Integrated Case

11-24

Allied Components Company

Basics of Capital Budgeting

You recently went to work for Allied Components Company, a supplier of auto repair parts used in the after-market with products from Daimler, Chrysler, Ford, and other automakers. Your boss, the chief financial officer (CFO), has just handed you the estimated cash flows for two proposed projects. Project L involves adding a new item to the firm's ignition system line; it would take some time to build up the market for this product, so the cash inflows would increase over time. Project S involves an add-on to an existing line, and its cash flows would decrease over time. Both projects have 3-year lives, because Allied is planning to introduce entirely new models after 3 years.

Here are the projects' net cash flows (in thousands of dollars):

	0	1	2	3
Project L	**-100**	**10**	**60**	**80**
Project S	**-100**	**70**	**50**	**20**

Depreciation, salvage values, net working capital requirements, and tax effects are all included in these cash flows.

The CFO also made subjective risk assessments of each project, and he concluded that both projects have risk characteristics that are similar to the firm's average project. Allied's WACC is 10%. You must determine whether one or both of the projects should be accepted.

A.	**What is capital budgeting? Are there any similarities between a firm's capital budgeting decisions and an individual's investment decisions?**

Answer: **[Show S11-1 through S11-3 here.] Capital budgeting is the process of analyzing <u>additions to fixed assets</u>. Capital budgeting is important**

because, more than anything else, fixed asset investment decisions chart a company's course for the future. Conceptually, the capital budgeting process is identical to the decision process used by individuals making investment decisions. These steps are involved:

1. **Estimate the cash flows—interest and maturity value or dividends in the case of bonds and stocks, operating cash flows in the case of capital projects.**
2. **Assess the riskiness of the cash flows.**
3. **Determine the appropriate discount rate, based on the riskiness of the cash flows and the general level of interest rates. This is called the project cost of capital in capital budgeting.**
4. **Find (a) the PV of the expected cash flows and/or (b) the asset's rate of return.**
5. **If the PV of the inflows is greater than the PV of the outflows (the NPV is positive), or if the calculated rate of return (the IRR) is higher than the project cost of capital, accept the project.**

B.	**What is the difference between independent and mutually exclusive projects? Between projects with normal and nonnormal cash flows?**

Answer: **[Show S11-4 and S11-5 here.] Projects are independent if the cash flows of one are not affected by the acceptance of the other. Conversely, two projects are mutually exclusive if acceptance of one impacts adversely the cash flows of the other; that is, at most one of two or more such projects may be accepted. Put another way, when projects are mutually exclusive it means that they do the same job. For example, a forklift truck versus a conveyor system to move materials, or a bridge versus a ferry boat.**

Projects with <u>normal</u> cash flows have outflows, or costs, in the first year (or years) followed by a series of inflows. Projects with <u>nonnormal</u> cash flows have one or more outflows after the inflow stream has begun. Here are some examples:

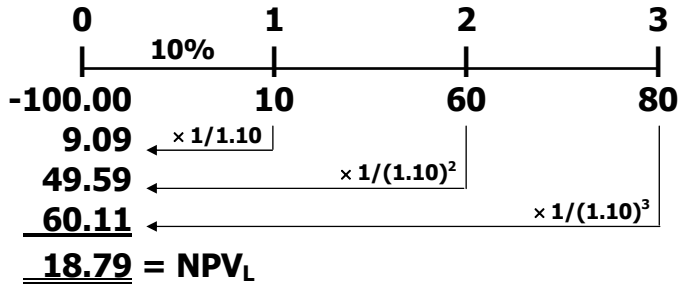
	Inflow (+) or Outflow (-) in Year					
	0	1	2	3	4	5
Normal	-	+	+	+	+	+
	-	-	+	+	+	+
	-	-	-	+	+	+
Nonnormal	-	+	+	+	+	-
	-	+	+	-	+	-
	+	+	+	-	-	-

C. (1) Define the term <u>net present value (NPV)</u>. What is each project's NPV?

Answer: [Show S11-6 through S11-8 here.] The <u>net present value (NPV)</u> is simply the sum of the present values of a project's cash flows:

$$NPV = \sum_{t=0}^{N} \frac{CF_t}{(1 + WACC)^t}.$$

Project L's NPV is $18.79:



NPVs are easy to determine using a <u>calculator</u> with an NPV function. Enter the cash flows sequentially, with outflows entered as negatives; enter the WACC; and then press the NPV button to obtain the project's NPV, $18.78 (note the penny rounding difference). The NPV of Project S is NPV_S = $19.98.

C. (2) What is the rationale behind the NPV method? According to NPV, which project(s) should be accepted if they are independent? Mutually exclusive?

Answer: [Show S11-9 here.] The rationale behind the NPV method is straightforward: If a project has NPV = $0, then the project generates exactly enough cash flows (1) to recover the cost of the investment and (2) to enable investors to earn their required rates of return (the opportunity cost of capital). If NPV = $0, then in a financial (but not an accounting) sense, the project breaks even. If the NPV is positive, then more than enough cash flow is generated, and conversely if NPV is negative.

Consider Project L's cash inflows, which total $150. They are sufficient (1) to return the $100 initial investment, (2) to provide investors with their 10% aggregate opportunity cost of capital, and (3) to still have $18.78 left over on a present value basis. This $18.78 excess PV belongs to the shareholders—the debtholders' claims are fixed—so the shareholders' wealth will be increased by $18.78 if Project L is accepted. Similarly, Allied's shareholders gain $19.98 in value if Project S is accepted.

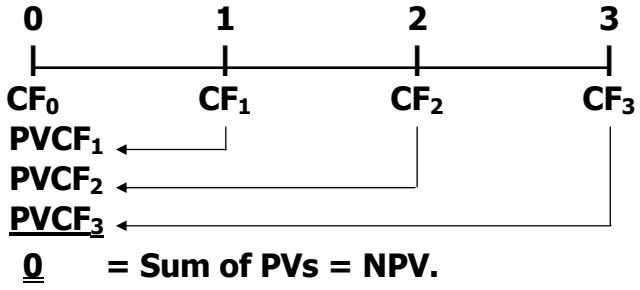
If Projects L and S are <u>independent</u>, then both should be accepted, because both add to shareholders' wealth, hence to the stock price. If the projects are <u>mutually exclusive</u>, then Project S should be chosen over L, because S adds more to the value of the firm.

C. (3) Would the NPVs change if the WACC changed? Explain.

Answer: The NPV of a project is <u>dependent</u> on the WACC used. Thus, if the WACC changed, the NPV of each project would change. NPV declines as WACC increases, and NPV rises as WACC falls.

D. (1) Define the term internal rate of return (IRR). What is each project's IRR?

Answer: **[Show S11-10 here.] The internal rate of return (IRR) is that discount rate which forces the NPV of a project to equal zero:**

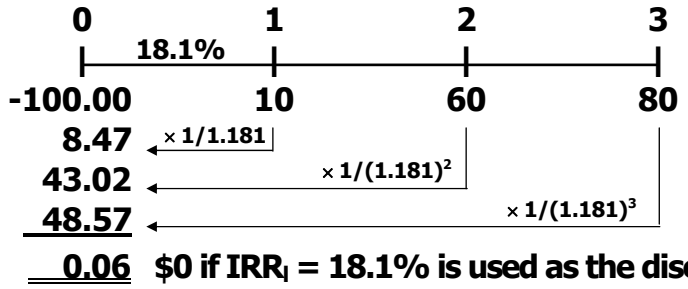


Expressed as an equation, we have:

$$\text{IRR: } \sum_{t=0}^{N} \frac{CF_t}{(1+\text{IRR})^t} = \$0 = \text{NPV.}$$

Note that the IRR equation is the same as the NPV equation, except that to find the IRR the equation is solved for the particular discount rate, IRR, which forces the project's NPV to equal zero (the IRR) rather than using the WACC in the denominator and finding NPV. Thus, the two approaches differ in only one respect: In the NPV method, a discount rate is specified (the project's WACC) and the equation is solved for NPV, while in the IRR method, the NPV is specified to equal zero and the discount rate (IRR) that forces this equality is found.

Project L's IRR is 18.1%:



Therefore, $IRR_L \approx 18.1\%$.

A financial calculator is extremely helpful when calculating IRRs. The cash flows are entered sequentially, and then the IRR button is pressed. For Project S, IRRS ≈ 23.6%. Note that with many calculators, you can enter the cash flows into the cash flow register, also enter WACC = I/YR, and then calculate both NPV and IRR by pressing the appropriate buttons.

D. (2) How is the IRR on a project related to the YTM on a bond?

Answer: [Show S11-11 here.] The IRR is to a capital project what the YTM is to a bond—it is the expected rate of return on the project, just as the YTM is the promised rate of return on a bond.

D. (3) What is the logic behind the IRR method? According to IRR, which projects should be accepted if they are independent? Mutually exclusive?

Answer: [Show S11-12 here.] IRR measures a project's profitability in the rate of return sense: If a project's IRR equals its cost of capital, then its cash flows are just sufficient to provide investors with their required rates of return. An IRR greater than WACC implies an economic profit, which accrues to the firm's shareholders, while an IRR less than WACC indicates an economic loss, or a project that will not earn enough to cover its cost of capital.

Projects' IRRs are compared to their costs of capital, or hurdle rates. Since Projects L and S both have a hurdle rate of 10%, and since both have IRRs greater than that hurdle rate, both should be accepted if they are independent. However, if they are mutually exclusive, Project S would be selected, because it has the higher IRR.

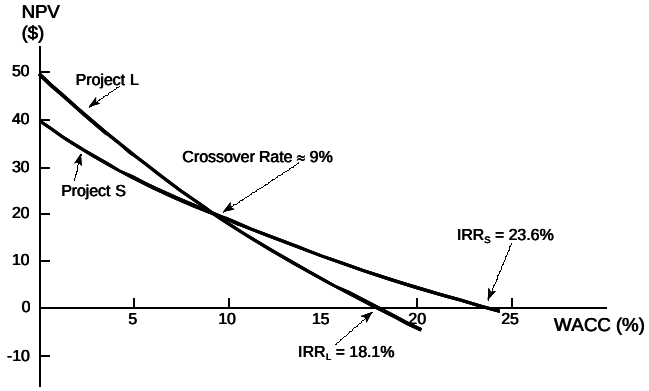
D. (4) Would the projects' IRRs change if the WACC changed?

Answer: **IRRs are <u>independent</u> of the WACC. Therefore, neither IRR_S nor IRR_L would change if WACC changed. However, the <u>acceptability</u> of the projects could change—L would be rejected if WACC were greater than 18.1%, and S would be rejected if WACC were greater than 23.6%.**

E. (1) Draw NPV profiles for Projects L and S. At what discount rate do the profiles cross?

Answer: **[Show S11-13 and S11-14 here.] The <u>NPV profiles</u> are plotted in the figure below. Note the following points:**

1. **The <u>Y-intercept is the project's NPV when WACC = 0%</u>. This is $50 for L and $40 for S.**
2. **The <u>X-intercept is the project's IRR</u>. This is 18.1% for L and 23.6% for S.**
3. **<u>NPV profiles are curves rather than straight lines</u>. To see this, note that these profiles approach cost = -$100 as WACC approaches infinity.**
4. **From the figure below, it appears that the <u>crossover rate</u> is between 8% and 9%.**



WACC	NPV_L	NPV_S
0%	$50	$40
5	33	29
10	19	20
15	7	12
20	(4)	5

E. (2) Look at your NPV profile graph without referring to the actual NPVs and IRRs. Which project(s) should be accepted if they are independent? Mutually exclusive? Explain. Are your answers correct at any WACC less than 23.6%?

Answer: [Show S11-15 here.] The NPV profiles show that the IRR and NPV criteria lead to the same accept/reject decision for any independent project. Consider Project L. It intersects the X-axis at its IRR, 18.1%. According to the IRR rule, L is acceptable if WACC is less than 18.1%. Also, at any WACC less than 18.1%, L's NPV profile will be above the X-axis, so its NPV will be greater than $0. Thus, for any independent project, NPV and IRR lead to the same accept/reject decision.

Now assume that L and S are mutually exclusive. In this case, a conflict might arise. First, note that $IRR_S = 23.6\% > 18.1\% = IRR_L$. Therefore, regardless of the size of WACC, Project S would be ranked higher by the IRR criterion. However, the NPV profiles show that $NPV_L > NPV_S$ if WACC is less than the crossover rate. Therefore, for any WACC less than the crossover rate, say WACC = 7%, the NPV rule says choose L, but the IRR rule says choose S. Thus, if WACC is less than the crossover rate, a ranking conflict occurs.

F. (1) What is the underlying cause of ranking conflicts between NPV and IRR?

Answer: [Show S11-16 here.] For normal projects' NPV profiles to cross, one project must have both a higher vertical axis intercept and a

steeper slope than the other. A project's vertical axis intercept typically depends on (1) the size of the project and (2) the size and timing pattern of the cash flows—large projects, and ones with large distant cash flows, would generally be expected to have relatively high vertical axis intercepts. The slope of the NPV profile depends entirely on the timing pattern of the cash flows—long-term projects have steeper NPV profiles than short-term ones. Thus, we conclude that NPV profiles can cross in two situations: (1) when mutually exclusive projects differ in scale (or size) and (2) when the projects' cash flows differ in terms of the timing pattern of their cash flows (as for Projects L and S).

F. (2) What is the reinvestment rate assumption, and how does it affect the NPV versus IRR conflict?

Answer: [Show S11-17 here.] The underlying cause of ranking conflicts is the reinvestment rate assumption. All DCF methods implicitly assume that cash flows can be reinvested at some rate, regardless of what is actually done with the cash flows. Discounting is the reverse of compounding. Since compounding assumes reinvestment, so does discounting. NPV and IRR are both found by discounting, so they both implicitly assume some discount rate. Inherent in the NPV calculation is the assumption that cash flows can be reinvested at the project's cost of capital, while the IRR calculation assumes reinvestment at the IRR rate.

F. (3) Which method is the best? Why?

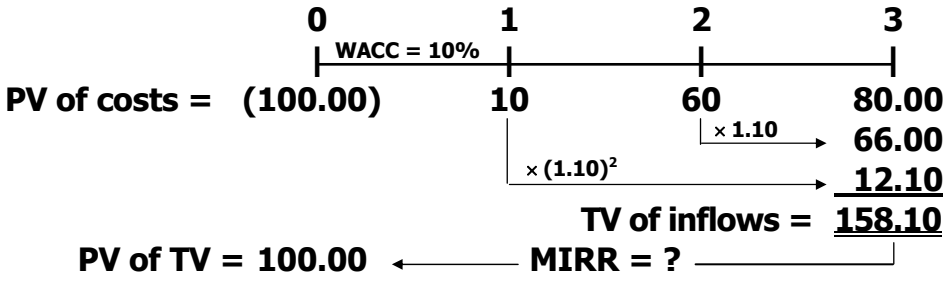
Answer: Whether NPV or IRR gives better rankings depends on which has the better reinvestment rate assumption. Normally, the NPV's assumption is better. The reason is as follows: A project's cash

inflows are generally used as substitutes for outside capital, that is, projects' cash flows replace outside capital and, hence, save the firm the cost of outside capital. Therefore, in an opportunity cost sense, a project's cash flows are reinvested at the cost of capital.

Note, however, that NPV and IRR always give the same accept/reject decisions for independent projects, so IRR can be used just as well as NPV when <u>independent</u> projects are being evaluated. The NPV versus IRR conflict arises only if <u>mutually exclusive</u> projects are involved.

G. (1) Define the term <u>modified IRR (MIRR)</u>. Find the MIRRs for Projects L and S.

Answer: [Show S11-18 and S11-19 here.] MIRR is that discount rate which equates the <u>present value of the terminal value of the inflows, compounded at the cost of capital, to the present value of the costs</u>. Here is the setup for calculating Project L's modified IRR:



$$\$100 = \frac{\$158.10}{(1+\text{MIRR})^3}$$

$$\text{PV costs} = \frac{TV}{(1+\text{MIRR})^N} = \sum_{t=0}^{N} \frac{COF_t}{(1+\text{WACC})^t} = \frac{\sum_{t=1}^{N} CIF_t(1+r)^{N-t}}{(1+\text{MIRR})^N}.$$

After you calculate the TV, enter N = 3, PV = -100, PMT = 0, FV = 158.1, and then press I/YR to get the answer, $MIRR_L$ = 16.5%. We could calculate $MIRR_S$ similarly: $MIRR_S$ = 16.9%. Thus, Project S is

ranked higher than L. This result is consistent with the NPV decision.

G. (2) What are the MIRR's advantages and disadvantages vis-à-vis the NPV?

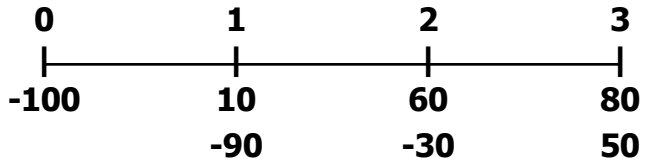
Answer: [Show S11-20 here.] MIRR does not always lead to the same decision as NPV when mutually exclusive projects are being considered. In particular, small projects often have a higher MIRR, but a lower NPV, than larger projects. Thus, MIRR is not a perfect substitute for NPV, and NPV remains the single best decision rule. However, MIRR is superior to the regular IRR, and if a rate of return measure is needed, MIRR should be used.

Business executives agree. Business executives prefer to compare projects' rates of return to comparing their NPVs. This is an empirical fact. As a result, financial managers are substituting MIRR for IRR in their discussions with other corporate executives. This fact was brought out in the October 1989 FMA meetings, where executives from Du Pont, Hershey, and Ameritech, among others, all reported a switch from IRR to MIRR.

H. (1) What is the payback period? Find the paybacks for Projects L and S.

Answer: [Show S11-21 through S11-23 here.] The payback period is the expected number of years required to recover a project's cost. We calculate the payback by developing the cumulative cash flows as shown below for Project L (in thousands of dollars):

	Expected NCF		
Year	Annual	Cumulative	
0	($100)	($100)	
1	10	(90)	
2	60	(30)	Payback is between
3	80	50 ←	t = 2 and t = 3



Project L's $100 investment has not been recovered at the end of Year 2, but it has been more than recovered by the end of Year 3. Thus, the recovery period is between 2 and 3 years. If we assume that the cash flows occur evenly over the year, then the investment is recovered $30/$80 = 0.375 ≈ 0.4 into Year 3. Therefore, $Payback_L$ = 2.4 years. Similarly, $Payback_S$ = 1.6 years.

H. (2) What is the rationale for the payback method? According to the payback criterion, which project(s) should be accepted if the firm's maximum acceptable payback is 2 years, if Projects L and S are independent, if Projects L and S are mutually exclusive?

Answer: Payback represents a type of "breakeven" analysis: The payback period tells us when the project will break even in a cash flow sense. With a required payback of 2 years, Project S is acceptable, but Project L is not. Whether the two projects are independent or mutually exclusive makes no difference in this case.

H. (3) What is the difference between the regular and discounted payback methods?

Answer: [Show S11-24 here.] Discounted payback is similar to payback except that discounted rather than raw cash flows are used.

Optional Question

What is Project L's discounted payback, assuming a 10% cost of capital?

Answer:

	Expected Net Cash Flows		
Year	Raw	Discounted	Cumulative

0	($100)	($100.00)	$100.00)
1	10	9.09	(90.91)
2	60	49.59	(41.32)
3	80	60.11	18.79

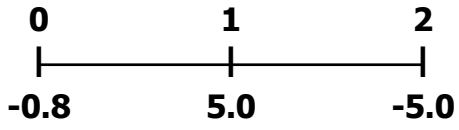
Discounted payback$_L$ = 2 + ($41.32/$60.11) = 2.69 = 2.7 years.
Versus 2.4 years for the regular payback.

H. (4) What are the two main disadvantages of discounted payback? Is the payback method of any real usefulness in capital budgeting decisions? Explain.

Answer: **Regular payback has three critical deficiencies: (1) <u>It ignores the time value of money.</u> (2) <u>It ignores the cash flows that occur after the payback period.</u> (3) <u>Unlike the NPV, which tells us by how much the project should increase shareholder wealth, and the IRR, which tells us how much a project yields over the cost of capital, the payback merely tells us when we get our investment back.</u> Discounted payback does consider the time value of money, but it still fails to consider cash flows after the payback period and it gives us no specific decision rule for acceptance; hence, it has 2 basic flaws. In spite of its deficiency, many firms today still calculate the discounted payback and give some weight to it when making capital budgeting decisions. However, payback is not generally used as the primary decision tool. Rather, it is <u>used as a rough measure of a project's liquidity</u> and <u>riskiness</u>.**

I. As a separate project (Project P), the firm is considering sponsoring a pavilion at the upcoming World's Fair. The pavilion would cost $800,000, and it is expected to result in $5 million of incremental cash inflows during its 1 year of operation. However, it would then take another year, and $5 million of costs, to demolish the site and

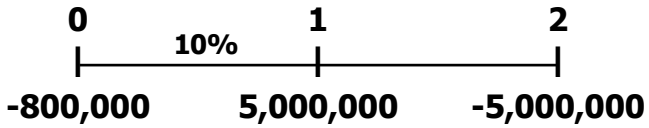
return it to its original condition. Thus, Project P's expected net cash flows look like this (in millions of dollars):



The project is estimated to be of average risk, so its WACC is 10%.

I. (1) What is Project P's NPV? What is its IRR? Its MIRR?

Answer: [Show S11-25 here.] Here is the time line for the cash flows, and the NPV:



NPV_P = -$386,776.86.

We can find the NPV by entering the cash flows into the cash flow register, entering I/YR = 10, and then pressing the NPV button. However, calculating the IRR presents a problem. With the cash flows in the register, press the IRR button. An HP-10BII financial calculator will give the message "error-soln." This means that Project P has multiple IRRs. An HP-17BII will ask for a guess. If you guess 10%, the calculator will show IRR = 25%. If you guess a high number, such as 200%, it will show the second IRR, 400%.[1] The MIRR of Project P = 5.6%, and is found by calculating the discount rate that equates the terminal value ($5.5 million) to the present value of costs ($4.93 million).

I. (2) Draw Project P's NPV profile. Does Project P have normal or nonnormal cash flows? Should this project be accepted? Explain.

[1] **Looking at the figure below, if you guess an IRR to the left of the peak NPV rate, the lower IRR will appear. If you guess IRR > peak NPV rate, the higher IRR will appear.**

Answer: **[Show S11-26 through S11-28 here.] You could put the cash flows in your calculator and then enter a series of I/YR values, get an NPV for each, and then plot the points to construct the NPV profile. We used a spreadsheet model to automate the process and then to draw the profile. Note that the profile crosses the X-axis twice, at 25% and at 400%, signifying two IRRs. Which IRR is correct? In one sense, they both are—both cause the project's NPV to equal zero. However, in another sense, both are wrong—neither has any economic or financial significance.**

Project P has nonnormal cash flows; that is, it has more than one change of signs in the cash flows. Without this nonnormal cash flow pattern, we would not have the multiple IRRs.

Since Project P's NPV is negative, the project should be rejected, even though both IRRs (25% and 400%) are greater than the project's 10% WACC. The MIRR of 5.6% also supports the decision that the project should be rejected.