cash flows and it also reflects all projects taken by the company rather than just the most recent ones. Furthermore, the book value of equity can be affected by actions such as buybacks.

15-21

Year	Forecast CF	Actual CF	PV at 12%	PV of actual at 11.5%
1986	−1,500	−2,200	$(1,500.00)	$(2,200.00)
1987	100	−150	$89.29	$(134.53)
1988	150	50	$119.58	$40.22
1989	200	100	$142.36	$72.14
1990	250	150	$158.88	$97.05
1991	275	100	$156.04	$58.03
1992	300	175	$151.99	$91.07
1993	325	200	$147.01	$93.35
1994	350	200	$141.36	$83.72
1995	350	175	$126.21	$65.70

a. NPV of Project using forecast CF and 12% discount rate = ($267.28)

b. NPV of Project using actual CF and 11.5% discount rate = ($1,733.3)

c. PV of continuing the project = 175/0.115 = $1,521.74

Salvage Value of Project today = $1,500.00. Continue the project.

CHAPTER 16

16-1 Income bonds do share some characteristics with preferred stock. The primary difference is that interest paid on income bonds is tax deductible while preferred dividends are not. Income bondholders also have prior claims on the assets, if the firm goes bankrupt. In calculating cost of capital, the primary difference again will be that the cost of income bonds will be lower because of the tax savings.

16-3 The first characteristic—a fixed dividend and a fixed life—is a characteristic of debt, as is the last one—no voting rights. The other two—no tax deductions and secondary claims on the assets—make it more like equity. In fact, this security looks a lot like preferred stock, and I would treat it as such.

16-5 The convertible bond is a 10-year bond with a face value of $1,000 and a coupon rate of 5%. If it yielded the same rate as the straight bond, that is, 8%, its price would be equal to $25/0.04\ (1 - 1/1.04^{20}) + 1000/1.04^{20} = 796.15$, assuming semiannual coupons. Hence, the equity component of the convertible can be estimated as 1,100 − 796.15 = 303.85.

The total equity component of the firm's asset value = 50(1 m) + 303.85(20,000) = $56.077 m.

The debt component = $25 m + 796.15(20,000) = 40.923 m.

Hence, the debt ratio = 40.923/(40.923 + 56.077) = 42.19%

16-7 There are two factors. One is that small high-growth companies do not have substantial current cash flows. Convertible bonds, by keeping the interest expense low allow these companies to borrow. The second factor is that small high-growth companies tend to be volatile. This volatility makes the conversion option more valuable to investors and reduces the interest expense on the debt further.

16-9 Value of Common Stock = 1 million × 50 = $50 million

Value of Warrants = 200,000 × $12 = $2.4 million

Value of Straight Debt = $250 million

Value of Straight Debt portion of Convertible Debt = $10{,}000 \times (60 \times (\text{PVA}, 9\%, 10) + 1{,}000/1.09^{10}) = \$8.075$ million

Value of Conversion Option = 10,000 × 1,000 − $8,075,000 = $1.925 million

Value of Debt = $250 + $8.075 = $258.075 million

Value of Equity = $50 + $2.4 + $1.925 million = $54.325 million

Debt Ratio = 258.075/(258.075 + 54.325) = 82.61%

16-11 Bank debt may be preferable for those companies that have substantial private information on their riskiness (or lack of it). While they may not be willing to reveal this information to bond markets (where even competitors could observe it), they may be willing to reveal it to a bank (where there is a greater chance of confidentiality).

16-13 Interest is tax deductible, whereas preferred dividends are not. This statement is generally true for companies paying taxes.

CHAPTER 17

17-1 a. The cost of internal equity = 6.5 + 1.2(6) = 14.3%

b. The cost of external equity = (100/95)(14.3) = 15.0526%

17-3 We assume that Office Helpers is choosing to go public instead of using venture capital. Furthermore, we assume that the market valuation of $120 will hold even with the IPO. Finally, let us assume that $20 million needs to be raised. Now, if the target price is $10, which represents an underpricing of 20%, the true value of the shares will be 10/.8 = $12.5 per share. At this price, the firm would have to issue 20/10 or 2 million shares. Since the 2 million shares will represent a value of $25 million, the total number of shares outstanding would be 2(120/25) = 9.6 million shares. Of this, the existing shareholders would get 7.6 million shares, representing a value of (7.6/9.6)120 = $95 m; the public shareholders would get (2/9.6)120 = $25 m for which they would have paid 2(10) = $20 m, or an undervaluation of 5/25 or 20%.

17-5 a. The expected return using the CAPM is 6.5 + 1.1(6) = 13.1%.

b. Venture capitalists typically have to invest a large portion of their portfolio in a single firm; hence there is a lot of diversifiable risk that they would have to hold. Furthermore, firms requiring venture capital would normally be riskier than other firms in the industry.

17-7 I would agree with this statement. I would test it empirically by looking at the extent of underpricing for firms of different sizes. I would also look at the degree of underpricing of well-known firms that decide to go in for an IPO.

17-9 a. Number of shares you would need to sell in rights offering = $100 mil/$25 = 4 million

Number of shares outstanding = 10 million

You would need five rights to buy two shares.

b. Ex-rights price = (50 × 10+25 × 4)/14 = $42.86

c. Value per right = Pre-rights price – Ex-rights price = $50 – $42.86 = $7.14

d. If the price of the right were higher than $7.14, I would sell my rights at the higher price and keep the difference as excess return. The stock price after the rights issue and the cash will yield me more than what I paid for the stock, which was $50.

17-11 a. The current capital is $15(1 million shares) = $15 million. Additional capital to be raised is $10(0.5 million shares) = $5 million. Hence, net income after the issue will be $1 million(20/15) = $1.33 million. EPS would be 1.33/1.5 = 88.67 cents per share.

b. Earnings per share under this alternative scenario would be 1.33/1.33 = $1 per share.

c. No, if I have availed myself of the rights issue; in this case, I would have the same proportional ownership of the firm. Even if I had sold the right, I would have been compensated for the lost value.

CHAPTER 18

18-1 a. Annual tax savings from debt = $ 40 million × 0.09 × 0.35 = $1.26

b. PV of Savings assuming savings are permanent = $40 million × 0.35 = $14.00

c. PV of Savings assuming savings occur for 10 years = $1.26 (PVA, 9%, 10) = $8.09

d. PV of Savings will increase:
If savings are permanent = 1.26/0.07 = $18.00
If savings are for 10 years = $1.26 (PVA, 7%, 10) = $8.85

18-3 a. Ignoring the net operating loss

PV of Tax Savings = $5 billion (0.36) = $1.8 billion

b. Yes. The net operating loss will mean that this tax savings will not occur for a while. For instance, if it will be five years before Westinghouse will have enough taxable income to claim the interest deduction, this $1.8 billion should be discounted back five years to arrive at the present value.

18-5 a. Moderate. The low leverage may provide an opening.

b. Moderate to High. The poor projects and the low leverage may make them susceptible; the poor earnings may act as impediment.

c. Low.

d. Low.

e. Highest.

18-7 That is not true. Due to the agency conflicts between stockholders and bondholders, bondholders charge higher interest rates or write in much stronger covenants, either of which imposes real costs on the firm.

18-9 That is also not true. There is a cost to maintaining flexibility–opportunity costs associated with maintaining excess debt capacity and large cash balances. These costs may outweigh the benefits for some firms, especially those with mediocre investment prospects.

18-11 Of $1 paid to bondholders from corporate before-tax income, the bondholder gets (1 – 0.4) = 60 cents. Of the same dollar paid to equity holders, the equity holder gets (1 – 0.3)(1 – 0.2) = 56 cents. Hence, debt does have a tax advantage.

If a firm with no debt and a market value of $100 million borrowed $50 million in this world, it would obtain a benefit of 1 – 0.56/0.6 = 1/16 of the amount issued, or 50/16 = $3.33 million. Hence, the firm value would be 100 + 50 + 3 = $153 million.

18-13 a. The past policy of not using debt can be justified by noting that returns on projects were high (increasing the need for flexibility) and that earnings in the future were likely to be volatile (because of the growth).

b. Given that returns on projects are declining, I would argue for a greater use for debt.

18-15 Bond covenants have a real cost to firms because they reduce their flexibility. These covenants might prevent firms from taking good projects (if the covenants restrict investment policy), repurchasing stock, or taking fresh debt for new projects.

18-17 a. An electric utility is regulated (reducing agency costs), has stable and predictable cash flows (reducing bankruptcy needs), and knows its future investment needs with some precision (reducing the need for flexibility). All of these factors will increase its capacity to carry debt.

b. Yes. Both the regulation and the monopoly characteristics reduce the agency costs and bankruptcy costs, increasing debt capacity.

18-19 I would expect the debt ratios of large firms to increase because governments will then bear a portion of the bankruptcy costs.

18-21 I would expect strong firms to issue straight debt and financially weak firms to issue preferred or convertible preferred.

18-23 The fact that the stock price goes to zero in a bankruptcy is not caused by the bankruptcy but by the actions that the firm has taken in the years prior that reduced cash flows and value. In other words, it is not caused by the bankruptcy itself and should not be viewed as cost occurring as a consequence of it.

18-25 It is in the interests of incumbent managers to keep leverage low. By doing so, they minimize the chances that the firm will go bankrupt (which might affect their personal value) substantially, and they also reduce the oversight that might come with higher debt ratios. Thus, you would expect firms to be underlevered if stockholders do not have much power.

18-27 High growth cellular firms often have significant needs for funds for long-term infrastructure investments. Debt is usually used for these investments. Brand name firms often value flexibilities and many borrow less than they can afford to.

CHAPTER 19

19-1 (1) Book Value Debt/Equity Ratio = 2,500/2,500 = 100%

Market Value of Equity = 50 × 80 = 4,000

Market Value of Debt = 0.80 × 2,500 = 2,000

Debt/Equity Ratio in market value terms = 2,000/4,000 = 50,00%

(2) Book Value Debt/(Debt + Equity) = 2,500/(2,500 + 2,500) = 50%

Market Value Debt/(Debt + Equity) = 2,000/(2,000 + 4,000) = 33.33%

(3) After-tax Cost of Debt = 12% (1 – 0.4) = 7.20%

(4) Cost of Equity = 8% + 1.2 (5.5%) = 14.60%

(5) Cost of Capital = 14.60% (4,000/6,000) + 7.20% (2,000/6,000) = 12.13%

19-3 (a), (b), and (c)
Unlevered Beta = Levered Beta/$(1 + (1 - t)(D/E))$
$= 1.2/(1 + 0.6 \times 0.5) = 0.92$

	D/E Ratio	Beta	Cost of Equity	Cost of Debt	WACC
Option 1	20.00%	1.03	13.69%	6.60%	12.51%
Option 2	100.00%	1.48	16.12%	7.80%	11.96%
Option 3	500.00%	3.69	28.31%	10.80%	13.72%

(d)

	Δ Firm Value	New Firm Value	Debt	Equity	Stock Price
Option 1	($180)	$5,820	$1,000	$4,820	$75.68
Option 2	$86	$6,086	$3,000	$3,086	$81.72
Option 3	($693)	$5,307	$5,000	$307	$66.14

Note: The change in firm value will mean that the debt ratios computed above will also change.

(e) From a cost of capital standpoint, option 2 is the best one.

(f) If Rubbermaid's income is more volatile, the firm should be more cautious in adding debt.

(g) If the new debt or equity is used to take projects, the analysis will change for three reasons:
(1) The projects may have a different risk profile from the firm's risk profile.
(2) The NPV of the projects has to be added to the value change calculated.
(3) The firm value itself will increase as the new debt and equity are issued.

(h) I would factor in the firm's need for flexibility into the analysis—the greater the need for flexibility the less likely it is that I would add on debt. Furthermore, I would look at how responsive managers are to stockholders; if they are not, I would be more likely to add debt.

(i) The higher rating in option 1 lowers the cost of debt, but it is accomplished by replacing debt with more expensive equity.

19-5 (a+b) The current D/E ratio = 200/500 = 0.4 and a debt to capital ratio of 0.2857. The cost of capital = $(1 - 0.2857)(8 + 1.5(5.5)) + (0.2857)(1 - 0.46)(11) = 13.30\%$.

The unlevered beta becomes $1.5/(1 + (1 - 0.46)(0.4)) = 1.234$.

With the new borrowing, the beta becomes $1.234(1 + (1 - 0.46)(0.6)) = 1.634$, and the D/E ratio becomes 0.6; the leverage ratio = 0.375. The new cost of capital becomes $(0.625)(8 + 1.634(5.5)) + (0.375)(1 - 0.46)(12.5) = 13.15\%$. Since the cost of capital drops, you should go ahead with the borrowing, assuming that the new funds are invested in similar projects as the existing firm.

(c) At this capital structure, the firm would change in value by (200 + 500)(0.0015/1,315) = $8 million
Hence, the price per share increases to $50 + $8 million/10 million = $50.80.

(d) If we now assume that these funds can be invested in a new project with before-tax income of $20 m a year (but with similar risk), the after-tax flows are 10.8 m per year. The NPV of this investment would be 10.8/0.1315 – 100 = –17.17m. Hence the project is not desirable.

(e) If the flows in (5) are certain, then we discount them at the risk-free rate of 8%. Hence, the NPV of the project = 10.8/0.08 – 100 = $35.0. The project would therefore be acceptable.

19-7 (a) Optimal Debt Ratio

Debt Ratio	Beta	Cost of Equity	AT Cost of Debt	Cost of Capital	
0%	1.50	17.25%	6.00%	17.25%	
10%	1.60	17.80%	6.30%	16.65%	
20%	1.73	18.49%	6.60%	16.11%	
30%	1.89	19.37%	7.20%	15.72%	
40%	2.10	20.55%	7.80%	15.45%	
50%	2.40	22.20%	8.40%	15.30%	Optimal
60%	2.85	24.68%	9.60%	15.63%	
70%	3.60	28.80%	10.80%	16.20%	
80%	5.10	37.05%	12.00%	17.01%	
90%	9.60	61.80%	15.00%	19.68%	

The optimal debt ratio is 50%.

(b) Change in Firm Value = 20,000,000 (0.1725 – 0.1530)/0.1530 = $2,549,020

Increase in Stock Price from going to optimal debt ratio = $2.55

New Stock Price = $22.55

19-9 a. Current Cost of Equity = 7% + 1.12 (5.5%) = 13.16%

b. Current pre-tax Cost of Debt = Interest Expense/Book Debt = 10/100 = 10%

After-tax Cost of Debt = 10% (1 – 0.4) = 6%

(The book interest rate can be used since the bonds are trading at par.)

c. Current Cost of Capital = 13.16% (500/600) + 6% (100/600) = 11.97%

d. With the swap, the value of equity drops to 150. The value of debt rises to 450. The unlevered beta = 1.12/(1 + 0.6(1/5)) = 1; the new levered beta = 1(1 + (1 – 0.2963)(450/150)) = 3.11. (Note that the tax rate used is the effective tax rate of 29.63%). The new cost of equity = 0.07 + 3.11(0.055) = 24.11%.

e. The annual interest payments would be 450(0.15) = 67.50. However, the EBIT is only 50. Hence the effective tax rate will have to be adjusted to (50/67.5)(0.4) = 0.2963.

f. The WACC = (150/600)24.11 + (450/600)(1 – 0.2963)(15) = 13.94%.

19-11 a. Market Value of Equity = 40 million × $20 = 800

Cost of Equity = 8% + 1.15 (5.5%) = 14.33%

Cost of Capital = 14.33% (0.8) + 10% (1 – 0.4) (0.2) = 12.66%

b. If the firm borrows $200 million and buys back stock, Equity will drop to $600 million.

New Debt/Equity Ratio = 400/600 = 0.67

Unlevered Beta = 1.15/(1 + 0.6 × 0.25) = 1.00

New Beta = 1.00 (1 + 0.6 × 0.67) = 1.40

New Cost of Equity = 8% + 1.40 (5.5%) = 15.70%

New Cost of Capital = 15.70% (0.6) + 11% (1 – 0.4) (0.4) = 12.06%

c. Increase in firm value from moving to optimal = (0.1266 – 0.1206)(1,000)/0.1206 = $49.75

Increase in Stock Price = $ 49.75/40 = $1.24

d. The firm currently pays dividends of $1 per share. An increase to $2 per share per year will change equity value to 800(1.1266) – 2(40) = $821.28 m, assuming that the required rate of return on equity does not change. This assumes that the market continues to expect a rate of return of 12.66%, although the expected change in leverage may increase it. If the new capital expenditure is financed with debt, the amount of debt will go up to $350 m. Hence, the debt/equity ratio will equal 350/821.28 = 0.426.

19-13 Current Market Value of Equity = 27.5 million × $25 = $687.50

T-Bond Rate = 7%

Current Debt outstanding = $25.00

Current Debt/Equity Ratio = 25/687.5 = 3.64%

Unlevered Beta = 0.70/(1 + 0.65 × 0.0364) = 0.6838208

Return on Capital = EBIT (1 – t)/(BV of Debt + Equity) = 63.3 (1 – 0.35)/(25 + 200) = 18.29%

Return on Equity = ROC + D/E (ROC – Interest Rate on Debt (1 – t))

a, b, and c. Cost of Equity, ROE, and Differential Return at each level of Debt

Debt Ratio	D/E Ratio	Beta	Cost of Equity	Interest Rate	ROE	ROE-COE
0%	0.00%	0.68	10.76%	6.70%	18.29%	7.53%
10%	11.11%	0.73	11.03%	7.00%	19.81%	8.78%
20%	25.00%	0.79	11.37%	7.50%	21.64%	10.27%
30%	42.86%	0.87	11.81%	8.00%	23.90%	12.09%
40%	66.67%	0.98	12.39%	8.50%	26.79%	14.40%
50%	100.00%	1.13	13.21%	9.00%	30.72%	17.52%
60%	150.00%	1.35	14.43%	10.00%	35.97%	21.54%
70%	233.33%	1.72	16.47%	11.00%	44.27%	27.81%
80%	400.00%	2.46	20.54%	12.00%	60.23%	39.69%
90%	900.00%	4.68	32.76%	15.00%	95.12%	62.35%

The differential return is maximized at 90% debt.

d. Value of the firm might not be maximized at 90% debt because the focus of this approach is to maximize equity returns. To the degree that this can be accomplished by expropriating wealth from bondholders or by increasing risk, this may not maximize firm value. It is also based on the presumption that the ROC will be unaffected by the changes in rating that accompany the higher debt ratio.

19-15 a. Estimate of Market Value of Debt

Present Value of Interest Expenses ($55 million) and book value ($664 million) at the cost of debt of 7.5%.

Estimated Market Value of Debt = $700! Estimated market value is $700 million.

Market Value of Equity = 173 × $30.75 = $5,320

b. Cost of Equity = 6.50% + 1.17 (5.5%) = 12.94%

Cost of Capital = 12.94% (5320/(5320 + 700)) + 7.5% (1 – 0.36)(700/(5,320 + 700)) = 11.99%

c. Increase in value per share = $1.25

Total Increase in firm value = 173 * 1.25 = $216

(5,320 + 700) (0.1199 – x)/x = 216.25

Solving for x,

x = (6,020 × 0.1199)/(6,020 + 216.25) = 11.57%

The cost of capital at the optimal is 11.57%.

19-17 a. Unlevered Firm Value = Current Firm Value – Tax Savings + Exp. Bankruptcy Cost @ existing debt = (1,760 + 527) – 527 × 0.36 + 2.3% of 0.30 (2,287–527*0.36)

X = 2,287 – 190 + (0.023)(0.3)(2,287 – 190) = $2,111

b. At a debt ratio of 50%,

New Levered Firm Value = $ 2,111 + (0.36) (0.5) (Levered Firm Value) – (0.4661) (0.30) (2,111)

X = 2,111 + 0.18 X – (0.4661) (0.3) (2,111)

Solving for X,

X = (2,111 – (0.4661)(0.3)(2,111))/(0.82) = $2,214.41

19-19 a. The optimal debt ratio is so high because Reebok has a high EBIT relative to firm value.

EBIT/Firm Value = 420/3,343 = 12.56%

If one adds back depreciation to this return, it is quite clear that at existing levels, Reebok has substantial cash flows to meet any debt payments, which in turn is pushing up the optimal debt ratio.

b. My primary concern with moving toward this optimal would lie in whether these operating cash flows are sustainable, given the volatility of the product market that Reebok serves.

19-21 a. Current market value of equity = 12.2(210) = 2,562. If we capitalize lease payments at the same rate as the debt, we get a present value of 150/0.1012 = 1,482. This is a high estimate, since the actual life of the lease payments is probably lower. The market value of the debt itself is 3,000 m. Hence, the debt/equity ratio = (1,482 + 3,000)/2,562 = 1.75, or a debt ratio of 0.6364.

b. The cost of equity = 0.0612 + 1.26(0.055) = 0.1305. The WACC = (0.6364)(1 – 0.35)10.12% + (0.3636)13.05% = 8.93%

c. The current beta = 1.26; the unlevered beta = 1.26/(1 + (1 – 0.35)1.75) = 0.5895. Hence, the levered beta at a debt ratio of 30% = 0.5895(1 + (1 – 0.35)(0.3/0.7) = 0.753; the cost of equity = 0.0612 + 0.753(0.055) = 0.1026. The WACC = (0.3)(1 – 0.35)(0.0812) + (0.7)(0.1026) = 8.77%. The firm value at this optimum = (2562 + 1482 + 3,000)[1 + (0.0893 – 0.0877)/0.0877] = 7,172.51 m. (which includes the capitalized value of lease payments).

d. Yes, if 1995 operating income was depressed, the estimated bond rating is probably biased downward. Hence, the true firm value is probably higher.

19-23 a. The expected bankruptcy cost = 0.0141(0.30)(12.14 + 20.55) = 0.1383 billion. The tax advantage to debt = 12.14(0.36) = 4.37 billion. Hence, the unlevered firm value = 12.14 + 20.55 + 0.1383 – 4.37 = 28.46 billion.

b. Suppose the levered firm value at a debt ratio of 50% = x. Then, the expected bankruptcy cost = 0.023(0.3)x. The tax benefit = (0.5)(0.36)x, assuming that the marginal tax rate would still be 36%. Then, we have the equation, x = 28.46 – 0.023(0.3)x + (0.5)(0.36)x. Solving, we find x = $34.42 billion.

c. Since the earnings will be more volatile, you'd expect the leverage ratio to be lower.

19-25 It is true that the return on equity can be increased by borrowing money, since the after-tax cost of debt is likely to be lower than the return on assets (which is currently equal to the return on equity) of 12.75%. Borrowing money will also increase the cost of equity, however. The net effect will determine whether leverage will increase firm value. If the business risk of the firm is high (a high unlevered beta), then the increase in the cost of equity may exceed the increase in return on equity.

CHAPTER 20

20-1 a. There are a number of ways in which BMD can increase its debt ratio:

1. It can borrow $1.15 billion and buy back stock.
2. It can borrow $1.15 billion and pay special dividends.
3. It can borrow more than $1.15 billion and take projects over time, in which case its optimal dollar debt will be higher.

For instance, if the money is borrowed now to take projects, the debt needed can be estimated approximately: $X/(2{,}300 + X) = 0.5$. Solving for X, $X = 2{,}300$.

b. From the viewpoint of the effect on equity, there is no difference between repurchasing stock and paying a special dividend. There may be a tax difference to the recipient, since dividends and capital gains are taxed differently.

c. If BMD has a cash balance of $250 million, it can use this cash to buy back stock. BMD, therefore, needs to borrow only $1.025 billion to get to 50%.

20-3 The solution to this problem is similar to that of problem 2, except that dividends are constant in this case.

a. If the existing policy of paying $50 million in dividends is continued.

	Current	1	2	3	4	5
Debt	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00
Equity	$ 500.00	$ 518.00	$ 537.43	$ 558.40	$ 581.04	$ 605.48
D/(D+E)	90.91%	90.61%	90.29%	89.95%	89.59%	89.20%
D/E	1,000.00%	965.25%	930.35%	895.41%	860.52%	825.79%
Dividends	$ 50.00	$ 50.00	$ 50.00	$ 50.00	$ 50.00	$ 50.00
Beta	1.20	1.16	1.13	1.09	1.06	1.02
Expected Return	13.60%	13.40%	13.21%	13.01%	12.81%	12.61%
Dividend Yield	10.00%	9.65%	9.30%	8.95%	8.61%	8.26%
Exp. Price Appr.	3.60%	3.75%	3.90%	4.05%	4.21%	4.36%

b. When dividends drop to zero, the debt ratio drops faster. However, starting from a ratio of 90.91%, it is necessary to adopt more drastic strategies such as buying back equity to reach the desired debt equity ratio of 30%.

	Current	1	2	3	4	5
Debt	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00	$ 5,000.00
Equity	$ 500.00	$ 568.00	$ 641.40	$ 720.63	$ 806.16	$ 898.47
D/(D+E)	90.91%	89.80%	88.63%	87.40%	86.12%	84.77%
D/E	1,000.00%	880.28%	779.54%	693.83%	620.23%	556.50%
Dividends	$ –	$ –	$ –	$ –	$ –	$ –
Beta	1.20	1.08	0.97	0.89	0.81	0.74
Expected Return	13.60%	12.92%	12.35%	11.87%	11.45%	11.09%
Dividend Yield	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Exp. Price Appr.	13.60%	12.92%	12.35%	11.87%	11.45%	11.09%

The information on growth rates in operating income and depreciation could be used, if desired, to obtain a different estimate of the market value of equity.

20-5 To advise TL Corporation on designing debt, I would need to get information on the types of assets/projects that it plans to finance with the debt.

In particular, I would need to know the following:

1. Are the projects short term or long term?
2. What is the pattern of cash flows on these projects?
3. Are these cash flows stable or volatile?
4. What currency will these cash flows be in?
5. What other factors (economy, industry-specific facts) affect cash flows?

20-7

Year	Equity	Debt	Firm Value	Long Bond Rate	GNP Growth	Dollar	Inflation Rate
1985	$1,825	$436	$2,261	11.40%	6.44%	125.95	3.50%
1986	$2,261	$632	$2,893	9.00%	5.40%	112.89	1.90%
1987	$2,390	$795	$3,185	9.40%	6.90%	95.88	3.70%
1988	$1,961	$655	$2,616	9.70%	7.89%	95.32	4.10%
1989	$2,260	$836	$3,096	9.30%	7.23%	102.26	4.80%
1990	$1,876	$755	$2,631	9.30%	5.35%	96.25	5.40%
1991	$2,010	$795	$2,805	8.80%	2.88%	98.82	4.20%
1992	$2,589	$833	$3,422	8.10%	6.22%	104.58	3.00%
1993	$3,210	$649	$3,859	7.20%	5.34%	105.22	3.00%
1994	$3,963	$1,053	$5,016	8.00%	5.97%	98.6	2.60%

a. To estimate the duration, we regress changes in firm value against changes in the long bond rate.

Year	Change in Firm Value	Change in Long Bond Rate
1986	27.95%	−2.40%
1987	10.09%	0.40%
1988	−17.86%	0.30%
1989	18.35%	−0.40%
1990	−15.02%	0.00%
1991	6.61%	−0.50%
1992	22.00%	−0.70%
1993	12.77%	−0.90%
1994	29.98%	0.80%

Change in Firm Value = 0.08 − 6.51 (Change in Long Bond Rate)

The t statistic for the slope coefficient is only 1.01; it is not statistically significant.

The estimate of the duration is 6.5 years.

b. To estimate the cyclicality, we regress changes in firm value against GNP growth rates.

Year	Change in Firm Value	GNP Growth
1986	27.95%	6.44%
1987	10.09%	5.40%
1988	−17.86%	6.90%
1989	18.35%	7.89%
1990	−15.02%	7.23%
1991	6.61%	5.35%
1992	22.00%	2.88%
1993	12.77%	6.22%
1994	29.98%	5.34%

Change in Firm Value = 0.38 − 4.68 (GNP Growth)

The t statistic on the slope coefficient is 1.15.

While the regression suggests that the firm is countercyclical, the t statistic is not statistically significant.

c. To estimate the sensitivity of firm value to exchange rates, regress changes in firm value against changes in weighted dollar.

Year	Change in Firm Value	Change in Weighted Dollar
1986	27.95%	–10.37%
1987	10.09%	–15.07%
1988	–17.86%	–0.58%
1989	18.35%	7.28%
1990	–15.02%	–5.88%
1991	6.61%	2.67%
1992	22.00%	5.83%
1993	12.77%	0.61%
1994	29.98%	–6.29%

Change in Firm Value = 0.10 – 0.03 (Change in Weighted Dollar)

The *t* statistic is close to zero.

The firm's value is unaffected by changes in exchange rates.

d. To estimate the sensitivity of firm value to inflation rates, regress changes in firm value against changes in inflation rates.

Year	Change in Firm Value	Change in Inflation Rate
1986	27.95%	–1.60%
1987	10.09%	1.80%
1988	–17.86%	0.40%
1989	18.35%	0.70%
1990	–15.02%	0.60%
1991	6.61%	–1.20%
1992	22.00%	–1.20%
1993	12.77%	0.00%
1994	29.98%	–0.40%

Change in Firm Value = 0.10 – 6.84 (Change in Inflation Rate)

Again, while the results suggest that the firm's value is negatively affected by inflation, the *t* statistic is only 1.30.

e. On all of these regressions, there is considerable noise in the estimates. If the results from these regressions deviate significantly from industry averages, I would use the industry averages. In addition, if I knew that the firm was planning to enter into new businesses, I would factor these into my analysis.

20-9 When the regression analysis is done with both operating income and firm value as dependent variables, there might be different results from each.

The reasons for the differences are as follows:

a. Operating income might be smoothed out, whereas firm value is not.

b. Firm value reflects changes not only in operating income but also in discount rates and expected future growth. I would be more inclined to use firm value to measure duration and sensitivity to economic factors. I would use operating income to examine sensitivity to inflation, especially if floating rate debt were to be issued.

20-11 a. Since Upjohn is a potential takeover target, I would suggest moving to the optimal debt ratio quickly.

b. Cost of Equity = 6.50% + 1.17 (5.5%) = 12.94%

While the current return on equity > current cost of equity, the decline in the return on equity would suggest a greater emphasis on stock buybacks and dividends.

20-13 a. Given that firm value is negatively affected by changes in interest rates and that the regression suggests that the duration of the debt should be 6.33 years, I would argue that Bethlehem Steel should have debt with a maturity greater than a year.

b. It might make sense, however, for Bethlehem Steel to use short-term debt to finance long-term projects if:

(1) They believe that they are much less risky than the market assesses them to be (bond ratings, cost of debt).

(2) They anticipate changing their business mix in the near future and enter different businesses.

(3) They believe they can forecast changes in the term structure better than other market participants.

20-15 a. It can be argued that the slope coefficient is a measure of the duration of the assets owned by these firms; hence, it can determine the duration of the debt.

b. The slope coefficients are estimated with substantial noise; I would use the average across all six firms as my measure of duration for each of them.

Average Slope Coefficient = 8.93

CHAPTER 21

21-1 (Price before – Price After)/Dividends = $(1 - t_o)/(1 - .t_{cg})$, 1 that is, $3.5/5 = (1 - t_o)/(1 - 0.4)$

Solving for the ordinary tax rate, ordinary tax rate = $t_o = 1 - 0.6 \times 3.5/5 = 58\%$

21-3 Assume that the true capital gains tax rate = Stated Rate/$(1 + R)^n$

$(P_b - P_a) = (1 - t_o)/(1 - t_{cg})$ or $(\$10 - \$9.20) = (1 - 0.5)/(1 - 0.5/1.1^n)$

Solving for n, n = approximately 3 years.

21-5 I would expect the price to drop since the actual dividend increase of 2% is less than the expected dividend increase of 5%.

21-7 I would expect the price reaction to be positive. The price increase in this case may send a positive signal to financial markets. The answer is different from the previous problem because the auto parts industry is a more stable one than the software business (reducing the negative signaling implications of the dividend increase). Furthermore, the fact that the company already pays a substantial dividend implies that its stockholders will be less averse to receiving more in dividends.

21-9 I would expect it to decline. The preceding news on earnings and revenues has probably already conveyed the message that the firm is in financial trouble to financial markets. The decline in dividends, however, may cement this message by indicating that management believes that the earnings decline is not a short-term phenomenon.

21-11 I would expect bond prices to drop. Selling assets (especially liquid ones) and paying dividends make these bonds much riskier.

CHAPTER 22

22-1 a. Dividend Payout Ratio = (2 * 50)/480 = 20.83%

b. Free Cash Flows to Equity this year

Net Income	$480
– (Cap Ex – Depr) (1–DR)	$210
– (Change in WC) (1–DR)	$351
FCFE	$235

Dividends as % of FCFE = 100/235 = 42.55%

c.

Project	Investment	Beta	IRR	Cost of Equity
A	$190 mil	0.6	12.00%	11.80%
B	$200 mil	0.8	12.00%	12.90%
C	$200 mil	1	14.50%	14.00%
D	$200 mil	1.2	15.00%	15.10%
E	$100 mil	1.5	20.00%	16.75%

Accept projects A, C, and E. The total investment is $490 million.

d. Estimation of FCFE next year

Net Income	$540
– (Cap Ex – Depreciation) (1 –DR)	$168
– (Change in WC) (1 – DR)	$35
= FCFE	$337

e. I may not pay this amount as dividends because of my concerns that I would not be able to maintain these dividends. I would also hold back some cash for future projects if I felt that investment needs could vary substantially over time.

f. If $125 million is paid out as dividends, the cash balance will increase by $212 million [$337 – $125].

22-3 Current WACC = 100/(100 + (50)(10))(1 – 0.4)10% + (50)(10)/(100 + (50)(10)) 16% = 14.33%

Initial Investment	EBIT	Annual Depr.	Lifetime	Salvage	Cash flow per yr.	NPV
10	1	0.5	5	2.5	1.1	–4.97358
40	5	1	10	10	4	–16.7809
50	5	1	10	10	4	–26.7809

a. Since all projects have NPV < 0, none of them should be accepted.

b. The firm has free cash flow to equity equal to Net Income + (1 – δ)(Capital expenditures – Depreciation) = 90 + 8 = $98 m. This is the maximum that it can pay out in dividends. This assumes that some of the depreciation is used to pay back debt. Alternatively, I would add back the entire depreciation to the net income to get $100 million as FCFE.

22-5

	Current	1	2	3
Net Income	$100.00	$110.00	$121.00	$133.10
+ Depreciation	$50.00	$54.00	$58.32	$62.99
– Cap Ex	$60.00	$60.00	$60.00	$60.00
– Change in WC	$10.00	$10.00	$10.00	$10.00
= FCFE	$80.00	$94.00	$109.32	$126.09
Dividends Paid		$66.00	$72.60	$79.86
Cash Balance	$50.00	$78.00	$114.72	$160.95

The cash balance at the end of year 3 = 160.95 million.

22-7 a. No. Its FCFE is negative: FCFE = 10 – (25 – 5) = –10 million.

b.

	Current	1	2	3	4	5
Net Income	$10.00	$14.00	$19.60	$27.44	$38.42	$53.78
– (Cap Ex- Depr)	$20.00	$22.00	$24.20	$26.62	$29.28	$32.21
= FCFE	<0	<0	<0	>0	>0	>0

The company will have positive FCFE by year 4. It can start paying dividends after that year.

22-9

Year	Net Income	(Cap Ex – Depr) (1-DR)	Ch WC (1-DR)	FCFE
1996	$485.10	$151.96	$8.75	$324.39
1997	$533.61	$164.11	$9.19	$360.31
1998	$586.97	$177.24	$9.65	$400.08
1999	$645.67	$191.42	$10.13	$444.12
2000	$710.23	$206.73	$10.64	$492.86

This is the amount that the company can afford to pay in dividends.

b. The perceived uncertainty in these cash flows will make me more conservative in paying out the entire amount in FCFE in the year in which I make it.

22-11 Assuming that we are talking about the second scenario, where the firm does borrow money, I would defend my decision by noting that I have a track record of great projects and that I am retaining the cash for future projects. My track record will probably make me credible, at least as long as I can keep my return on equity above my cost of equity.

22-13 The company will have a negative FCFE since it will have to generate enough cash flows to make the principal payment of $100 million. Recalculating the FCFE,

Estimated Net Income next year	$140.80
– (Cap Ex – Depreciation)	$28.60
– Change in Working Capital	$50.00
– Principal Repayment	$100.00
FCFE	$(37.80)

22-15

Company	Payout Ratio	Dividend Yield	Growth
Fedders	11%	1.20%	22%
Maytag	37%	2.80%	23%
National Presto	67%	4.90%	13.50%
Toro	15%	1.50%	16.50%
Whirlpool	30%	2.50%	20.50%
Average	32%	2.58%	19.10%
Black & Decker	24%	1.30%	23%

a. Black & Decker pays less in dividends than the average company in the sector.

b. Black & Decker also has higher growth than the average company in the sector. One way of controlling for differences in growth rate is to regress dividend payout ratios and yields against the growth rates.

Dividend Payout Ratio = 0.88 – 2.90 (Expected Growth)

Dividend Yield = 0.07 – 0.23 (Expected Growth)

Black & Decker's predicted payout ratio = 0.88 – 2.90 (0.23) = 21.30%

Black & Decker's predicted dividend yield = 0.07 – 0.23 × (0.23) = 1.71%

22-17 No. Given the higher growth rate, I would expect that Handy and Harman will pay less in dividends than the average firm in the sector. The higher growth creates a greater reinvestment need.

CHAPTER 23

23-1 a. No. The earnings per share will increase only if the return on assets exceeds the after-tax cost of borrowing.

b. No. The risk will increase as leverage increases, and the stock price may go down even with higher EPS.

c. If the increase in earnings per share more than offsets the higher risk from increased leverage, the price will go up.

23-3 Forward contracts to buy equity are riskier than announcements of buybacks because they represent legal obligations to buy stock at a stated price. The firm does not have the option to back down.

23-5 No. The splitoff will not solve the problem because incumbent management (which is the problem) is still running the firm. I would recommend breaking up the firm and selling its component parts to outsiders, or a splitoff where incumbent management explicitly disavows control in the splitoff entities.

23-7 a. No. Given the preponderance of institutional investment and the fact that the price is only $50 (rather than $400 or $500), I do not believe that this action is going to increase the investor base for the company.

b. While I would expect an initial positive reaction to the split, this increase will be sustained only if the firm follows up with positive news that confirms the signal sent by the split—that is, that higher earnings and stock prices will follow.

23-9 The positive reaction can be explained by several factors. First, the action suggested that the management of the firm was aware that it had a problem and was willing to deal with it. Second, the splitup units had more independence and were no longer burdened by the policies and practices of the other units. Third, it allowed each of the splitup units to reveal its assets and earning power separately, making it easier to value the component parts.

23-11 Spinoffs and splitoffs may make it easier to value firms since they isolate the assets of the entity being valued. It is easier to estimate risk parameters for the entity if it is traded separately. This benefit should be greatest for complex firms with financial statements that are difficult to break down and analyze.

23-13 No. I do not think Nabisco's stockholders will be satisfied. Although one of the objectives for the spinoff—separating the contaminated tobacco division from the food division—may have been accomplished, the other—removing management that they view as incompetent—would not.

23-15 For every five shares that a stockholder has in the old Disney, he will have had a value of $30(5) = $150; subsequent to the tracking stock issuance, he will have (28)(5) + 12 = $152 in all. Hence, each stockholder has benefited.

CHAPTER 24

24-1 a. Reinvestment Rate = g/ROC = 5%/10% = 50%

b. Firm Value = 100 (1.05)(1-.5)/(.10-.05) = $1050.00

c. Value of Firm = 100/.10 = $1,000.00

24-3 Expected Growth rate next year = Reinvestment rate × ROC = .5 × 1.0 = 5%

Expected FCFF next year = 100 (1.05) (1-.5) = $52.20

24-5 Unlevered beta of other networking software firms with cash = 1.20

Unlevered beta corrected for cash = 1.20/(1-.10) = 1.33

Levered Beta for Netsoft's operating assets = 1.33 (1 + (1-.4) (15/85)) = 1.47

Cost of Equity for Netsoft = 6% + 1.47 (5.5%) = 14.09%

Cost of Capital for Netsoft = 14.09% (.85) + 10% (1-.4) (.15) = 12.88%

Value of Operating Assets = 200 × 1.04/(.1288-.04) = $2,342.34

Value of Cash = $250.00

Value of Firm = $2,592.34

24-7 a. Value of Equity = Value of operating assets + cash and non-operating assets - debt = 127.55 + 10 - 15 = $122.55

b. Value per share = 122.55/5 = $ 24.51

c. Value of common stock = Value of Equity - Value of options = 122.55 -7 = $115.55

Value per share = 115.55/5 = $23.11

24-9 a., b. From the information given, we can compute the following:

	1993	1994	1995	1996	1997	1998	1999
Revenues	13,500	14,782.50	16,186.84	17,724.59	19,408.42	21,252.22	22,102.31
EBITDA	1,290	1,412.55	1,546.74	1,693.68	1,854.58	2,030.77	2,223.69
Interest	215	215.00	215.00	215.00	215.00	215.00	
Depreciation	400	438.00	479.61	525.17	575.06	629.70	689.52
Cap. Exp	450	492.75	539.56	590.82	646.95	708.41	689.52
Working Capital	945	1,034.78	1,133.08	1,240.72	1,358.59	1,487.66	1,547.16
FCFF		440.21	482.02	527.82	577.96	632.87	861.00
PV(FCFF)		402.50	440.74	482.61	528.46	578.66	

The WACC in 1993 can be computed as 9.37%, using the cost of equity of 13.05% based on the current beta of 1.1.

Given the current beta and the current D/E ratio of 3200/3968, the unlevered beta = 0.87. If we assume that the operations of the firm do not change until after 1988, we can infer that the WACC for the firm is constant until 1998. After 1998, the stock beta changes to 0.87(1+(1-0.4)(0.05)) = 0.964 implying a cost of equity of 12.3% for 1999 and beyond. This, is turn, can be used to compute a WACC of 8.4%.

We can discount the FCFF to the firm from 1994 to 1998 at the WACC of 9.37% and thereafter at the rate of 8.4%. This yields a PV(FCFF up to 1998) = $2,432.98 m, and a PV(FCFF after 1998) = $1,3073.26 m, or a firm value of $15,506.24 m. The implied equity value, therefore, is $15,506 - $3,200 = $12,306 m, for a per share price of $198.49.

The shares are grossly underpriced.

24-11 Unlevered Beta (using last 5 years) = 0.9/(1+(1-.4)(.2)) = 0.80

Unlevered Beta of Non-cash assets = 0.80/(1-.15) = 0.94

Levered Beta for Non-cash assets = 0.94 (1+0.6(.5)) = 1.222

Cost of Equity for Non-cash Assets = 6% + 1.22(5.5%) = 12.71%

Cost of Capital for Non-cash Assets = 12.71%(.667)+.07 × .6 × (.333)= 9.88%

Estimated FCFF next year from Non-cash Assets = (450-50)(1-.4)(1.05)-90 = 162

Estimated Value of Non-cash Assets = 162/(.0988-.05) = $ 3,320

Cash Balance = $500

Estimated Value of the Firm = $ 3,820

Less Value of Debt Outstanding of $800 = Value of Equity = $3,020

24-13 Adjusted pre-tax operating income = $ 10 million - $ 1.5 million = $8.50

Adjusted after-tax operating income = $ 8.5 million (1-.40) = $5.10

Firm Value = 5.1(1.05)/(.09-.05) = $133.88

Illiquidity Discount = .30 - .04 (ln(100) = 11.58%

Firm Value after Illiquidity Discount = 133.88 (1-.1158) = $118.37

24-15 a. The average P/E ratio = 13.2, while the median P/E ratio = 12.25, which is the average of the 7th ranking and 8th ranking firm's P/E ratios. The fact that the mean and the median are relatively close to each other means that there is no appreciable skewness:

there are no great extreme values. We can, therefore, interpret either number as a means of the market's valuation of earnings

b. This would be true if Thiokol's riskiness were equal or less than that of the industry, on average. Another reason for Thiokol to have a lower P/E ratio even with no underpricing is if it were a low growth stock, say, because of a high payout ratio.

c. These kinds of differences can be controlled for using the regression approach. Using this approach, the second to last column gives us the estimated P/E ratios based on the payout ratio, risk, and growth. The last column, which represents the difference between the actual P/E ratio and the estimated P/E ratio gives us an estimate of relative under- or overvaluation. Positive values imply overvaluation, while negative values imply undervaluation:

Company	Actual P/E	Expected Growth	Beta	Payout	Estimated P/E ratio	Difference
Thiokol	8.7	5.5	0.95	15	11.44	-2.74
Northrop	9.5	9	1.05	47	14.82	-5.32
Lockheed Corp.	10.2	9.5	0.85	37	12.31	-2.11
United Industrial	10.4	4.5	0.7	50	9.11	1.29
Martin Marietta	11	8	0.85	22	11.34	-0.34
Grumman	11.4	10.5	0.8	37	12.07	-0.67
Raytheon	12.1	9.5	0.75	28	10.85	1.25
Logicon	12.4	14	0.85	11	13.17	-0.77
Loral Corporation	13.3	16.5	0.75	23	13.21	0.09
Rockwell	13.9	11.5	1	38	14.85	-0.95
General Dynamics	15.5	11.5	1.25	40	17.90	-2.40
GM- Hughes	16.5	13	0.85	41	13.68	2.82
Boeing	17.3	3.5	1.1	28	12.90	4.40
McDonnell Doug.	22.6	13	1.15	37	17.15	5.45

24-17 a. The average Price/Book Value ratio = 1.66. I wouldn't necessarily use this ratio to price the new issue because of the heterogeneity amongst these firms. In particular, even though most of the firms have zero payout ratios like our firm, nevertheless, some of them have high payout ratios, such as Browning Ferris and Safety-Kleen. Growth rates also vary quite a bit. These factors affect the Market Value to Book Value ratio.

b. I would try to control for differences in growth and risk. I would expect the IPO to trade at a higher P/BV ratio because of its higher growth rate. I would also examine the ROE; a higher ROE should translate into a higher P/BV ratio.

24-19 Yes. There are several reasons why Walgreen might have a high Price to Sales ratio and still be fairly priced; however, they don't seem to apply here. One reason might be that the firm expects higher sales in the future. However, Walgreen's expected growth rate of 13.5% is less than the average of the firms, which is 14.5. Furthermore, the payout ratio is higher than the average for the sample (22.3). On the other hand, the firm's beta is higher than the average for the sample (0.9) and so is the firm's profit margin of 2.7 relative to 1.9. However, on balance, the firm does seem to be overpriced, at least compared with firms such as Arbor Drugs, which has a higher profit margin, a lower payout ratio, *and* a higher expected growth rate.

CHAPTER 25

25-1 a. It should have no effect on value, since expected cash flows are unchanged by the announcement.

b. The stock price might be affected. To the extent that investors form expectations based upon what they know about the firm, this action might lower expectations for the future and reduce the perceived value. The fact that value does not change but price may drop reflects the likelihood that this stock was over valued before it announced the restructuring.

25-3 Cost of capital = 12% (.6) + 8% (1-.4) (.4) = 9.12%

Value of firm = (100 × (1-.4)-25) (1.04)/(.0912-.04) = $ 710.94

With a 0% tax rate, Cost of capital = 12% (.6) + 8%(.4) = 10.40%

Value of firm = (100 -25) (1.04)/(.104-.04) = $ 1,218.75

25-5 Return on capital = 50/250 = 20%
Reinvestment rate = 25/50 = 50%

a. Expected Growth rate = 0.5 × 0.2 = 10.0%

b. Expected Growth rate with higher reinvestment rate = 0.8 × .20 = 16%

c. Expected Growth rate with lower return on capital = 0.8 × .15 = 12%

25-7 a. Expected Growth rate = 5.35% (Nothing changes)

b. Cost of capital = 12.5% (0.8) + 4.5% (0.2) = 10.90%
Value of firm = $ 2 (1-.5)/(.109-.0535) = $18.00

c. Value of firm with no growth or reinvestment = $18.35
Value destroyed by new investments = $0.35

25-9 Value of firm with no advertising campaign (10 million growing at 15% for 3 years, constant forever thereafter) = $147.08

Value of firm with advertising campaign = PV(10 million growing 15% for 10 years, constant forever thereafter) - PV of Cost of advertising campaign = $160.37

To solve for the probability
Increase in value from advertising = Value of firm with advertising - Value of firm without advertising = $ 137.64
Present value of advertising cost = PV of $ 50 million for 3 years = $124.34
Probability of success needed = X (137.64) = 124.34
Probability = 90.34%

25-11 Book value of equity at start of year = 1,250 - 50 = $1200 (after subtracting out retained earnings of $50 million

Book value of debt at start of year = 350 - 50 = $300

Book value of capital at start of year = $1500

a. Return on capital = 180/1500 = 12%

b. Cost of capital = 12%(2500/(2500 + 350))+ 5% (350/(2500+350)) = 11.14% (Note that the market value of equity was double the book value at the end of 1998.)

c. EVA = (.12 -.1114) (1500) = $12.89

25-13

Year	Operating lease Commitment	PV of Commitment
1	55	$51.89
2	60	$53.40
3	60	$50.38
4	55	$43.57
5	50	$37.36
6-15	40	$220.00
		$456.59

Capital invested before operating leases (in millions) = $ 1,000.00
Capital invested after operating leases = $ 1,456.59
Operating income before operating lease adjustment = $150
Operating income after operating lease adjustment = $177.40
Return on capital before lease adjustment = 9%
Return on capital after lease adjustment = 7.31%
Cost of capital before lease adjustment = 11%
Cost of capital after = 11%(2/2.457)+6%(1-.4)(.457/2.457) = 9.62%
EVA before lease adjustment = (.09-.11) (1000) = -$20.00
EVA after lease adjustment = (.0731-.0962) (1457) = -$33.74

25-15 a. EVA this year = 20 million - 60 × .15 = $11.00

PV of EVA over next 5 years = \$55.00 (note that the growth and discount rates offset each other.
Capital invested = \$60.00
Value of firm = \$115.00

b. EVA this year = 20 million - 40 × 0.15 = \$14
PV of EVA over next 5 years = \$70.00
Capital invested = \$40.00
Value of firm = \$110.00

CHAPTER 26

26-1 a to d.

	Grumman Independent	Northrop Independent	Combined No Synergy	Combined with Synergy
Revenues	\$3,281	\$4,620	\$7,901	\$7,901
– COGS	\$2,920	\$4,043	\$6,963	\$6,795
– Depreciation	\$74	\$200	\$274	\$274
= EBIT	\$287	\$378	\$664	\$832
EBIT (1 – t)	\$187	\$245	\$432	\$541
– ΔGWC	\$16	\$22	\$38	\$38
= FCFF	\$171	\$223	\$394	\$503
Cost of Equity	12.50%	12.50%	12.50%	12.50%
Cost of Debt	5.53%	5.53%	5.53%	5.53%
WACC	11.38%	11.98%	11.73%	11.73%
Firm Value	\$2,681	\$3,199	\$5,879	\$7,479

e. Synergy Gain = \$7,479 – \$5,879 = \$1,600

Note: Firm Value = $FCFF_1/(WACC - g)$

26-3 a, b, c, and d.

	Novell	WordPerfect	No synergy	w/Synergy
Revenues	\$1,500	\$690		\$2,232
COGS	\$855	\$518		\$1,406
Depreciation	\$53	\$29		\$83
EBIT	\$593	\$144		\$743
EBIT (1 – t)	\$385	\$93		\$83
– Cap Expenditure	\$94	\$46		\$143
+ Depreciation	\$53	\$29		\$83
– ΔGWorking Capital	\$120	\$27		\$147
= FCFF	\$224	\$49		\$276
Cost of Equity (Initial)	14.98%	13.88%		14.85%
Cost of Equity (Stable)	13.05%	13.05%		13.05%
Value of firm	\$12,059	\$1,554	\$13,613	\$14,377

The cost of equity is also the weighted average cost of capital because neither firm has any debt.

The weights are based on the estimated values.

(The free cash flow to the firm under synergy in year 1 is greater than the sum of the FCFF of the two individual firms because of the higher growth rate in cash flows. All the estimated numbers under synergy are based on the new expected growth rate which is 24%.)

e. Value of Synergy = 14,377 – 13,613 = \$764 million
Maximum Price for Wordperfect = 1,554 + 764 = \$2,318 million

26-5 a.

Value of Synergy	Pre-merger	Post-merger
Value of Aetna	22,800	21,800
Value of US Healthcare	1,550	1,875
Total	24,350	23,675

The total market value of the two firms declined by $675 million after the merger was announced. This would suggest that the market does not believe there is synergy.

b. Managers may be overoptimistic about the potential for synergy, whereas markets might be much too pessimistic. I would tend to believe the markets.

26-7 I would expect it to be shared between the two companies if there are no competing bidders on the horizon. If there are, I would expect the target company's stockholders to get the benefits.

26-9 a. While the overall evidence on stock price reaction to antitakeover amendements is mixed, I would expect stockholders to react negatively in this case because of PMT's history of poor performance.

b. It would not, but I would probably be even more aggressive in ensuring that the management does not adopt this clause.

26-11 a. No. The stockholders could do it themselves at far lower costs.

b. Yes. Diversification may provide a benefit to the owner of a private firm since much of his or her wealth is probably concentrated in the firm.

c. If by doing this acquisition, the publicly traded firm was able to increase its debt capacity substantially and take better projects, it might make sense to do the acquisition.

CHAPTER 27

27-1 The cost of capital of Genzyme is 15(0.9) + (0.1)(4) = 13.9%. The present value of the drug if it were developed immediately for commercial production would be 100(1.05)/(0.139 – 0.05) = 1,179.78. Since the costs of immediate development are $1 billion, the net present value of immediate development is positive and equals $179.78 million. However, it might be worth more to wait.

The inputs to the option to wait are as follows: S = $1,179.78; K = 1,000; t = 14; Standard deviation = 50%; r = 5%; γ = Dividend Yield = 1/Project Life = 1/14 = 0.0714286. The value of the option is $Se^{-\gamma t} N(d_1) - Ke^{-rt} N(d_2)$, where $d_1 = \ln(S/K) + (r - \gamma + \sigma^2/2)t/\sigma\sqrt{t}$, $d_2 = d_1 - \sigma\sqrt{t}$. The option value can be written as $1179.78e^{-14(0.0714286)} N(0.8634) - 1{,}000e^{-14(0.05)}N(-1.0074)$. Since $N(d_1)$ = 0.806041; $N(d_2)$ = 0.156871, the option value is 349.8352 – 77.8998 = 271.935 million, which is clearly greater than $179.78, as we would expect.

27-3 Using put-call parity, we can value a call with K = 50 and a 1-year life:

Call – Put = $S - Ke^{-rt}$ = $12.00 + $45 – $50 $e^{-(0.1)}$ = $ 11.76

We can also value a call with a strike price of $75:

Call = $31 + $45 – $75 $e^{-(0.1)}$ = $8.14

The value of the executive package can be estimated as follows:

Guaranteed Payment = $500,000

Value of Bonus Package:

10,000 × ($11.76 – $8.14) = $36,200

(This is a capped call since the executive bonus is capped off at $75.)

27-5 a. True. Equity investors cannot lose more than their equity investment.

b. False. They can make equity more valuable, not the firm.

c. True. It transfers wealth to the bondholders.

d. True. This is the equivalent of the life of the option.

e. True. There is a transfer of wealth to bondholders.

27-7 a. Free cash flows to the firm equal $850 + 400 – 400 = $850. Firm Value =

{$850(0.6)(1.20)[1 – $1.20^5/1.10^5$]}/(0.10 – 0.20) + $850(0.6)$(1.20)^5$ (1.05)/[(0.10 – 0.05)$(1.1)^5$] = $19,883

b. Standard Deviation of Firm = $[(0.67)^2(0.35)^2 + (0.33)^2 (0.15)^2 + 2 (0.67)(0.33) (0.5) (0.35) (0.15)$

= 0.2619

$S = 19{,}883.21$
$r = 5\%$
K = FV of Debt = 10,000
Variance = $0.2619^2 = 0.07$
t = Average Duration of Debt = 3
Dividend Yield = 0
$d_1 = 2.07$ $N(d_1) = 0.98$
$d_2 = 1.62$ $N(d_2) = 0.95$
Value of Call (Equity) = $11,350

c. Market Value of Equity = $12,200
Implied Variance = 0.25 (Trial and Error)
Implied Standard Deviation = 0.5

d. Market Value of Debt = $8,534

27-9 Current Value of Developed Reserve = $10{,}000{,}000 \times (\$20 - \$6) = \$140{,}000{,}000$

Exercise Price = Cost of Developing Reserve = $120,000,000
t = 20 years
$r = 7\%$
$s = 20\%$
$y = 4\%$
Value of Call (Natural Resource Reserve) = $37,360,435

27-11 a. S = PV of Cash Inflows on Project = 250
K = Cost of Taking Project = 500
t = 10 years
r = 6%
s = 0.6
y = 10/250 = 4%
Value of Call (Product Patent) = $95 million

b. It is an increasing function of the variance in project cash flows. This analysis suggests that the rights to products in technologically volatile areas are likely to be worth a great deal, even though the products may not be viable now.