CHAPTER 10

Risk and Refinements In Capital Budgeting

INSTRUCTOR'S RESOURCES

Overview

Chapters 8 and 9 developed the major decision-making aspects of capital budgeting. Cash flows and budgeting models have been integrated and discussed in providing the principles of capital budgeting. However, there are more complex issues beyond those presented. Chapter 10 expands capital budgeting to consider risk with such methods as sensitivity analysis, scenario analysis, and simulation. Capital budgeting techniques used to evaluate international projects, as well as the special risks multinational companies face, are also presented. Additionally, two basic risk-adjustment techniques are examined: certainty equivalents and risk-adjusted discount rates.

PMF DISK

PMF Tutor

A topic covered for this is risk-adjusted discount rates (RADRs).

PMF Problem-Solver: Capital Budgeting Techniques

This module allows the student to compare the annualized net present value of projects with unequal lives.

PMF Templates

No spreadsheet templates are provided for this chapter.

Study Guide

There are no particular *Study Guide* examples suggested for classroom presentation.

ANSWERS TO REVIEW QUESTIONS

10-1 There is usually a significant degree of uncertainty associated with capital budgeting projects. There is the usual business risk along with the fact that future cash flows are an estimate and do not represent exact values. This uncertainty exists for both independent and mutually exclusive projects. The risk associated with any single project has the capability to change the entire risk of the firm. The firm's assets are like a portfolio of assets. If an accepted capital budgeting project has a risk different from the average risk of the assets in the firm, it will cause a shift in the overall risk of the firm.

10-2 *Risk,* in terms of cash inflows from a project, is the variability of expected cash flows, hence the expected returns, of the given project. The breakeven cash inflow—the level of cash inflow necessary in order for the project to be acceptable—may be compared with the probability of that inflow occurring. When comparing two projects with the same breakeven cash inflows, the project with the higher probability of occurrence is less risky.

10-3 **a.** *Sensitivity analysis* uses a number of possible inputs (cash inflows) to assess their impact on the firm's return (NPV). In capital budgeting, the NPVs are estimated for the pessimistic, most likely, and optimistic cash flow estimates. By subtracting the pessimistic outcome NPV from the optimistic outcome NPV, a range of NPVs can be determined.

b. *Scenario analysis* is used to evaluate the impact on return of simultaneous changes in a number of variables, such as cash inflows, cash outflows, and the cost of capital, resulting from differing assumptions relative to economic and competitive conditions. These return estimates can be used to roughly assess the risk involved with respect to the level of inflation.

c. *Simulation* is a statistically based approach using random numbers to simulate various cash flows associated with the project, calculating the NPV or IRR on the basis of these cash flows, and then developing a probability distribution of each project's rate of returns based on NPV or IRR criterion.

10-4 **a.** *Multinational companies (MNCs)* must consider the effect of *exchange rate risk*, the risk that the exchange rate between the dollar and the currency in which the project's cash flows are denominated will reduce the project's future cash flows. If the value of the dollar depreciates relative to that currency, the market value of the project's cash flows will decrease as a result. Firms can use hedging to protect themselves against this risk in the short term; for the long term, financing the project using local currency can minimize this risk.

b. *Political risk,* the risk that a foreign government's actions will adversely affect the project, makes international projects particularly risky, because it cannot be predicted in advance. To take this risk into account, managers should either adjust expected cash flows or use risk-adjusted discount rates when performing the capital budgeting analysis. Adjustment of cash flows is the preferred method.

c. Tax laws differ from country to country. Because only after-tax cash flows are relevant for capital budgeting decisions, managers must account for all taxes paid to foreign governments and consider the effect of any foreign tax payments on the firm's U.S. tax liability.

d. *Transfer pricing* refers to the prices charged by a corporation's subsidiaries for goods and services traded between them; the prices are not set by the open market. In terms of capital budgeting decisions, managers should be sure that transfer prices accurately reflect actual costs and incremental cash flows.

e. MNCs cannot evaluate international capital projects from only a financial perspective. The *strategic viewpoint* often is the determining factor in deciding whether or not to undertake a project. In fact, a project that is less acceptable on a purely financial basis than another may be chosen for strategic reasons. Some reasons for MNC foreign investment include continued market access, the ability to compete with local companies, political and/or social reasons (for example, gaining favorable tax treatment in exchange for creating new jobs in a country), and achievement of a particular corporate objective such as obtaining a reliable source of raw materials.

10-5 *Risk-adjusted discount rates* reflect the return that must be earned on a given project in order to adequately compensate the firm's owners. The relationship between RADRs and the CAPM is a purely theoretical concept. The expression used to value the expected rate of return of a security k_i ($k_i = R_F + [b \text{ x } (k_m - R_F)]$) is rewritten substituting an asset for a security. Because real corporate assets are not traded in efficient markets and estimation of a market return, k_m, for a portfolio of such assets would be difficult, the CAPM is not used for real assets.

10-6 A firm whose stock is actively traded in security markets generally does not increase in value through diversification. Investors themselves can more efficiently diversify their portfolio by holding a variety of stocks. Since a firm is not rewarded for diversification, the risk of a capital budgeting project should be considered independently rather than in terms of their impact on the total portfolio of assets. In practice, management usually follows this approach and evaluates projects based on their total risk.

10-7 Yet RADRs are most often used in practice for two reasons: 1) financial decision makers prefer using rate of return-based criteria, and 2) they are easy to estimate and apply. In practice, risk is subjectively categorized into classes, each having a RADR assigned to it. Each project is then subjectively placed in the appropriate risk class.

10-8 A comparison of NPVs of unequal-lived mutually exclusive projects is inappropriate because it may lead to an incorrect choice of projects. The annualized net present value converts the net present value of unequal-lived projects into an annual amount that can be used to select the best project. The expression used to calculate the ANPV follows:

$$ANPV = \frac{NPV_j}{PVIFA_{k\%, nj}}$$

10-9 *Real Options* are opportunities embedded in real assets that are part of the capital budgeting process. Managers have the option of implementing some of these opportunities to alter the cash flow and risk of a given project. Examples of real options include:

Abandonment – the option to abandon or terminate a project prior to the end of its planned life.

Flexibility - the ability to adopt a project that permits flexibility in the firm's production process, such as be able to reconfigure a machine to accept various types of inputs.

Growth - the option to develop follow-on projects, expand markets, expand or retool plants, and so on that would not be possible without implementation the project that is being evaluated.

Timing - the ability to determine the exact timing of when various action of the project will be undertaken.

10-10 *Strategic NPV* incorporates the value of the real options associated with the project while *traditional NPV* includes only the identifiable relevant cash flows. Using strategic NPV could alter the final accept/reject decision. It is likely to lead to more accept decisions since the value of the options is added to the traditional NPV as shown in the following equation.

$NPV_{strategic} = NPV_{traditional} =$ Value of real options

10-11 *Capital rationing* is a situation where a firm has only a limited amount of funds available for capital investments. In most cases, implementation of the acceptable projects would require more capital than is available. Capital rationing is common for a firm, since unfortunately most firms do not have sufficient capital available to invest in all acceptable projects. In theory, capital rationing should not exist because firms should accept all projects with positive NPVs or IRRs greater than the cost of capital. However, most firms operate with finite capital expenditure budgets and must select the best from all acceptable projects, taking into account the amount of new financing required to fund these projects.

10-12 The internal rate of return approach and the net present value approach to capital rationing both involve ranking projects on the basis of IRRs. Using the IRR approach, a cut-off rate and a budget constraint are imposed. The NPV first ranks projects by IRR and then takes into account the present value of the benefits from each project in order to determine the combination with the highest overall net present value. The benefit of the NPV approach is that it guarantees a maximum dollar return to the firm, whereas the IRR approach does not.

SOLUTIONS TO PROBLEMS

10-1 LG 1: Recognizing Risk

a. & b.

Project	Risk	Reason
A	Low	the cash flows from the project can be easily determined since this expenditure consists strictly of outflows. The amount is also relatively small.
B	Medium	the competitive nature of the industry makes it so that Caradine will need to make this expenditure to remain competitive. The risk is only moderate since the firm already has clients in place to use the new technology.
C	Medium	Since the firm is only preparing a proposal; their commitment at this time is low. However, the $450,000 is a large sum of money for the company and it will immediately become a sunk cost.
D	High	although this purchase is in the industry in which Caradine normally operates; they are encountering a large amount of risk. The large expenditure, the competitiveness of the industry, and the political and exchange risk of operating in a foreign country adds to the uncertainty.

NOTE: Other answers are possible depending on the assumptions a student may make. There is too little information given about the firm and industry to establish a definitive risk analysis.

10-2 LG 2: Breakeven Cash Flows

a. $\$35,000 = CF(PVIFA_{14\%,12})$
$\$35,000 = CF\ (5.66)$
$CF = \$6,183.75$
Calculator solution: $6,183.43

b. $\$35,000 = CF(PVIFA_{10\%,12})$
$\$35,000 = CF\ (6.814)$
$CF = \$5,136.48$
Calculator solution: $5,136.72

The required cash flow per year would decrease by $1,047.27.

10-3 LG 2: Breakeven Cash Inflows and Risk

a.

Project X

$PV_n = PMT \times (PVIFA_{15\%,5\ yrs.})$
$PV_n = \$10,000 \times (3.352)$
$PV_n = \$33,520$

$NPV = PV_n - \text{Initial investment}$
$NPV = \$33,520 - \$30,000$
$NPV = \$3,520$
Calculator solution: $3,521.55

Project Y

$PV_n = PMT \times (PVIFA_{15\%,5\ yrs.})$
$PV_n = \$15,000 \times (3.352)$
$PV_n = \$50,280$

$NPV = PV_n - \text{Initial investment}$
$NPV = \$50,280 - \$40,000$
$NPV = \$10,280$
Calculator solution: $10,282.33

b.

Project X	**Project Y**
\$CF x 3.352 = \$30,000	\$CF x 3.352 = \$40,000
\$CF = \$30,000 ÷ 3.352	\$CF = \$40,000 ÷ 3.352
\$CF = \$8,949.88	\$CF = \$11,933.17

c.

Project X	**Project Y**
Probability = 60%	Probability = 25%

d. Project Y is more risky and has a higher potential NPV. Project X has less risk and less return while Project Y has more risk and more return, thus the risk-return trade-off.

e. Choose Project X to minimize losses; to achieve higher NPV, choose Project Y.

10-4 LG 2: Basic Sensitivity Analysis

a. Range A = \$1,800 - \$200 = \$1,600 Range B = \$1,100 - \$900 = \$200

b.

	NPV			
Outcome	Project A		Project B	
	Table Value	Calculator Solution	Table Value	Calculator Solution
Pessimistic	- \$ 6,297	- \$ 6,297.29	- \$ 337	- \$ 337.79
Most likely	514	513.56	514	513.56
Optimistic	7,325	7,324.41	1,365	1,364.92
Range	\$13,622	\$13,621.70	\$1,702	\$1,702.71

c. Since the initial investment of projects A and B are equal, the range of cash flows and the range of NPVs are consistent.

d. Project selection would depend upon the risk disposition of the management. (A is more risky than B but also has the possibility of a greater return.)

10-5 LG 4: Sensitivity Analysis

a. Range P = \$1,000 - \$500 = \$500
Range Q = \$1,200 - \$400 = \$800

b.

	NPV			
Outcome	Project A		Project B	
	Table Value	Calculator Solution	Table Value	Calculator Solution
Pessimistic	\$73	\$ 72.28	-\$ 542	-\$ 542.17
Most likely	1,609	1,608.43	1,609	1,608.43
Optimistic	3,145	3,144.57	4,374	4,373.48

c. Range P = \$3,145 - \$73 = \$3,072 (Calculator solution: \$3,072.29)
Range Q = \$4,374 - (-\$542) = \$4,916 (Calculator solution: \$4,915.65)

Each computer has the same most likely result. Computer Q has both a greater potential loss and a greater potential return. Therefore, the decision will depend on the risk disposition of management.

10-6 LG 2: Simulation

a. Ogden Corporation could use a computer simulation to generate the respective profitability distributions through the generation of random numbers. By tying various cash flow assumptions together into a mathematical model and repeating the process numerous times, a probability distribution of project returns can be developed. The process of generating random numbers and using the probability distributions for cash inflows and outflows allows values for each of the variables to be determined. The use of the computer also allows for more sophisticated simulation using components of cash inflows and outflows. Substitution of these values into the mathematical model yields the NPV. The key lies in formulating a mathematical model that truly reflects existing relationships.

b. The advantages to computer simulations include the decision maker's ability to view a continuum of risk-return trade-offs instead of a single-point estimate. The computer simulation, however, is not feasible for risk analysis.

10-7 LG 4: Risk–Adjusted Discount Rates-Basic

a. Project E:

PV_n = $6,000 x ($PVIFA_{15\%,4}$)
PV_n = $6,000 x 2.855
PV_n = $17,130

NPV = $17,130 - $15,000
NPV = $2,130
Calculator solution: $2,129.87

Project F:

Year	CF	$PVIF_{15\%,n}$	PV
1	$6,000	.870	$5,220
2	4,000	.756	3,024
3	5,000	.658	3,290
4	2,000	.572	1,144
			$12,678

NPV = $12,678 - $11,000
NPV = $1,678
Calculator solution: $1,673.05

Project G:

Year	CF	$PVIF_{15\%,n}$	PV

1	$ 4,000	.870	$3,480
2	6,000	.756	4,536
3	8,000	.658	5,264
4	12,000	.572	6,864
			$20,144

NPV = $20,144 - $19,000
NPV = $1,144
Calculator solution: $1,136.29

Project E, with the highest NPV, is preferred.

b. $RADR_E$ = .10 + (1.80 x (.15 - .10)) = .19
$RADR_F$ = .10 + (1.00 x (.15 - .10)) = .15
$RADR_G$ = -.10 + (0.60 x (.15 - .10)) = .13

c. **Project E**: $6,000 x (2.639) = $15,834
NPV = $15,834 - $15,000
NPV = $834
Calculator solution: $831.51

Project F: Same as in **a.**, $1,678 (Calculator solution: $1,673.05)

Project G:

Year	CF	$PVIF_{13\%,n}$	PV
1	$ 4,000	.885	$ 3,540
2	6,000	.783	4,698
3	8,000	.693	5,544
4	12,000	.613	7,356
			$ 21,138

NPV = $21,138 - $19,000
NPV = $2,138
Calculator solution: $2,142.93

Rank:	Project
1	G
2	F
3	E

d. After adjusting the discount rate, even though all projects are still acceptable, the ranking changes. Project G has the highest NPV and should be chosen.

10-8 LG 4: Risk-adjusted Discount rates-Tabular

a. NPV_A = ($7,000 x 3.993) - $20,000
NPV_A = $7,951 (Use 8% rate)
Calculator solution: $ 7,948.97

NPV_B = ($10,000 x 3.443) - $30,000
NPV_B = $4,330 (Use 14% rate)
Calculator solution: $ 4,330.81
Project A, with the higher NPV, should be chosen.

b. Project A is preferable to Project B, since the net present value of A is greater than the net present value of B.

10-9 LG 4: Risk-adjusted Rates of Return using CAPM

a. k_X = 7% + 1.2(12% - 7%) = 7% + 6% = 13%

k_Y = 7% + 1.4(12% - 7%) = 7% + 7% = 14%

NPV_X = $30,000($PVIFA_{13\%,4}$) - $70,000
NPV_X = $30,000(2.974) - $70,000
NPV_X = $89,220 - $70,000 = $19,220

NPV_Y = $22,000($PVIF_{14\%,1}$) + $32,000($PVIF_{14\%,2}$) + $38,000($PVIF_{14\%3}$) + $46,000($PVIF_{14\%,4}$) - $70,000
NPV_Y = $22,000(.877) + $32,000(.769) + $38,000(.675) + $46,000(.592) - $70,000
NPV_Y = $19,294 + $24,608 + $25,650 + $27,232 - 70,000 = $26,784

b. The RADR approach prefers Y over X. The RADR approach combines the risk adjustment and the time adjustment in a single value. The RADR approach is most often used in business.

10-10 LG 4: Risk Classes and RADR

a. **Project X:**

Year	CF	$PVIF_{22\%,n}$	PV
1	$80,000	.820	$65,600
2	70,000	.672	47,040
3	60,000	.551	33,060
4	60,000	.451	27,060
5	60,000	.370	22,200
			$194,960

NPV = $194,960 - $180,000
NPV = $14,960
Calculator solution: $14,930.45

Project Y:

Year	CF	$PVIF_{13\%,n}$	PV
1	$50,000	.885	$ 44,250
2	60,000	.783	46,980
3	70,000	.693	48,510
4	80,000	.613	49,040
5	90,000	.543	48,870
			$237,650

NPV = $237,650 - $235,000
NPV = $2,650
Calculator solution: $2,663.99

Project Z:

Year	CF	$PVIFA_{15\%,5}$	PV
1	$90,000		
2	$90,000		
3	$90,000	3.352	$ 301,680
4	$90,000		
5	$90,000		

NPV = $ 301,680 - $ 310,000
NPV = - $ 8,320
Calculator solution: -$8,306.04

b. Projects X and Y are acceptable with positive NPV's, while Project Z with a negative NPV is not. Project X with the highest NPV should be undertaken.

10-11 LG 5: Unequal Lives–ANPV Approach

a. **Machine A**

PV_n = PMT x ($PVIFA_{12\%,6\ yrs.}$)
PV_n = $12,000 x (4.111)
PV_n = $49,332

NPV = PV_n - Initial investment
NPV = $ 49,332 - $ 92,000
NPV = - $ 42,668
Calculator solution: - $ 42,663.11

Machine B

Year	CF	$PVIFA_{12\%,n}$	PV
1	$10,000	.893	$ 8,930
2	20,000	.797	15,940
3	30,000	.712	21,360
4	40,000	.636	25,440
			$ 71,670

NPV = $71,670 - $65,000
NPV = $6,670
Calculator solution: $6,646.58

Machine C

PV_n = PMT x ($PVIFA_{12\%,5\ yrs.}$)
PV_n = $ 30,000 x 3.605
PV_n = $ 108,150

NPV = PV_n - Initial investment
NPV = $ 108,150 - $ 100,500
NPV = $ 7,650
Calculator solution: $ 7,643.29

Rank	Project
1	C
2	B
3	A

(Note that A is not acceptable and could be rejected without any additional analysis.)

b. $\text{Annualized NPV } (ANPV_j) = \dfrac{NPV_j}{PVIFA_{k\%,\, nj}}$

Machine A:
ANPV = - $ 42,668 ÷ 4.111 (12%,6 years)
ANPV = - $ 10,378

Machine B:
ANPV = $ 6,670 ÷ 3.037 (12%,4 years)
ANPV = $ 2,196

Machine C
ANPV = $ 7,650 ÷ 3.605 (12%,5 years)
ANPV = $ 2,122

Rank	Project
1	B
2	C
3	A

c. Machine B should be acquired since it offers the highest ANPV. Not considering the difference in project lives resulted in a different ranking based in part on C's NPV calculations.

10-12 LG 5: Unequal Lives–ANPV Approach

a. Project X

Year	CF	$PVIF_{14\%,n}$	PV
1	$ 17,000	.877	$ 14,909
2	25,000	.769	19,225
3	33,000	.675	22,275
4	41,000	.592	24,272
			$ 80,681

NPV = $80,681 - $78,000
NPV = $2,681
Calculator solution: $2,698.32

Project Y

Year	CF	$PVIF_{14\%,n}$	PV
1	$ 28,000	.877	$ 24,556
2	38,000	.769	29,222
			$ 53,778

NPV = $53,778 - $52,000
NPV = $1,778
Calculator solution: $1,801.17

Project Z

PV_n = PMT x ($PVIFA_{14\%,8\ yrs.}$)
PV_n = $15,000 x 4.639
PV_n = $69,585

NPV = PV_n - Initial investment
NPV = $69,585 - $66,000
NPV = $3,585
Calculator solution: $3,582.96

Rank	Project
1	Z
2	X
3	Y

b. $$\text{Annualized NPV }(ANPV_j) = \frac{NPV_j}{PVIFA_{k\%,\,nj}}$$

Project X
ANPV = $2,681 ÷ 2.914 (14%,4 yrs.)
ANPV = $920.04

Project Y
ANPV = $1,778 ÷ 1.647 (14%,2 yrs.)
ANPV = $1,079.54

Project Z
ANPV = $3,585 ÷ 4.639 (14%, 8 yrs.)
ANPV = $772.80

Rank	Project
1	Y
2	X
3	Z

c. Project Y should be accepted. The results in **a** and **b** show the difference in NPV when differing lives are considered.

10-13 LG 5: Unequal Lives–ANPV Approach

a. Sell

Year	CF	$PVIF_{12\%,n}$	PV
1	$ 200,000	.893	$ 178,600
2	250,000	.797	199,250
			$ 377,850

NPV = $377,850 - $200,000
NPV = $177,850
Calculator solution: $177,786.90

License

Year	CF	$PVIF_{12\%,n}$	PV
1	$ 250,000	.893	$ 223,250
2	100,000	.797	79,700
3	80,000	.712	56,960
4	60,000	.636	38,160
5	40,000	.567	22,680
			$ 420,750

NPV = $420,750 - $200,000
NPV = $220,750
Calculator solution: $220,704.25

Manufacture

Year	CF	$PVIF_{12\%,n}$	PV
1	$ 200,000	.893	$ 178,600
2	250,000	.797	199,250
3	200,000	.712	142,400
4	200,000	.636	127,200
5	200,000	.567	113,400
6	200,000	.507	101,400
			$ 862,250

NPV = $862,250 - $450,000
NPV = $412,250
Calculator solution: $412,141.16

Rank	Alternative
1	Manufacture
2	License
3	Sell

b. $$\text{Annualized NPV }(ANPV_j) = \frac{NPV_j}{PVIFA_{k\%,\,nj}}$$

Sell
ANPV = $177,850 ÷ 1.690 (12%, 2yrs.)
ANPV = $105,236.69

License
ANPV = $220,750 ÷ 3.605 (12%,5yrs.)
ANPV = $61,234.40

Manufacture
ANPV = $412,250 ÷ 4.111 (12%,6 yrs.)

ANPV = $100,279.74

Rank	Alternative
1	Sell
2	Manufacture
3	License

c. Comparing projects of unequal lives gives an advantage to those projects that generate cash flows over the longer period. ANPV adjusts for the differences in the length of the projects and allows selection of the optimal project.

10-14 LG 6: Real Options and the Strategic NPV

a. Value of real options = value of abandonment + value of expansion + value of delay
Value of real options = (.25 x $1,200) + (.30 x $3,000) + (.10 x $10,000)
Value of real options = $300 + $900 + $1,000
Value of real options = $2,200

$NPV_{strategic} = NPV_{traditional}$ + Value of real options
$NPV_{strategic} = -1,700 + 2,200 = \$500$

b. Due to the added value from the options Rene should recommend acceptance of the capital expenditures for the equipment.

c. In general this problem illustrates that by recognizing the value of real options a project that would otherwise be unacceptable ($NPV_{traditional} < 0$) could be acceptable ($NPV_{strategic} > 0$). It is thus important that management identify and incorporate real options into the NPV process.

10-15 LG 6: Capital Rationing-IRR and NPV Approaches

a. Rank by IRR

Project	IRR	Initial investment	Total Investment
F	23%	$ 2,500,000	$ 2,500,000
E	22	800,000	3,300,000
G	20	1,200,000	4,500,000
C	19		
B	18		
A	17		
D	16		

Projects F, E, and G require a total investment of $4,500,000 and provide a total present value of $5,200,000, and therefore a net present value of $700,000.

b. Rank by NPV (NPV = PV - Initial investment)

Project	NPV	Initial investment
F	$500,000	$2,500,000
A	400,000	5,000,000
C	300,000	2,000,000
B	300,000	800,000
D	100,000	1,500,000
G	100,000	1,200,000
E	100,000	800,000

Project A can be eliminated because, while it has an acceptable NPV, its initial investment exceeds the capital budget. Projects F and C require a total initial investment of $4,500,000 and provide a total present value of $5,300,000 and a net present value of $800,000. However, the best option is to choose Projects B, F, and G, which also use the entire capital budget and provide an NPV of $900,000.

c. The internal rate of return approach uses the entire $4,500,000 capital budget but provides $200,000 less present value ($5,400,000 - $5,200,000) than the NPV approach. Since the NPV approach maximizes shareholder wealth, it is the superior method.

d. The firm should implement Projects B, F, and G, as explained in part **c**.

10-16 LG 6: Capital Rationing-NPV Approach

a.

Project	PV
A	$ 384,000
B	210,000
C	125,000
D	990,000
E	570,000
F	150,000
G	960,000

b. The optimal group of projects is Projects C, F, and G, resulting in a total net present value of $235,000.

Chapter 10 Case

Evaluating Cherone Equipment's Risky Plans for Increasing Its Production Capacity

a. **(1)**

Plan X

Year	CF	$PVIF_{12\%,n}$	PV
1	$ 470,000	.893	$ 419,710
2	610,000	.797	486,170
3	950,000	.712	676,400
4	970,000	.636	616,920
5	1,500,000	.567	850,500
			$3,049,700

NPV = $3,049,700 - $2,700,000
NPV = $349,700
Calculator solution: $349,700

Plan Y

Year	CF	$PVIF_{12\%,n}$	PV
1	$ 380,000	.893	$ 339,340
2	700,000	.797	557,900
3	800,000	.712	569,600
4	600,000	.636	381,600
5	1,200,000	.567	680,400
			$2,528,840

NPV = $2,528,840 - $2,100,000
NPV = $428,840
Calculator solution: $428,968.70

(2) Using a financial calculator the IRRs are:
IRR_X = 16.22%
IRR_Y = 18.82%

Both NPV and IRR favor selection of project Y. The NPV is larger by $79,140 ($428,840 - $349,700) and the IRR is 2.6% higher.

b.

Plan X

Year	CF	$PVIF_{13\%,n}$	PV
1	$ 470,000	.885	$ 415,950
2	610,000	.783	477,630
3	950,000	.693	658,350
4	970,000	.613	594,610
5	1,500,000	.543	814,500
			$2,961,040

NPV = $2,961,040 - $2,700,000
NPV = $261,040
Calculator solution: $261,040

Plan Y

Year	CF	$PVIF_{15\%,n}$	PV
1	$ 380,000	.870	$ 330,600
2	700,000	.756	529,200
3	800,000	.658	526,400
4	600,000	.572	343,200
5	1,200,000	.497	596,400
			$2,325,800

NPV = $2,325,800 - $2,100,000
NPV = $225,800
Calculator solution: $225,412.37

The RADR NPV favors selection of project X.

	Ranking		
Plan	NPV	IRR	RADRs
X	2	2	1
Y	1	1	2

c. Both NPV and IRR achieved the same relative rankings. However, making risk adjustments through the RADRs caused the ranking to reverse from the non-risk adjusted results. The final choice would be to select Plan X since it ranks first using the risk-adjusted method.

d. **Plan X**
Value of real options = .25 x $100,000 = $25,000

$NPV_{strategic}$ = $NPV_{traditional}$ + Value of real options
$NPV_{strategic}$ = $261,040 + $25,000 = $286,040

Plan Y
Value of real options = .20 x $500,000 = $100,000

$NPV_{strategic}$ = $NPV_{traditional}$ + Value of real options
$NPV_{strategic}$ = $225,412 + $100,000 = $328,412

e. The addition of the value added by the existence of real options the ordering of the projects is reversed. Project Y is now favored over project X using the RADR NPV for the traditional NPV.

f. Capital rationing could change the selection of the plan. Since Plan Y requires only $2,100,000 and Plan X requires $2,700,000, if the firm's capital budget was less than the amount needed to invest in project X, the firm would be forced to take Y to maximize shareholders' wealth subject to the budget constraint.

INTEGRATIVE CASE 3
LASTING IMPRESSIONS COMPANY

Integrative Case III involves a complete long-term investment decision. The Lasting Impressions Company is a commercial printer faced with a replacement decision in which two mutually exclusive projects have been proposed. The data for each press have been designed to result in conflicting rankings when considering the NPV and IRR decision techniques. The case tests the students' understanding of the techniques as well as the qualitative aspects of risk and return decision-making.

a. **(1)** Calculation of initial investment for Lasting Impressions Company:

	Press A		Press B	
Installed cost of new press =				
Cost of new press	$830,000		$640,000	
+ Installation costs	40,000		20,000	
Total cost-new press		$870,000		$660,000
- After-tax proceeds-sale of old asset =				
Proceeds from sale of old press	420,000		420,000	
+ Tax on sale of old press*	121,600		121,600	
Total proceeds-sale of old press		(298,400)		(298,400)
+ Change in net working capital"		90,400		0
Initial investment		$662,000		$361,600

*	Sale price	$420,000
	- Book value	116,000
	Gain	$304,000
	x Tax rate (40%)	121,600

Book value = $ 400,000 = [(.20 +.32 +.19) x $400,000] = $116,000

**Cash	$ 25,400
Accounts receivable	120,000
Inventory	(20,000)
Increase in current assets	$125,400
Increase in current liabilities	(35,000)
Increase in net working capital	$ 90,400

(2) Depreciation

Press A	Cost	Rate	Depreciation
1	$870,000	.20	$ 174,000
2	870,000	.32	278,400
3	870,000	.19	165,300
4	870,000	.12	104,400
5	870,000	.12	104,400
6	870,000	.05	43,500
			$ 870,000

Press B	Cost	Rate	Depreciation
1	$660,000	.20	$132,000
2	660,000	.32	211,200
3	660,000	.19	125,400
4	660,000	.12	79,200
5	660,000	.12	79,200
6	660,000	.05	33,000
			$ 660,000

Existing Press	Cost	Rate	Depreciation
1	$400,000	.12 (Yr. 4)	$ 48,000
2	400,000	.12 (Yr. 5)	48,000
3	400,000	.05 (Yr. 6)	20,000
4	0	0	0
5	0	0	0
6.,	0	0	0
			$116,000

Year	and Taxes	Depreciation	before Taxes	after Taxes	Cash Flow
1	$ 120,000	$ 48,000	$ 72,000	$ 43,200	$ 91,200
2	120,000	48,000	72,000	43,200	91,200
3	120,000	20,000	100,000	60,000	80,000
4	120,000	0	120,000	72,000	72,000
5	120,000	0	120,000	72,000	72,000
6	0	0	0	0	0

Press A Earnings Before

	Depreciation		Earnings	Earnings		Old	
			Incremental				
Year	and Taxes	Depreciation	Before Taxes	After Taxes	Cash Flow	Cash Flow	Cash
Flow							
1	$ 250,000	$ 174,000	$ 76,000	$ 45,600	$ 219,000	$ 91,200	$ 128,400
2	270,000	278,400	- 8,400	- 5,040	273,360	91,200	182,160
3	300,000	165,300	134,700	80,820	246,120	80,000	166,120
4	330,000	104,400	225,600	135,360	239,760	72,000	167,760
5	370,000	104,400	265,600	159,360	263,760	72,000	191,760
6	0	43,500	- 43,500	- 26,100	17,400	0	17,400

Press B Earnings Before

	Depreciation		Earnings	Earnings		Old	
	Incremental						
Year	and Taxes	Depreciation	Before Taxes	After Taxes	Cash Flow	Cash Flow	Cash
Flow							
1	$ 210,000	$ 132,000	$ 78,000	$ 46,800	$ 178,800	$ 91,200	$ 87,600
2	210,000	211,200	- 1,200	- 720	210,480	91,200	119,280
3	210,000	125,400	84,600	50,760	176,160	80,000	96,160
4	210,000	79,200	130,800	78,480	157,680	72,000	85,680
5	210,000	79,200	130,800	78,480	157,680	72,000	85,680
6	0	33,000	- 33,000	- 19,800	13,200	0	13,200

(3) Terminal cash flow:

	Press A		Press B	
After-tax proceeds-sale of new press =				
Proceeds on sale of new press	$ 400,000		$ 330,000	
Tax on sale of new press*	(142,600)		(118,800)	
Total proceeds-new press		$257,400		$211,200
- After-tax proceeds-sale of old press =				
Proceeds on sale of old press	(150,000)		(150,000)	
+ Tax on sale of old press**	60,000		60,000	
Total proceeds-old press		(90,000)		(90,000)
+ Change in net working capital		90,400		0
Terminal cash flow		$257,800		$121,200

* **Press A**

Sale price	$400,000
Less: Book value (Yr. 6)	43,500
Gain	$356,500
Tax rate	x.40
Tax	$142,600

Press B

Sale price	$330,000
Less: Book value (Yr. 6)	33,000
Gain	$297,000
Tax rate	x .40
Tax	$118,800

**

Sale price	$150,000
Less: Book value (Yr. 6)	0
Gain	$150,000
Tax rate	x.40
Tax	$ 60,000

	Press A	Press B
Initial Investment	$662,000	$361,600
Year	Cash Inflows	
1	$128,400	$ 87,600
2	182,160	119,280
3	166,120	96,160
4	167,760	85,680
5*	449,560	206,880

*

Year 5	Press A	Press B
Operating cash flow	$191,760	$ 85,680
Terminal cash inflow	257,800	121,200
Total	$449,560	$206,880

b.

Press A

Cash Flows

$128,400 $182,160 $166,120 $167,760 $449,560

0	1	2	3	4	5	6

End of Year

Press B

Cash Flows

	$87,600	$119,280	$96,160	$85,680	$206,880	
0	1	2	3	4	5	6

End of Year

c Relevant cash flow

Cumulative Cash Flows		
Year	Press A	Press B
1	$ 128,400	$ 87,600
2	310,560	206,880
3	476,680	303,040
4	644,440	388,720
5	1,094,000	595,600

(1) Press A: 4 years + [(662,000 - 644,440) ÷ 191,760]
Payback = 4 + (17,560 ÷ 191,760)
Payback = 4.09 years

Press B: 3 years + [(361,600 - 303,040) ÷ 85,680]
Payback = 3 + (58,560 ÷ 85,680)
Payback = 3.68 years

(2) Press A:

Year	Cash Flow	$PVIF_{14\%,t}$	PV
1	$ 128,400	.877	$ 112,607
2	182,160	.769	140,081
3	166,120	.675	112,131
4	167,760	.592	99,314
5	449,560	.519	233,322
			$ 697,455

Net present value = $697,455 - $662,000
Net present value = $35,455
Calculator solution: $35,738.83

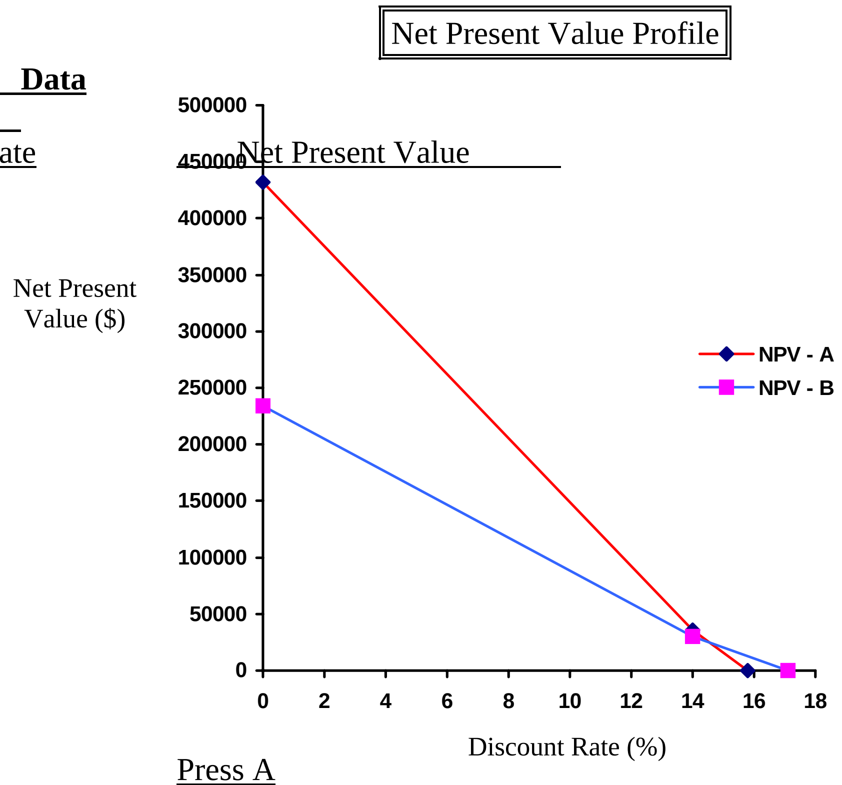
Press B:

Year	Cash Flow	$PVIF_{14\%,t}$	PV
1	$ 87,600	.877	$ 76,825
2	119,280	.769	91,726
3	96,160	.675	64,908
4	85,680	.592	50,723
5	206,880	.519	107,371
			$391,553

Net present value = $391,553 - $361,600
Net present value = $29,953
Calculator solution: $30,105.89

(3) Internal rate of return:
Press A:15.8%
Press B:17.1%

d.



Data for Net Present Value Profile

Net Present Value

Discount rate	Press A	
0%	$ 432,000	$ 234,000
14%	35,455	29,953
15.8%	0	-
17.1%	-	0

When the cost of capital is below approximately 15 percent, Press A is preferred over Press B, while at costs greater than 15 percent, Press B is preferred. Since the firm's cost of capital is 14 percent, conflicting rankings exist. Press A has a higher value and is therefore preferred over Press B using NPV, whereas Press B's IRR of 17.1 percent causes it to be preferred over Press A, whose IRR is 15.8 percent using this measure.

e. (1) If the firm has unlimited funds, Press A is preferred.
(2) If the firm is subject to capital rationing, Press B may be preferred.

f. The risk would need to be measured by a quantitative technique such as certainty equivalents or risk-adjusted discount rates. The resultant net present value could then be compared to Press B and a decision made.