Chapter 18

CAPITAL BUDGETING

QUESTIONS & ANSWERS

Q18.1 *AThe decision to start your own firm and go into business can be thought of as a capital budgeting decision. You only go ahead if projected returns look attractive on a personal and financial basis.@ Discuss this statement.*

Q18.1 ANSWER

The decision to start your own firm and go into business can indeed be thought of as a capital budgeting decision. You only go for it if projected returns look attractive on a personal and financial basis. Formally, capital budgeting is described as the process of planning expenditures that generate cash flows expected to extend beyond one year. The choice of one year is arbitrary, of course, but it is a convenient cutoff for distinguishing between classes of expenditures. Examples of capital outlays are expenditures for land, buildings, equipment and for additions to working capital (e.g., inventories and receivables) made necessary by expansion. New advertising campaigns or research and development programs are also likely to have impacts beyond one year and come within the classification of capital budgeting expenditures.

Practically speaking, the firm is an investment project, so the decision to go into business is a decision to fund a capital budgeting project. Both monetary and nonmonetary benefits are often vital considerations. Nobody can afford to finance a money-losing operation indefinitely, so self-finance businesses must cover out of pocket costs and a reasonable rate of return on investment. Still, many entrepreneurs are attracted by the opportunity to Arun their own show,@ and take some of their overall pay in the form of nonmonetary benefits, like work schedule flexibility or personal satisfaction.

Q18.2 *What major steps are involved in the capital budgeting process?*

Q18.2 ANSWER

Conceptually, the capital budgeting process involves six logical steps. First, the cost of the project must be determined. This is similar to finding the price that must be paid for a stock or bond. Next, management must estimate the expected cash flows from the project, including the value of the asset at a specified terminal date. This is similar to estimating the future dividend or interest payment stream on a stock or

bond. Third, the riskiness of projected cash flows must be estimated. To do this, management needs information about the probability distributions of the cash flows. Fourth, given the riskiness of projected cash flows and the cost of funds under prevailing economic conditions as reflected by the riskless rate, R_F, the firm must determine the appropriate discount rate, or cost of capital, at which the project=s cash flows are to be discounted. This is equivalent to finding the required rate of return on a stock or a bond investment. Fifth, expected cash flows are converted to a present value basis to obtain a clear estimate of the investment project=s value to the firm. This is equivalent to finding the present value of expected future dividends or interest plus principal payment. Finally, the present value of the expected cash inflows is compared with the required outlay, or cost, of the project. If the present value of cash flows derived from a project exceed the cost of the investment, the project should be accepted. Otherwise, the project should be rejected.

Q18.3 *OIBDA is an abbreviation for "operating income before depreciation and amortization." Like its predecessor EBITDA (Aearnings before interest, taxes, depreciation and amortization@), OIBDA is used to analyze profitability before non-cash charges tied to plant and equipment investments. Can you see any advantages or disadvantages stemming from the use of OIBDA instead of net income as a measure of investment project attractiveness?*

Q18.3 ANSWER

Because it eliminates the effects of financing and non-cash accounting decisions, OIBDA can provide a relatively good "apples-to-apples" comparison of profitability between companies and industries. For example, OIBDA as a percent of sales can be used to find companies that are the most efficient operators in an industry. Because it removes the impact of financing large capital investments and depreciation from the analysis, OIBDA can be used to evaluate industry trends over time for industries, companies and projects that are very different. OIBDA is a good measure of how much cash a company is generating because it adds non-cash charges like depreciation and amortization back to net income and includes the changes in working capital that also use or provide cash, such as changes in receivables, payables and inventories.

On the other hand, companies and investors can get into trouble relying upon OIBDA because capital costs are real, and must be paid at some point. Rapidly growing OIBDA can paint a misleading picture of robust profit growth for highly capital-intensive companies and investment projects. OIBDA is not free cash flow, or the amount of cash produced by a company or investment project after all operating expenses and investment requirements are covered. As a result, companies

that rely on OIBDA sometimes run into severe cash shortfalls when it comes to maintaining the amount of investment necessary to make OIBDA continue to grow.

Q18.4 *Toyota Motor Corp., like most major multinational corporations, enjoys easy access to world financial markets. Explain why the NPV approach is the most appropriate tool for Toyota=s investment project selection process.*

Q18.4 ANSWER

An investment project is attractive and should be pursued so long as the discounted net present value of cash inflows is greater than the discounted net present value of the investment requirement, or net cash outlay. Because the attractiveness of individual projects increases with the magnitude of this difference, high *NPV* projects are inherently more appealing and preferred to low *NPV* projects. Any investment project that is incapable of generating sufficient cash inflows to cover necessary cash outlays, when both are expressed on a present value basis, should not be undertaken. In the case of a project with a $NPV = 0$, project acceptance would neither increase nor decrease the value of the firm. Management would be indifferent to pursuing such a project. *NPV* analysis represents a practical application of the marginal concept, where the marginal revenues and marginal costs of investment projects are considered on a present value basis. Use of the *NPV* technique in the evaluation of alternative investment projects allows managers to apply the principles of marginal analysis in a simple and clear manner. The widespread practical use of the *NPV* technique also lends support to the view of value maximization as the prime objective pursued by managers in the capital budgeting process.

Just as acceptance of $NPV > 0$ projects will enhance the value of the firm, so too will acceptance of projects where the $PI > 1$, and the $IRR > k$. Conversely, acceptance of projects where $NPV < 0$, $PI < 1$, or $IRR < k$ would be unwise and reduce the value of the firm. Because each of these project evaluation techniques share a common focus on the present value of net cash inflows and outflows, they display a high degree of consistency in terms of the project accept/reject decision.

Q18.5 *Level 3 Communications, Inc., like many emerging telecom carriers, has only limited and infrequent access to domestic debt and equity markets. Explain the attractiveness of a Abenefit-cost ratio@ approach in capital budgeting for Level 3, and illustrate why the NPV, PI, and IRR capital budgeting decision rules sometimes provide different rank orderings of investment project alternatives.*

Q18.5 ANSWER

Smaller companies often have only limited and infrequent access to domestic debt and equity markets. In such circumstances, Acapital rationing@ is in effect and a Abenefit-cost ratio@ approach to capital budgeting ensures that the company receives the biggest profitability bang for the investment buck.

NPV is the difference between the marginal revenues and marginal costs of an individual investment project, when both revenues and costs are expressed in present value terms. *NPV* measures the relative attractiveness of alternative investment projects by the discounted dollar difference between revenues and costs. Therefore, *NPV* is an *absolute* measure of the attractiveness of a given investment project. Conversely, the *PI* reflects the difference between the marginal revenues and marginal costs of an individual project in ratio form. The *PI* is the ratio of the discounted present value of cash inflows divided by the discounted present value of cash outflows. *PI* is a *relative* measure of project attractiveness. It follows that application of the *NPV* method will lead to the highest ranking for large profitable projects. Use of the *PI* method will lead to the highest ranking for projects that return the greatest amount of cash inflow per dollar of outflow, regardless of project size. At times, application of the *NPV* method can create a bias for larger as opposed to smaller projects--a problem when all favorable $NPV > 0$ projects cannot be pursued. When capital is scarce, application of the *PI* method has the potential to lead to a better project mix for the firm=s overall investment portfolio.

Both *NPV* and *PI* methods differ from the *IRR* technique in terms of their underlying assumptions regarding the reinvestment of cash flows during the life of the project. In the *NPV* and *PI* methods, excess cash flows generated over the life of the project are Areinvested@ at the firms=s cost of capital. In the *IRR* method, excess cash flows are reinvested at the *IRR*. For especially attractive investment projects that generate an exceptionally high rate of return, the *IRR* can actually overstate project attractiveness because reinvestment of excess cash flows at a similarly high *IRR* is not possible. When reinvestment at the project-specific *IRR* is not possible, the *IRR* method must be adapted to take into account the lower rate of return that can be earned on excess cash flows generated over the life of individual projects. Otherwise, use of the *NPV* or *PI* methods is preferable.

A further and more serious conflict can arise between *NPV* and *IRR* methods when projects differ significantly in terms of the magnitude and timing of cash flows. When the size or cash flow pattern of alternative projects differs greatly, each project=s *NPV* can react quite differently to changes in the discount rate. As a result, changes in the appropriate discount rate can lead to reversals in project rankings.

Q18.6 *How is a crossover discount rate calculated, and how does it affect capital budgeting decisions?*

Q18.6 ANSWER

A reversal of project rankings occurs at the crossover discount rate, where *NPV* is equal for two or more investment alternatives. The ranking reversal problem is typical of situations where investment projects differ greatly in terms of their underlying *NPV* profiles. Hence, a potentially troubling conflict exists between *NPV*, *PI* and *IRR* methods. However, the ranking reversal problem and suggested conflict between *NPV*, *PI*, and *IRR* methods is much less serious than one might first imagine. Many comparisons between alternative investment projects involve neither crossing *NPV* profiles nor crossover discount rates. In many other instances, project comparisons involve crossover discount rates that are either too low or too high to affect project rankings at the current cost of capital. As a result, there is often no meaningful conflict between *NPV* and *IRR* project rankings.

When crossover discount rates are relevant, they can be easily calculated as the *IRR* of the *difference* between two investment alternatives. The *IRR* for the cash flow difference between two investment alternatives exactly balances the present value cost of higher cash outflows with the present value benefit of higher cash inflows. At this *IRR*, the cash flow difference between two investment alternatives has a $NPV = 0$. When k is less than this crossover *IRR*, the investment project with the greater nominal dollar return will have a larger *NPV* and tend to be favored. When k is greater than the crossover *IRR*, the project with an earlier cash flow pattern will have the larger *NPV* and be favored. When k equals the crossover *IRR*, the cash flow difference between projects has a $NPV = 0$, and each project will have exactly the same *NPV*. Once an economically relevant crossover discount rate has been determined, management must decide whether to rely on *NPV* or *IRR* decision rules in the resolution of the ranking reversal problem. Logic suggests that the *NPV* ranking should dominate because that method will result in a value maximizing selection of projects. In most situations, it is also more realistic to assume reinvestment of excess cash flows during the life of a project at the current cost of capital k. This again favors *NPV* over *IRR* rankings. As a result, conflicts between *NPV* and *IRR* project rankings are usually resolved in favor of the *NPV* rank order.

Q18.7 *An efficient firm employs inputs in such proportions that the marginal product/price ratios for all inputs are equal. In terms of capital budgeting, this implies that the marginal cost of debt should equal the marginal cost of equity in the optimal capital structure. In practice, firms often issue debt at interest rates substantially below the yield that investors require on the firm=s equity shares. Does this mean that many firms are not operating with optimal capital structures? Explain.*

Q18.7 ANSWER

No, the phenomenon of lower observed yields for debt versus equity instruments does not imply suboptimal capital structures. The explanation lies in the less directly observed impact of a given method of financing on the cost of other forms of capital funding. For example, the use of debt instruments to acquire capital increases the leverage of a firm. This increases risk to both debt and equity holders and, hence, increases the marginal cost of both forms of capital. This indirect cost of debt financing must be added to the observed yield on debt instruments to obtain a measure of the true economic cost of debt. Similarly, increased use of equity instruments reduces leverage and risk, and increases the firm=s ability to issue more debt. When these added benefits of equity financing are properly accounted for, the true marginal cost of equity financing is reduced to a level equal to the economic cost of debt. This assumes, of course, that the firm employs an optimal capital structure.

Q18.8 *Suppose that Black & Decker=s interest rate on newly-issued debt is 7.5% and the firm=s marginal federal-plus-state income tax rate is 40%. This implies a 4.5% after-tax component cost of debt. Also assume that the firm has decided to finance next year=s projects by selling debt. Does this mean that next year=s investment projects have a 4.5% cost of capital?*

Q18.8 ANSWER

The answer is no, at least not usually. In financing a particular set of projects with debt, the firm typically uses some of its potential for obtaining further low-cost debt financing. As expansion takes place, the firm typically finds it necessary to raise additional high-cost equity to avoid unacceptably high leverage. As a result, the current component cost of debt seldom measures the true long-term opportunity cost of debt financing. To illustrate, suppose that the firm has a current 4.5% cost of debt and a 10% cost of equity. In the first year it borrows heavily, using its debt capacity in the process, to finance projects yielding 6%. In the second year, it has projects available that yield 9%, or substantially above the return on first-year projects, but it cannot accept them because they would have to be financed with 10% equity. To avoid this problem, the firm should be viewed as an ongoing concern, and the cost of capital should be calculated as a weighted average of the various types of funds it uses.

Q18.9 *Research in financial economics concludes that stockholders of target firms in takeover battles Awin@ (earn abnormal returns) and that stockholders of successful bidders do not lose subsequent to takeovers, even though takeovers usually occur at*

substantial premiums over pre-bid market prices. Is this observation consistent with capital market efficiency?

Q18.9 ANSWER

Yes, buyouts at above pre-bid market prices are a signal that economic resources are moving from less efficient to more efficient uses. As discussed in Chapter 1, unfriendly takeovers are especially unfriendly to inefficient managements which are replaced. Even friendly takeovers constitute an economic Aevent,@ because they signal a change in the use of firm assets. Therefore, bidding firms can offer a premium to sellers based upon their superior subsequent use of the assets taken over. In both pre-bid and post-bid periods, market prices appear, on average, to reflect the discounted net present value of the expected future stream of net cash flows (profits), as is necessary for capital market efficiency.

Q18.10 *ARisky projects are accepted for investment on the basis of favorable expectations concerning profitability. In the post-audit process, they must not be unfairly criticized for failing to meet those expectations.@ Discuss this statement.*

Q18.10 ANSWER

It is a simple fact that some investment projects undertaken on the basis of favorable expectations of profit fail to work out. The purchase of automobile insurance is not a mistake just because one doesn=t get into an automobile accident during the year. Similarly, the pursuit of an attractive investment project is not a mistake just because hoped-for benefits fail to materialize. No wildcat oil driller expects to hit oil on every drilling project. Instead, the successful oil driller hopes to hit oil on a sufficiently high percentage of the wells drilled to earn an attractive risk-adjusted rate of return on an overall basis. A percentage of all projects undertaken by a reasonably aggressive firm will prove unsuccessful. This must be considered when appraising the performances of managers who submit capital expenditure requests. Projects also sometimes fail to meet expectations for reasons that no one could realistically anticipate. If the post-audit process is not used carefully, managers may be reluctant to suggest potentially profitable but risky projects. Because of these difficulties, some firms tend to play down the importance of the post-audit. However, the best-run and most successful organizations in business and government are those that put the greatest emphasis on post-audits. Accordingly, the post-audit process is one of the most important elements in an effective capital budgeting system.

SELF-TEST PROBLEMS & SOLUTIONS

ST18.1 ***NPV and Payback Period Analysis****. Suppose that your college roommate has approached you with an opportunity to lend $25,000 to her fledgling home healthcare business. The business, called Home Health Care, Inc., plans to offer home infusion therapy and monitored in-the-home healthcare services to surgery patients in the Birmingham, Alabama, area. Funds would be used to lease a delivery vehicle, purchase supplies, and provide working capital. Terms of the proposal are that you would receive $5,000 at the end of each year in interest with the full $25,000 to be repaid at the end of a ten-year period.*

A*. Assuming a 10% required rate of return, calculate the present value of cash flows and the net present value of the proposed investment.*

B*. Based on this same interest rate assumption, calculate the cumulative cash flow of the proposed investment for each period in both nominal and present-value terms.*

C*. What is the payback period in both nominal and present-value terms?*

D*. What is the difference between the nominal and present-value payback period? Can the present-value payback period ever be shorter than the nominal payback period?*

ST18.1 ***SOLUTION***

A. The present value of cash flows and the net present value of the proposed investment can be calculated as follows:

Year	Cash Flow	Present Value Interest Factor	Present Value Cash Flow
0	($25,000)	1.0000	($25,000)
1	5,000	0.9091	4,545
2	5,000	0.8264	4,132
3	5,000	0.7513	3,757
4	5,000	0.6830	3,415
5	5,000	0.6209	3,105
6	5,000	0.5645	2,822

7	5,000	0.5132	2,566
8	5,000	0.4665	2,333
9	5,000	0.4241	2,120
10	5,000	0.3855	1,928
Cost of Capital			10.0%
Present Value of Benefits			$30,723
Present Value of Cost			$25,000
Net Present Value			$5,723

B. The cumulative cash flow of the proposed investment for each period in both nominal and present-value terms is:

Year	Cash Flow	Present Value Interest Factor	Present Value Cash Flow	Cumulative Cash Flow	Cumulative PV Cash Flow
0	($25,000)	1.0000	($25,000)	($25,000)	($25,000)
1	5,000	0.9091	4,545	(20,000)	(20,455)
2	5,000	0.8264	4,132	(15,000)	(16,322)
3	5,000	0.7513	3,757	(10,000)	(12,566)
4	5,000	0.6830	3,415	(5,000)	(9,151)
5	5,000	0.6209	3,105	0	(6,046)
6	5,000	0.5645	2,822	5,000	(3,224)
7	5,000	0.5132	2,566	10,000	(658)
8	5,000	0.4665	2,333	15,000	1,675
9	5,000	0.4241	2,120	20,000	3,795
10	5,000	0.3855	1,928	25,000	5,723

Payback Period	5 years
Present Value Payback Period	8.28 years (= 8 + $658/$2,333).

C. Based on the information provided in part B, it is clear that the cumulative cash flow in nominal dollars reached $0 at the end of Year 5. This means that the nominal payback period is 5 years. The cumulative cash flow in present-value dollars exceeds $0 when the Year 8 interest payment is received. This means that the

present-value payback period is roughly 8 years. If cash flows were received on a continuous basis, the present-value payback period would be 8.28 years (= \$658/\$2,333).

D. Assuming a positive rate of interest, the present-value payback period is always longer than the nominal payback period. This stems from the fact that present-value dollars are always less than nominal dollars, and it therefore takes longer to receive a fixed dollar amount back in terms of present-value dollars rather than in nominal terms.

ST18.2 ***Decision Rule Conflict***. *Bob Sponge has been retained as a management consultant by Square Pants, Inc., a local speciality retailer, to analyze two proposed capital investment projects, projects X and Y. Project X is a sophisticated working capital and inventory control system based upon a powerful personal computer, called a system server, and PC software specifically designed for inventory processing and control in the retailing business. Project Y is a similarly sophisticated working capital and inventory control system based upon a powerful personal computer and general- purpose PC software. Each project has a cost of \$10,000, and the cost of capital for both projects is 12%. The projects= expected net cash flows are as follows:*

	Expected Net Cash Flow	
Year	***Project X***	***Project Y***
0	*(\$10,000)*	*(\$10,000)*
1	*6,500*	*3,500*
2	*3,000*	*3,500*
3	*3,000*	*3,500*
4	*1,000*	*3,500*

A. *Calculate each project=s nominal payback period, net present value (NPV), internal rate of return (IRR), and profitability index (PI).*

B. *Should both projects be accepted if they are interdependent?*

C. *Which project should be accepted if they are mutually exclusive?*

D. *How might a change in the cost of capital produce a conflict between the NPV and IRR rankings of these two projects? At what values of k would this conflict exist? (Hint: Plot the NPV profiles for each project to find the crossover discount rate k.)*

E. *Why does a conflict exist between NPV and IRR rankings?*

ST18.2 SOLUTION

A. *Payback*:

To determine the nominal payback period, construct the cumulative cash flows for each project:

	Cumulative Cash Flow	
Year	**Project X**	**Project Y**
0	($10,000)	($10,000)
1	(3,500)	(6,500)
2	(500)	(3,000)
3	2,500	500
4	3,500	4,000

$$\text{Payback}_X = 2 + \frac{\$500}{\$3,000} = 2.17 \text{ years}.$$

$$\text{Payback}_Y = 2 + \frac{\$3,000}{\$3,500} = 2.86 \text{ years}.$$

Net Present Value (NPV):

$$\text{NPV}_X = -\$10,000 + \frac{\$6,500}{(1.12)^1} + \frac{\$3,000}{(1.12)^2} + \frac{\$3,000}{(1.12)^3} + \frac{\$1,000}{(1.12)^4}$$
$$= \$966.01.$$
$$\text{NPV}_Y = -\$10,000 + \frac{\$3,500}{(1.12)^1} + \frac{\$3,500}{(1.12)^2} + \frac{\$3,500}{(1.12)^3} + \frac{\$3,500}{(1.12)^4}$$
$$= \$630.72.$$

Internal Rate of Return (IRR):

To solve for each project=s *IRR*, find the discount rates that set *NPV* to zero:

$$\text{IRR}_X = 18.0\%.$$
$$\text{IRR}_Y = 15.0\%.$$

Profitability Index (PI):

$$\text{PI}_X = \frac{\text{PV Benefits}}{\text{PV Costs}} = \frac{\$10,966.01}{\$10,000} = 1.10.$$
$$\text{PI}_Y = \frac{\$10,630.72}{\$10,000} = 1.06.$$

B. Using all methods, project X is preferred over project Y. Because both projects are acceptable under the *NPV*, *IRR*, and *PI* criteria, both projects should be accepted if they are interdependent.

C. Choose the project with the higher *NPV* at k = 12%, or project X.

D. To determine the effects of changing the cost of capital, plot the *NPV* profiles of each project. The crossover rate occurs at about 6% to 7%. To find this rate exactly, create a project Δ, which is the difference in cash flows between projects X and Y:

Year	Project X - Project Y = Project Δ Net Cash Flow
0	$0
1	3,000
2	(500)

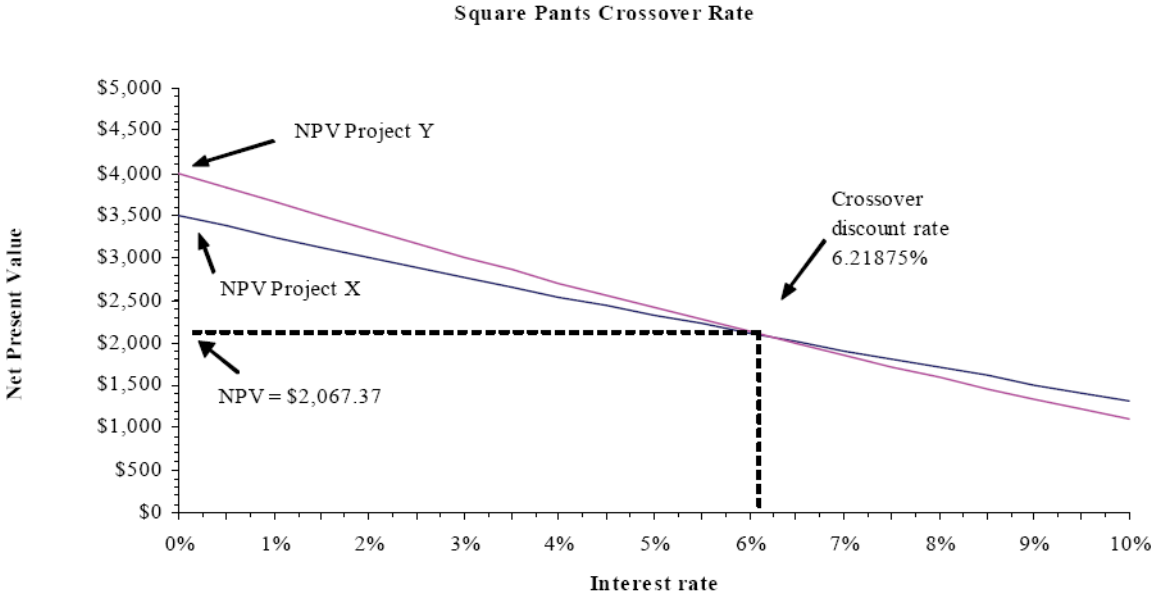
3	(500)
4	(2,500)

Then find the *IRR* of Project Δ:

$$IRR_{\Delta} = \text{Crossover Rate} = 6.2\%.$$

Thus, if the firm=s cost of capital is less than 6.2%, a conflict exists, because $NPV_Y > NPV_X$ but $IRR_X > IRR_Y$.

Graphically, the crossover discount rate is illustrated as follows:



E. The basic cause of conflict is the differing reinvestment rate assumptions between *NPV* and *IRR*. The conflict occurs in this situation because the projects differ in their cash flow timing.

PROBLEMS & SOLUTIONS

P18.1 ***Cost of Capital****. Identify each of the following statements as true or false, and explain your answers.*

A. *Information costs both increase the marginal cost of capital and reduce the internal rate of return on investment projects.*

B. *Depreciation expenses involve no direct cash outlay and can be safely ignored in investment-project evaluation.*

C. *The marginal cost of capital will be less elastic for larger firms than for smaller firms.*

D. *In practice, the component costs of debt and equity are jointly rather than independently determined.*

E. *Investments necessary to replace worn-out or damaged equipment tend to have low levels of risk.*

P18.1 SOLUTION

A. True. The need to gather information concerning the creditworthiness of borrowers increases the interest rates charged by creditors. Similarly, the task of information gathering in the investment project evaluation process reduces the *IRR* from those projects.

B. False. Even though depreciation expenses involve no direct cash outlay, they must be explicitly considered in investment project evaluation because they affect corporate cash outlays for income tax payments.

C. False. The marginal cost of capital will tend to be more elastic for larger as opposed to smaller firms. Large firms tend to have easy access to capital markets given their relatively long operating history, and substantial resources. On the other hand, the

marginal cost of capital can increase rapidly (be quite inelastic) for smaller firms which, for example, face capital constraints due to scarce managerial talent.

D. True. The component costs of debt and equity tend to be jointly as opposed to independently determined. Higher levels of debt, for example, will usually increase the perceived level of risk for debt holders and equity holders alike, and, therefore, raise the interest rate charged by creditors and the rate of return requirement of stockholders.

E. True. Investments necessary to replace worn out or damaged equipment have highly predictable returns and low levels of risk.

P18.2 ***Decision Rule Criteria****. The net present value (NPV), profitability index (PI), and internal rate of return (IRR) methods are often employed in project valuation. Identify each of the following statements as true or false, and explain your answers.*

A. *The IRR method can tend to understate the relative attractiveness of superior investment projects when the opportunity cost of cash flows is below the IRR.*

B. *A PI = 1 describes a project with an NPV = 0.*

C. *Selection solely according to the NPV criterion will tend to favor larger rather than smaller investment projects.*

D. *When NPV = 0, the IRR exceeds the cost of capital.*

E. *Use of the PI criterion is especially appropriate for larger firms with easy access to capital markets.*

P18.2 ***SOLUTION***

A. False. The *IRR* method implicitly assumes reinvestment of net cash flows during the life of the project at the *IRR* and will overstate the relative attractiveness of superior investment projects when the opportunity cost of cash flows is below the *IRR*. If, for example, a project has a projected *IRR* = 22%, but cash flows Athrown off@ during the life of the project can only be reinvested at, say, 15%, then the true *IRR* for the project will be less than 22% and its relative attractiveness will be overstated using the *IRR* method.

B. True. The *PI* = PV Cash Flows/Cost, and *NPV* = PV Cash Flows -Cost. Therefore, when PV Cash Flows = Cost, *PI* = 1 and *NPV* = 0.

C. True. Selection according to the *NPV* criterion will tend to favor larger as opposed to smaller investment projects.

D. False. The *IRR* is the interest rate that equates the PV cash flows with the investment cost of a project. *NPV* = PV Cash Flows - Cost, when cash flows are discounted at an appropriate risk-adjusted cost of capital, *k*. Therefore, when *IRR* = *k*, *NPV* = 0.

E. False. Larger firms with easy access to capital markets maximize the value of the firm through the capital budgeting process by selecting projects according to the *NPV* criterion. Smaller firms, which face capital budget constraints forcing rejection of some *NPV* > 0 projects, can best employ scarce capital through use of the *PI* criterion.

P18.3 ***Cost of Capital***. *Indicate whether each of the following would increase or decrease the cost of capital that should be used by the firm in investment project evaluation. Explain.*

A. *Interest rates rise because the Federal Reserve System tightens the money supply.*

B. *The stock market suffers a sharp decline, as does the company=s stock price, without (in management=s opinion) any decline in the company=s earnings potential.*

C. *The company=s home state eliminates the corporate income tax in an effort to keep or attract valued employers.*

D. *In an effort to reduce the federal deficit, Congress raises corporate income tax rates.*

E. *A merger with a leading competitor increases the company=s stock price substantially.*

P18.3 ***SOLUTION***

A. Increase. A general rise in interest rates will increase the cost of debt, and increase the weighted average cost of capital used in investment project evaluation.

B. Increase. As stock prices fall, the required return per dollar of equity capital will rise. This will force upward the weighted average cost of capital used in investment project evaluation.

C. Decrease. As state corporate income taxes fall, the after-tax component cost of debt will rise and increase the relative attractiveness of equity financing. The firm=s weighted average cost of capital will decline, however, as the after-tax returns available to debt plus equity holders will increase from a given stream of cash flows, and cause bond and stock prices to rise.

Of course, average state tax rates are fairly modest compared with federal tax rates, and the effect of changing state tax rates on the weighted average cost of capital can be expected to be similarly modest. Still, on balance and holding all else equal, we would expect the weighted average cost of capital to be marginally less for firms headquartered in Florida (a no tax state) versus Wisconsin (a relatively high tax state).

D. Increase. As federal corporate income tax rates rise, the after-tax returns available to debt plus equity holders will fall, and the weighted average cost of capital will increase. On a relative basis, debt will become preferred to equity financing. (Also see part C answer.)

E. Decrease. Holding all else equal, an increase in the stock price for a company will reduce the component cost of equity and the weighted average cost of capital.

P18.4 ***Present Value****. New York City licenses taxicabs in two classes: (1) for operation by companies with fleets and (2) for operation by independent driver-owners having only one cab. Strict limits are imposed on the number of taxicabs by restricting the number of licenses, or medallions, that are issued to provide service on the streets of New York City. This medallion system dates from a Depression-era city law designed to address an overabundance of taxis that depressed driver earnings and congested city streets. In 1937, the city slapped a moratorium on the issuance of new taxicab licenses. The number of cabs, which peaked at 21,000 in 1931, fell from 13,500 in 1937 to 11,787 in May 1996, when the city broke a 59-year cap and issued an additional 400 licenses. However, because the city has failed to allow sufficient expansion, taxicab medallions have developed a trading value in the open market. After decades of often-explosive medallion price increases, individually-owned licenses now trade for more than $200,000 each, and fleet licenses fetch more than $250,000 each.*

A. *Discuss the factors determining the value of a license. To make your answer concrete, estimate numerical values for the various components that together can be summarized in a medallion price of $200,000.*

B. *What factors would determine whether a change in the fare fixed by the city would raise or lower the value of a medallion?*

C. *Cab drivers, whether hired by companies or as owners of their own cabs, seem unanimous in opposing any increase in the number of cabs licensed. They argue that an increase in the number of cabs would increase competition for customers and drive down what they regard as an already unduly low return to drivers. Is their economic analysis correct? Who would gain and who would lose from an expansion in the number of licenses issued at a nominal fee?*

P18.4 SOLUTION

A. The price of a medallion will be determined by the above-normal or economic profits that can be obtained in the taxicab industry. More precisely, the price of a medallion will equal the discounted present value of all future profits over and above those necessary to attract and maintain the capital necessary to operate in the industry. For example, if one expected the current licensing arrangements to continue in perpetuity, and if opportunity costs for investments of this type were 10%, then the $200,000 medallion price indicates an expected economic profit of $20,000 (= 0.1 H $200,000) per year.

B. The effect of fare changes on medallion values depends on the price elasticity of demand for cab service. With an inelastic demand for cab service, fare increases lead to higher profits and, hence, higher medallion prices. Fare reductions, on the other hand, would reduce the value of a medallion. With elastic demand, one would have to examine both the added revenues and costs associated with fare reductions, or revenue losses and cost reductions associated with fare increases, to answer this question.

C. The $200,000 price of a medallion is a tangible indicator that excess or economic profits exist in the industry. It is impossible for the return to be Aunduly low@ with such a premium being offered for the license to operate. The obvious losers from an expansion of licenses at a nominal cost would be the holders of current medallions. They would lose the $200,000 current value of their medallions. The purchasers of cab services and potential entrants into the industry would both benefit. Customers

would benefit through more service at lower fares. New entrants would benefit through lower capital costs and generally easier entry.

P18.5 ***NPV and PI***. *The Pacific Princess luxury cruise line is contemplating leasing an additional cruise ship to expand service from the Hawaiian Islands to Long Beach or San Diego. A financial analysis by staff personnel resulted in the following projections for a five-year planning horizon:*

	Long Beach	***San Diego***
Cost	*$2,000,000*	*$3,000,00*
PV of expected cash flow @ k = 15%	*2,500,000*	*3,600,000*

A. *Calculate the net present value for each service. Which is more desirable according to the NPV criterion?*

B. *Calculate the profitability index for each service. Which is more desirable according to the PI criterion?*

C. *Under what conditions would either or both of the services be undertaken?*

P18.5 ***SOLUTION***

A.

Long Beach

NPV_{LB} = PV Cash Flow - Cost

= $2,500,000 - $2,000,000

= $500,000

San Diego

NPV_{SD} = PV Cash Flow - Cost

= $3,600,000 - $3,000,000

= $600,000

Because $NPV_{SD} > NPV_{LB}$, the San Diego service is ranked ahead of the Long Beach alternative, using the *NPV* criterion. However, because $NPV > 0$ for each service, both are acceptable and profitable.

B.

Long Beach

$$PI_{LB} = \frac{\text{PV Cash Flow}}{\text{Cost}}$$

$$= \$2{,}500{,}000/\$2{,}000{,}000$$

$$= 1.25$$

San Diego

$$PI_{SD} = \frac{\text{PV Cash Flow}}{\text{Cost}}$$

$$= \$3{,}600{,}000/\$3{,}000{,}000$$

$$= 1.2$$

Because $PI_{LB} > PI_{SD}$, the Long Beach service is ranked ahead of the San Diego alternative using the *PI* criterion. However, because $PI > 0$ for each service, both are acceptable and profitable.

C. Should the company have relatively abundant capital resources, or at least $5,000,000 available for investment, both services should be initiated. However, when capital resources are scarce, use of the *PI* criterion, and initiation of the Long Beach service first, would result in scarce funds being used where their relative impact on value is greatest.

P18.6 ***NPV and PI***. *Louisiana Drilling and Exploration, Inc. (LD&E) has the funds necessary to complete one of two risky oil and gas drilling projects. The first, Permian Basin 1, involves the recovery of a well that was plugged and abandoned five years ago but that may now be profitable, given improved recovery techniques. The second, Permian Basin 2, is a new onshore exploratory well that appears to be especially promising. Based on a detailed analysis by its technical staff, LD&E projects a ten-year life for each well with annual net cash flows as follows:*

Project	***Probability***	***Annual Cash Flow***
Permian Basin 1	*0.08*	*$500,000*
	0.84	*1,000,000*
	0.08	*1,500,000*
Permian Basin 2	*0.18*	*300,000*
	0.64	*900,000*
	0.18	*1,500,000*

In the recovery-project valuation, LD&E uses an 8% riskless rate and a standard 12% risk premium. For exploratory drilling projects, the company uses larger risk premiums proportionate to project risks as measured by the project coefficient of variation. For example, an exploratory project with a coefficient of variation one and one-half times that for recovery projects would require a risk premium of 18% (= 1.5 H 12%). Both projects involve land acquisition, as well as surface preparation and subsurface drilling costs of $3 million each.

A. *Calculate the expected value, standard deviation, and coefficient of variation for annual net operating revenues from each well.*

B. *Calculate and evaluate the NPV for each project using the risk-adjusted discount rate method.*

C. *Calculate and evaluate the PI for each project.*

P18.6 SOLUTION

A. Permian Basin #1

$$E(CF_1) = \$500,000(0.08) + \$1,000,000(0.84) + \$1,500,000(0.08)$$

$$= \$1,000,000$$

$$\sigma_1 = \sqrt{(\$500,000 - \$1,000,000)^2(0.08) + (\$1,000,000}$$

$$\sqrt{-\$1,000,000)^2(0.84) + (\$1,500,000 - \$1,000,000)^2(0.08)}$$

$= \$200,000$

$V_1 = \sigma_1/E(CF_1)$

$= 0.2$

Permian Basin #2

$E(CF_2) = \$300,000(0.18) + \$900,000(0.64) + \$1,500,000(0.18)$

$= \$900,000$

$$\sigma_2 = \sqrt{(\$300,000 - \$900,000)^2(0.18) + (\$9,00,000}$$

$$\sqrt{-\$900,000)^2(0.64) + (\$1,500,000 - \$900,000)^2(0.18)}$$

$= \$360,000$

$V_2 = \sigma_2/E(CF_2)$

$= 0.4$

B. Permian Basin #1

NPV_1 = (PVIFA, N = 10, i = 8% + 12% = 20%)

H $E(CF_1)$ - Cost

= (4.1925)($1,000,000) - $3,000,000

= $1,192,500

Permian Basin #2

NPV_2 = (PVIFA, N = 10, i = 8% + 2(12%) = 32%)

H $E(CF_2)$ - Cost

= (2.9304)($900,000) - $3,000,000

= -$362,640 (A loss)

Therefore, the less risky Permian Basin #1 has a positive NPV_1 and should be undertaken, whereas the more risky Permian Basin #2 project has an $NPV_2 < 0$ and should be rejected.

(*Note*: $V_2 = 2V_1$ so the appropriate risk premium for Permian Basin #2 is 24% = 2 H 12%.)

C. Permian Basin #1

$$PI_1 = \frac{\text{PV Cash Flow}}{\text{Cost}}$$

= $4,192,500/$3,000,000

= 1.40

Permian Basin #2

$$PI_2 = \frac{\text{PV Cash Flow}}{\text{Cost}}$$

= $2,637,360/$3,000,000

= 0.88

Because the $PI_1 > PI_2$, the Permian Basin #1 project is ranked ahead of the Permian Basin #2 project. Moreover, because $PI_2 < 1$, this latter project is unattractive, and should not be pursued in any event.

P18.7 ***Investment Project Choice****. Carrie Bradshaw=s Manhattan Café, Inc., is considering investment in two alternative capital budgeting projects. Project A is an investment of $75,000 to replace working but obsolete refrigeration equipment. Project B is an investment of $150,000 to expand dining room facilities. Relevant cash flow data for the two projects over their expected two-year lives are:*

Project A			
Year 1		***Year 2***	
Probability	***Cash Flow***	***Probability***	***Cash Flow***
0.18	*$0*	*0.08*	*$0*
0.64	*50,000*	*0.84*	*50,000*
0.18	*100,000*	*0.08*	*100,000*

Project B			
Year 1		***Year 2***	
Probability	***Cash Flow***	***Probability***	***Cash Flow***
0.50	*$0*	*0.125*	*$0*
0.50	*200,000*	*0.75*	*100,000*
		0.125	*200,000*

A. *Calculate the expected value, standard deviation, and coefficient of variation of cash flows for each project.*

B. *Calculate the risk-adjusted NPV for each project using a 15% cost of capital for the riskier project and a 12% cost of capital for the less risky one. Which project is preferred using the NPV criterion?*

C. *Calculate the PI for each project, and rank the projects according to the PI criterion.*

D. *Calculate the IRR for each project, and rank the projects according to the IRR criterion.*

E. *Compare your answers to parts B, C, and D, and discuss any differences.*

P18.7 SOLUTION

A. Project A

Year 1:

$E(CF_{A1}) = \$0(0.18) + \$50{,}000(0.64) + \$100{,}000(0.18)$

$$= \$50,000$$

$$\sigma_{A1} = \sqrt{(\$0 - \$50,000)^2(0.18) + (\$50,000 - \$50,000)^2(0.64) + (\$100,000 - \$50,000)^2(0.18)}$$

$$= \$30,000$$

$$V_{A1} = \sigma_{A1}/E(CF_{A1})$$

$$= 0.6$$

Year 2:

$$E(CF_{A2}) = \$0(0.08) + \$50,000(0.84) + \$100,000(0.08)$$

$$= \$50,000$$

$$\sigma_{A2} = \sqrt{(\$0 - \$50,000)^2(0.08) + (\$50,000 - \$50,000)^2(0.84) + (\$100,000 - \$50,000)^2(0.08)}$$

$$= \$20,000$$

$$V_{A2} = \sigma_{A2}/E(CF_{A2})$$

$$= 0.4$$

Project B

Year 1:

$$E(CF_{B1}) = \$0(0.5) + \$200,000(0.5)$$

$$= \$100,000$$

$$\sigma_{B1} = \sqrt{(\$0 - \$100,000)^2(0.5) + (\$200,000$$

$$\sqrt{\text{-\$100,000)}^2(0.5)}$$

$$= \$100{,}000$$

$$V_{B1} = \sigma_{B1}/E(CF_{B1})$$

$$= 1$$

Year 2:

$$E(CF_{B2}) = \$0(0.125) + \$100{,}000(0.75) + \$200{,}000(0.125)$$

$$= \$100{,}000$$

$$\sigma_{B2} = \sqrt{(\$0 - \$100{,}000)^2(0.125) + (\$100{,}000 \text{-} \$100{,}000)^2(0.75) + (\$200{,}000 - \$100{,}000)^2(0.125)}$$

$$= \$50{,}000$$

$$V_{B2} = \sigma_{B2}/E(CF_{B2}) = 0.5$$

B. Project B has a higher standard deviation and coefficient of variation in project returns and, therefore, is the more risky of the two investment projects. Project B returns are discounted using a 15% cost of capital, whereas project A returns are discounted using a 12% cost of capital.

The net present value of each project is:

$$NPV_A = \$50{,}000(\text{PVIFA, N = 2, i = 12\%}) - \$75{,}000$$

$$= \$50{,}000(1.6901) - \$75{,}000$$

$$= \$9{,}505$$

$$NPV_B = \$100{,}000(\text{PVIFA, N = 2, i = 15\%}) - \$150{,}000$$

= $100,000(1.6257) - $150,000

= $12,570

Because the $NPV_B > NPV_A$, the riskier project B would be chosen when using the *NPV* criterion.

C. The profitability index for each project is:

PI_A = PV Cash Flows/Cost = $84,505/$75,000 = 1.13

PI_B = PV Cash Flows/Cost = $162,750/$150,000 = 1.08

Because $PI_A > PI_B$, the less risky project A would be chosen using the *PI* criterion.

D. The *IRR* is the interest rate that produces an *NPV* equal to zero.

For project A set:

NPV_A = $50,000(PVIFA, N = 2, i = X%) - $75,000 = 0

This *IRR* can be easily calculated using many types of hand-held calculators, or by trial and error with various interest rates in the preceding equation. In order for $NPV_A = 0$ in the above equation, we must find the interest rate associated with PVIFA(N = 2) = 1.5.

Using the appendix in the back of the book, we find:

INTEREST RATE	**PVIFA(N = 2)**	***NPV_A***
20%	1.5278	$1,390
24%	1.4568	(2,160)

Therefore, $20\% < IRR_A < 24\%$ (or exactly, 21.6%).

Similarly, for project B set:

NPV_B = $100,000(PVIFA, N = 2, i = X%) - $150,000 = 0

Obviously, $NPV_B = 0$ when PVIFA(N = 2) = 1.5. Therefore, $IRR_A = IRR_B = 21.6\%$ and the company would be indifferent between projects A and B according to the *IRR* criterion.

E. Both projects have an internal rate of return above the risk-adjusted cost of capital, and would increase the value of the firm after adoption. In the event of capital scarcity, however, project A is preferred because it has a greater return per dollar of investment than does project B. This preference for project A is reinforced for risk-averse management who would note that despite being riskier, project B has an *IRR* which is the same as the less risky project A.

P18.8 ***Cash Flow Estimation***. *Cunningham=s Drug Store, a medium-size drugstore located in Milwaukee, Wisconsin, is owned and operated by Richard Cunningham. Cunningham=s sells pharmaceuticals, cosmetics, toiletries, magazines, and various novelties. Cunningham=s most recent annual net income statement is as follows:*

Sales revenue	*$1,800,000*
Total costs	
Cost of goods sold	*$1,260,000*
Wages and salaries	*200,000*
Rent	*120,000*
Depreciation	*60,000*
Utilities	*40,000*
Miscellaneous	*30,000*
Total	*1,710,000*
Net profit before tax	*$90,000*

Cunningham=s sales and expenses have remained relatively constant over the past few years and are expected to continue unchanged in the near future. To increase sales, Cunningham is considering using some floor space for a small soda fountain. Cunningham would operate the soda fountain for an initial three-year period and then would reevaluate its profitability. The soda fountain would require an incremental investment of $20,000 to lease furniture, equipment, utensils, and so on. This is the only capital investment required during the three-year period. At the end of that time, additional capital would be required to continue operating the soda fountain, and no capital would be recovered if it were shut down. The soda fountain

is expected to have annual sales of $100,000 and food and materials expenses of $20,000 per year. The soda fountain is also expected to increase wage and salary expenses by 8% and utility expenses by 5%. Because the soda fountain will reduce the floor space available for display of other merchandise, sales of nonsoda fountain items are expected to decline by 10%.

A. *Calculate net incremental cash flows for the soda fountain.*

B. *Assume that Cunningham has the capital necessary to install the soda fountain and that he places a 12% opportunity cost on those funds. Should the soda fountain be installed? Why or why not?*

P18.8 SOLUTION

A. The relevant annual cash flows from the proposed soda fountain are:

Incremental revenue	$100,000
Increment cost	
Food and materials	$20,000
Wages and salaries ($200,000 H 0.08)	16,000
Utilities ($40,000 H 0.05)	2,000
Opportunity Cost: Profit contribution lost on regular sales	
= 0.1($1,800,000 - $1,260,000)	54,000
Total incremental cost	92,000
Net incremental annual cash flow	$8,000
Incremental investment	$20,000

B. No, the *NPV* for the proposed soda fountain should be calculated to determine the economic viability of the project.

$$NPV = (\text{Incremental annual cash flow})(\text{PVIFA, N = 3, i = 12\%}) - \$20{,}000$$

$$= \$8{,}000(2.4018) - \$20{,}000$$

$$= -\$785.60 \text{ (A loss)}$$

Because $NPV < 0$, Cunningham should not undertake the soda fountain investment project.

P18.9 ***Cash Flow Analysis***. *The Nigelwick Press, Inc. (NPI) is analyzing the potential profitability of three printing jobs put up for bid by the State Department of Revenue:*

	Job A	***Job B***	***Job C***
Projected winning bid (per unit)	*$5.00*	*$8.00*	*$7.50*
Direct cost per unit	*$2.00*	*$4.30*	*$3.00*
Annual unit sales volume	*800,000*	*650,000*	*450,000*
Annual distribution costs	*$90,000*	*$75,000*	*$55,000*
Investment required to produce annual volume	*$5,000,000*	*$5,200,000*	*$4,000,000*

Assume that (1) the company=s marginal city-plus-state-plus-federal tax rate is 50%; (2) each job is expected to have a six-year life; (3) the firm uses straight-line depreciation; (4) the average cost of capital is 14%; (5) the jobs have the same risk as the firm=s other business; and (6) the company has already spent $60,000 on developing the preceding data. This $60,000 has been capitalized and will be amortized over the life of the project.

A. *What is the expected net cash flow each year? (Hint: Cash flow equals net profit after taxes plus depreciation and amortization charges.)*

B. *What is the net present value of each project? On which project, if any, should NPI bid?*

C. *Suppose that NPI=s primary business is quite cyclical, improving and declining with the economy, but that job A is expected to be countercyclical. Might this have any bearing on your decision?*

P18.9 ***SOLUTION***

A. The $60,000 spent on job cost development is a sunk cost. This cost must, however, be accounted for in the tax calculation as a $10,000 per year non-cash expense. The annual net cash flow calculations are:

	Job A	**Job B**	**Job C**

Projected winning bid (per unit)	$5.00	$8.00	$7.50
Deduct direct cost per unit	2.00	4.30	3.00
Profit contribution per unit	$3.00	$3.70	$4.50
Times annual unit sales volume	800,000	650,000	450,000
Profit contribution per year	$2,400,000	$2,405,000	$2,025,000
Deduct annual distribution costs	90,000	75,000	55,000
Cash flow before amortization, depreciation and taxes	$2,310,000	$2,330,000	$1,970,000
Deduct amortization charges	10,000	10,000	10,000
Cash flow before depreciation and taxes	$2,300,000	$2,320,000	$1,960,000
Deduct depreciation	$833,333	$866,667	$666,667
Cash flow before taxes	$1,466,667	$1,453,333	$1,293,333
Deduct taxes	733,333	726,667	646,667
Cash flow	$733,333	$726,667	$646,667
Add back depreciation plus amortization	843,333	876,667	676,667
Net annual cash flow	$1,576,667	$1,603,333	$1,323,333
Investment required to produce annual volume	$5,000,000	$5,200,000	$4,000,000
Job cost development	$60,000		
Job life (years)	6		
Tax rate	50%		

B. The *NPV* calculations are:

	Job A	**Job B**	**Job C**
Net annual cash flow	$1,576,667	$1,603,333	$1,323,333
Times PVIFA	3.8887	3.8887	3.8887
Present value of annual net cash flows	$6,131,185	$6,234,881	$5,146,045
Deduct initial investment cost	5,000,000	5,200,000	4,000,000
Net present value (*NPV*)	$1,131,185	$1,034,881	$1,146,045
Relevant discount rate	14%		
Job life (years)	6		

Job C is the most profitable, and therefore is the most attractive because $NPV_C > NPV_A > NPV_B$. However, $NPV > 0$ for each job and each project is attractive.

C. Risk for the firm is reduced through diversification. If job A is counter-cylical, then it is least risky, other things being equal, and could be attractive on the basis of both its risk and return characteristics.

P18.10 ***Cost of Capital***. *Eureka Membership Warehouse, Inc., is a rapidly growing chain of retail outlets offering brand-name merchandise at discount prices. A security analyst=s report issued by a national brokerage firm indicates that debt yielding 13% composes 25% of Eureka=s overall capital structure. Furthermore, both earnings and dividends are expected to grow at a rate of 15% per year.*

Currently, common stock in the company is priced at $30, and it should pay $1.50 per share in dividends during the coming year. This yield compares favorably with the 8% return currently available on risk-free securities and the 14% average for all common stocks, given the company=s estimated beta of 2.

A. *Calculate Eureka=s component cost of equity using both the capital asset pricing model and the dividend yield plus expected growth model.*

B. *Assuming a 40% marginal federal-plus-state income tax rate, calculate Eureka=s weighted average cost of capital.*

P18.10 ***SOLUTION***

A. In the capital asset pricing model (CAPM) approach, the required return on equity is:

$$k_e = R_F + ß(k_M - R_F)$$

where k_e is the cost of equity, R_F is the risk-free rate, ß is stock beta, and k_M is the return on the market as a whole. Therefore,

$$k_e = 8\% + 2(14\% - 8\%)$$

$$= 20\%$$

In the dividend yield plus expected growth model approach, the required return on equity is:

$$k_e = \frac{D}{P} + g$$

Where D is the expected dividend during the coming period, P is the current price of the firm=s common stock, and g is the expected growth rate.

Therefore,

$$k_e = \frac{\$1.50}{\$30} + 0.15$$

$$= 0.2 \text{ or } 20\%$$

B. Given a 40% state plus federal income tax rate, the after-tax component cost of debt is:

$$\text{After-tax component cost of debt, } k_d = \text{Interest rate H (1.0 - tax rate)}$$

$$= 0.13 \text{ H } (1.0 - 0.4)$$

$$= 0.078 \text{ or } 7.8\%$$

Therefore,

$$\text{Weighted average cost of capital} = \text{Debt percentage x } k_d + \text{Equity percentage x } k_e$$

$$= 0.25(0.078) + 0.75(0.20)$$

$$= 0.1695 \text{ or } 16.95\%$$

CASE STUDY FOR CHAPTER 18

Sophisticated NPV Analysis at Level 3 Communications, Inc.

Level 3 Communications, LLC, provides integrated telecommunications services including voice, Internet access, and data transmission using rapidly improving optical and Internet protocol technologies (i.e., Abroadband@). Level 3 is called a facilities-based provider because it owns a substantial portion of the fiber optic plant, property, and equipment necessary to serve its customers.

The company traces its roots to Peter Kiewit Sons,= Inc., which was incorporated in Delaware in 1941 to continue a construction business founded in Omaha, Nebraska, in 1884. In subsequent years, Kiewit invested a portion of the cash flow generated by its construction activities in a variety of other businesses. Kiewit entered the coal mining business in 1943, the telecommunications business [consisting of Metropolitan Fiber Systems (MFS) and related

investments] in 1988, the information services business in 1990, and the alternative energy business in 1991. Kiewit has also made investments in several development-stage ventures.

In 1995, Kiewit distributed its MFS holdings to stockholders. In the seven years from 1988 to 1995, the company=s holdings in MFS had grown to a market value of approximately $1.75 billion. In December 1996, MFS was purchased by WorldCom in a transaction valued at $14.3 billion, more than a 28:1 payout and a 52% annual rate of return over 8 years for investors. Following its enormously successful investment in MFS, Kiewit decided to sell unrelated assets and focus its energies on the telecommunications business. In December 1997, the company=s stockholders ratified the decision of the bBoard to effect a split-off from the Kiewit Construction Group. As a result of the split-off, which was completed on March 31, 1998, the company no longer owns any interest in the Construction Group and adopted the name ALevel 3 Communications, Inc.@ The Kiewit Construction Group changed its name to APeter Kiewit Sons,= Inc.@ The term Level 3 comes from the layered set of protocols, or standards that are often used in the industry to describe telecommunications networks. The company=s strategy generally calls for services to be provided in the first three levels of these technical specifications.

During the first quarter of 2001, Level 3 completed construction activities relating to its North American intercity network. In 2003, the company added approximately 2,985 miles to its North America intercity network through acquisition of certain assets of Genuity Inc., a Massachusetts-based provider of communications services. Level 3 has also completed construction of an approximately 3,600 mile fiber optic intercity network that connects many major European cities, including Amsterdam, Berlin, Copenhagen, Frankfurt, Geneva, London, Madrid, Milan, Munich, Paris, Stockholm, Vienna, and Zurich. Level 3's European network is linked to the North American intercity network by a transatlantic cable system that went into service during 2000.

In December 2000, the company signed an agreement to collaborate with FLAG Telecom on the development of the Northern Asia undersea cable system connecting Hong Kong, Japan, Korea, and Taiwan. During the fourth quarter of 2001, the company announced the disposition of its Asian operations in a sale transaction with Reach, Ltd. Although the company believed that Asia represented an attractive longer-term investment opportunity, given current volatile market and economic conditions the company determined that it was necessary to focus its resources, both capital and managerial, on the immediate opportunities provided by the company=s operational assets in North America and Europe. This transaction closed on January 18, 2002. As part of the agreement, Reach and Level 3 agreed that Level 3 would provide capacity and services to Reach over Level 3's North American intercity network, and Level 3 would buy capacity and services from Reach in Asia. This arrangement allowed Level 3 to continue to service its customer base with capacity needs in Asia and provide Reach access to the Level 3 intercity networks in North America and Europe.

Today, Level 3 has grown to become an international communications and information services powerhouse headquartered in Broomfield, Colorado. Level 3 is one of the largest providers of wholesale dial-up service to Internet service providers (ISPs) in North America, and is the primary provider of Internet connectivity for millions of broadband subscribers through its cable and DSL partners. The company operates one of the largest communications and Internet backbones in the world. Level 3 provides services to the world=s ten largest telecom carriers, the top largest ISPs in North America, and Europe=s ten largest telecom carriers. A key contributor to the company=s success is its highly sophisticated approach to capital budgeting.

To help investors, employees, customers, and the general public understand the economics of its business and the company=s approach to capital budgeting, Level 3 has posted on the Internet what it calls a ASilicon Economics Model@ (http://www.level3.com/734.html). Level 3 has developed this model in an effort to demonstrate in a simplified format the dynamic relationships that exist between pricing strategies, cost compression, demand growth, and capital budgeting in an optimized net present value discounted cash flow model. In other words, the model represents an effort to demonstrate the effects of important economic relationships on capital budgeting decisions and the value of the firm. Because of its simplified nature, the Silicon Economics Model should not be interpreted as an attempt to predict Level 3's future operating performance or financial results. Level 3's internal optimization model contains tens of thousands of variables and relationships that for the sake of simplicity are not duplicated in this model.

In order to produce a model for public use that is not overly complex, several simplifying assumptions have been made in the Silicon Economics Model. The effects of market competition are not explicitly modeled, and only a single service offering is considered. In practice, Level 3 offers a wide variety of services in various geographic locations that have differing degrees of demand elasticity. The model places no limits on demand growth, such as would be imposed by limitations on Level 3's internal operating systems or external supply chain requirements. Capital expenditures (CAPEX) are modeled using an initial (one-time) infrastructure cost plus an incremental cost per unit. Cost-saving improvements in technology are modeled as a reduction in unit cost, or annual cost compression rate. Operational expenses (OPEX) are modeled using a fixed annual infrastructure cost, variable cost represented as a percentage of revenue, per-incremental-unit cost (activation related), and per-total-unit cost (support related). Cost reductions over time in these latter two categories can be modeled by specifying an annual productivity improvement factor. Network expenses (NETEX) are modeled as a cost per incremental unit. This unit cost is reduced at the same rate as the activation and support-related operational expenses.

Users can see the effects of varying assumptions on operating and financial performance by choosing different input parameters on the AData Entry@ worksheet. All default input values can be changed. The model will produce the net present value of consolidated cash flow for any choice of input parameters. Details concerning the calculation of expected revenue, capital expenses, operational expenses, and cash flow that are graphed by the model can be reviewed

and are displayed on the ADetails@ tab of the model. Five three-dimensional charts are automatically produced to illustrate the sensitivity of net present value to four primary input parameters, including the annual price reduction rate, price elasticity of demand, annual CAPEX compression (cost-reduction) rate, and annual OPEX and NETEX compression (cost-reduction) rate. For simplicity, all other operating and financial parameters are held constant. The price and elasticity chart displays model sensitivity to the pace of price reduction and price elasticity; price and CAPEX illustrates effects of price reductions on capital spending. Price and OPEX and NETEX shows impacts of the price reduction rate and operational and network expense compression rates; price and total cost shows sensitivity to the price reduction rate and total cost compression rate. CAPEX and OPEX and NETEX, shown in Figure 18.4 gives the relationship between the capital expense compression rate and operational and network expense compression rates. For illustration purposes, input assumptions are an initial demand of 8.5 million units, an initial price of $200, annual price reductions of 25%, a discount rate of 25%, and a 2.25 price elasticity of demand.

Figure 18.4 here

Table 18.7 here

Finally, Table 18.7 shows the net present value implications of these model input assumptions for the discounted net present value of the enterprise. It is important to remember that these data are for illustration purposes only. They are not predictions of actual operating and financial results for Level 3 or any other company.

A. Describe the essential components of Level 3's Silicon Economics Model.

B. Explain how Level 3's Silicon Economics Model differs from more standard and simplified approaches to capital budgeting. For comparison purposes, you may want to consider valuation spreadsheets compiled and maintained by various independent analysts and investors on the Internet (http://members.fcc.net/codyklen/LVLT/Level_3_Model.htm*)*

C. How would you judge the effectiveness and usefulness of the Silicon Economics Model?

CASE STUDY SOLUTION

A. Level 3's Silicon Economics Model demonstrates in a simplified format the dynamic relationships that exist between pricing strategies, cost compression, demand growth, and capital budgeting in an optimized net present value discounted cash flow model. In other words, the model represents an effort to show the effects of important economic relationships on capital budgeting decisions and the value of the firm. The effects of market competition are not explicitly modeled, and only a single service offering is considered. The model places no limits on demand growth, such as would be imposed by

limitations on Level 3's internal operating systems or external supply chain requirements. Capital expenditure costs are modeled using an initial (one-time) infrastructure cost plus an incremental cost per unit. Cost-saving improvements in technology are modeled as a reduction in unit cost, or annual cost compression rate. Operational expenses are modeled using a fixed annual infrastructure cost, variable cost represented as a percentage of revenue, per-incremental-unit cost (activation related), and per-total-unit cost (support related). Cost reductions over time in these latter two categories can be modeled by specifying an annual productivity improvement factor. Network expenses are modeled as a cost per incremental unit. This unit cost is reduced at the same rate as the activation and support-related operational expenses.

Effects of varying assumptions on operating and financial performance can be seen by choosing different input parameters on the ΑData Entry@ worksheet. All default input values can be changed. The model will produce the net present value of consolidated cash flow for any choice of input parameters. Details concerning the calculation of expected revenue, capital expenses, operational expenses and cash flow that are graphed by the model can be reviewed and are displayed on the ΑDetails@ tab of the model. Five three-dimensional charts are automatically produced to illustrate the sensitivity of net present value to four primary input parameters, including the annual price reduction rate, price elasticity of demand, annual CAPEX compression (cost-reduction) rate, and annual OPEX and NETEX compression (cost-reduction) rate. For simplicity, all other operating and financial parameters are held constant. The price and elasticity chart displays model sensitivity to the pace of price reduction and price elasticity; price and CAPEX illustrates effects of price reductions on capital spending. Price and OPEX and NETEX shows impacts of the price reduction rate and operational and network expense compression rates; price and total cost shows sensitivity to the price reduction rate and total cost compression rate. CAPEX and OPEX and NETEX gives the relationship between the capital expense compression rate and operational and network expense compression rates.

B. Level 3's Silicon Economics Model differs from more standard and simplified approaches to capital budgeting in that it makes explicit the effects of changes in basic economic assumptions on the capital budgeting process and upon the economic value of the firm (discounted net present values). For comparison purposes, it might be worth considering a more prosaic discounted net present value model that has been compiled and maintained on the Internet at http://members.fcc.net/codyklen/LVLT/Level_3_Model.htm by a savvy Level 3 stockholder).

C. The effectiveness and usefulness of the Silicon Economics Model should be judged according to simple criteria. Does the model help management, employees, stockholders and the general public better understand the basic economics of the business? Does the

model help management make better and more effective operating and financial decisions, including a more wise use of capital budgeting resources? And finally, is the model predictive in the sense of forecasting business results when appropriate input assumptions are made. In short, the Silicon Economics Model, or any model for that matter, should be judged according to the most simple criteria of all: Does it work?