UNIVERSITY OF RICHMOND
Robins School of Business™

§8. NPV, IRR, AND CAPITAL INVESTMENT DECISIONS

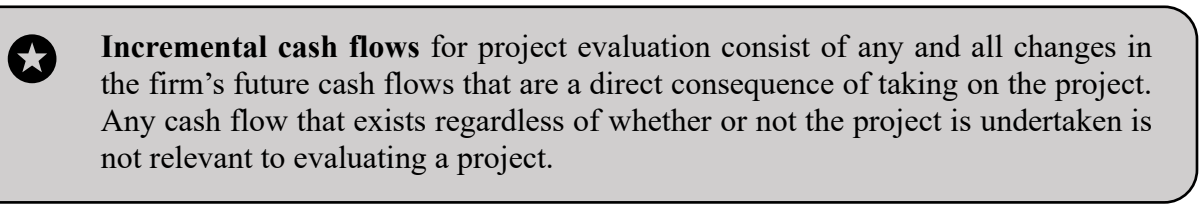
FIN 360: PRINCIPLES OF FINANCIAL MANAGEMENT

TABLE OF CONTENTS

Relevant Cash Flows

Recall that the **capital budgeting** decision is the process of analyzing, planning, justifying, and deciding on large capital expenditures, or making **capital investment** decisions. Such decisions include investing in long term projects, building factories, acquiring other businesses, and purchasing other fixed assets.

To evaluate a capital budgeting decision, managers must consider the **relevant cash flows** for the project, or all a firm's future cash flows that come about as a *direct consequence* of the project. Such relevant cash flows are referred to as the **incremental cash flows** of the project.



Incremental cash flows for project evaluation consist of any and all changes in the firm's future cash flows that are a direct consequence of taking on the project. Any cash flow that exists regardless of whether or not the project is undertaken is not relevant to evaluating a project.

The **stand-alone principle** is the assumption that evaluation of the project is based on these incremental cash flows alone, treating the project as a "mini firm" with its own income and expenses. We will determine whether purchasing this "mini firm" pays off.

Identifying Relevant Cash Flows

Given an understanding that incremental cash flows are relevant in project evaluation, we consider a number of costs and circumstances that warrant further examination as to whether they qualify as a relevant cash flow.

Table 1: Identifying Relevant Incremental Cash Flows

Category	Definition	Relevant Cash Flow?
Opportunity Costs	The most valuable alternative given up if a particular project is chosen.	Yes
Net Working Capital	Changes in current assets and current liabilities (i.e., purchasing inventories on account) due to a project.	Yes
Side Effects	**Erosion**, whereby the cash flows of a new project come at the expense of existing projects. **Synergies**, whereby the cash flows of a new project increase cash flows of existing projects.	Yes
Taxes	Taxes paid on the cash flows generated by the project.	Yes
Financing Costs	Debt incurred to pursue the project. Mixture of debt and equity financing.	No
Sunk Costs	A cost already incurred that cannot be "undone."	No

EXAMPLE: Casino and hotel operator MGM Resorts International is considering hiring a Big 3 consultant (Bain, McKinsey, or Boston Consulting Group) to make a recommendation on whether they should build a new casino on the Las Vegas strip. MGM owns a parking structure that they acquired a decade ago for $20 million, which now has a market value of $30 million. They would build the new casino on this location. If they build the new casino, it may pull patrons away from the casinos it currently owns, including the Grand, Luxor, and Excalibur. The firm will issue bonds (that is, borrow) to pay for the casino's cost, thus incurring new interest payments. Lastly, they will simultaneously increase the amount of cash they have on hand and realize increases in A/R associated with the project. They will incur a 21% tax on the casino's earnings.

Identify the cash flows associated with this project, and whether they should be considered as a part of the capital budgeting decision.

SOLUTION: You can identify the relevant cash flows by considering the difference between the firm's cash flows with and without the project.

Category	Definition	Relevant?
Opportunity Costs		
Net Working Capital		
Side Effects		
Taxes		
Financing Costs		
Sunk Costs		

PROJECTING CASH FLOWS: PRO FORMA FINANCIAL STATEMENTS

Recall **pro forma** financial statements are financial statements that forecast future years' operations. They help us calculate and visualize a project's incremental cash flows.

EXAMPLE: Whole Foods Markets, a subsidiary of Amazon, wants to develop an exclusive in-house energy drink with 100% all-natural ingredients for sale at select stores. It expects that it can sell 50,000 cans per year at a price of $4 each. The drinks each cost $2.50 to produce. Given health fads tend to come and go quickly, this product has a three-year useful life. To produce this drink, they will need to purchase $90,000 in manufacturing equipment, which will straight-line depreciate to zero after three years. They will acquire the financing for this project by borrowing through a 30-year bond issuance with a 5% coupon. Fixed costs of the project, such as rent and insuring a facility, are $17,430 per year. Whole Foods will need to invest $20,000 in net working capital, and the corporate tax rate is 21%.

SOLUTION: First, let's build a simple pro forma income statement for the project:

	Year 0	Year 1	Year 2	Year 3
Sales (50,000 cans @ $4)		$200,000	$200,000	$200,000
Variable Costs ($2.50/can)		125,000	125,000	125,000
Fixed Costs		17,430	17,430	17,430
Depreciation ($90k/3)		30,000	30,000	30,000
EBIT		$27,570	$27,570	$27,570
Taxes (21%)		5,790	5,790	5,790
Net Income		$21,780	$21,780	$21,780

⚠ Notice there is *no deduction for interest expense* in the above pro forma statements. It is not considered an incremental and relevant cash flow.

Recalling our formula for operating cash flows from the earlier sections, we determine this project p's operating cash flow as:

$$Cash\ Flow_p = OCF_p - \Delta NWC_p - Net\ Capital\ Spending_p$$

where

$$OCF_p = EBIT_p + Dep_p - Taxes_p$$

From our values above, the operating cash flows OCF_p in years 1 through 3 are:

$$OCF_p = EBIT_p + Dep_p - Taxes_p = \$27{,}570 + \$30{,}000 - \$5{,}790 = \$51{,}780$$

And we obtain the annual cash flows for the project in each year by filling out the table below:

	Year 0	Year 1	Year 2	Year 3
OCF		\$51,780	\$51,780	\$51,780
ΔNWC	–\$20,000			+\$20,000
Capital Spending	–\$90,000			
Total Project Cash Flow	–\$110,000	\$51,780	\$51,780	\$71,780

Net Working Capital Recovery occurs at the end of the project, after the cash flows wind down. For example, at the beginning of the project, the firm "invests" in its NWC (↑NWC: a cash *outflow*) by increasing inventories and accounts receivable (to cover its project's sales on credit). Payables may increase as well, but the firm will need to supply the balance.

As a project winds down, its inventories are sold, receivables are collected, and payables and bills associated with the project are paid, freeing up the original investment in working capital.

INTERPRETATION: Therefore, we observe that this project has a cost (including investment in NWC) of \$110,000 and is expected to produce cash flows of \$51,780, \$51,780, and \$71,780 over the next three years.

Given the forecasted cash flows, how might the company determine whether they should pursue this project?

DEPRECIATION TAX SHIELD

The **depreciation tax shield** is the tax saving resulting from the depreciation deduction prior to paying income tax, because depreciation expense (although it is *non-cash*) reduces the amount the firm needs to pay taxes on.

From the previous example:

$$Depreciation\ Tax\ Shield = Depreciation\ Expense \times Tax\ Rate$$

$$Depreciation\ Tax\ Shield = 30{,}000 \times 0.21 = \$6{,}300$$

Consider the first year of that example with and without the tax shield:

	Year 1: **with** tax shield	Year 1: **without** tax shield
Sales (50,000 cans at $4)	$200,000	$200,000
Variable Costs ($2.50/can)	125,000	125,000
Fixed Cost	17,430	17,430
Depreciation ($90k/3)	30,000	
EBIT	$27,570	$57,570
Taxes (21%)	5,790	12,090
Net Income	$21,780	$45,480

$$OCF_{with\ tax\ shield} = EBIT + Dep - Taxes = 27{,}570 + 30{,}000 - 5{,}790 = 51{,}780$$

$$OCF_{without\ tax\ shield} = EBIT + Dep - Taxes = 57{,}570 + 0 - 12{,}090 = 45{,}480$$

The difference between the OCF with and without the tax shield is **$51,780 – $45,480 = $6,300**.

A classic finance interview question is "how would a $10 increase in depreciation expense flow through the financial statements?" How would this change affect the income statement, statement of cash flow, and balance sheet? For simplicity, assume a tax rate of 20%.

SALVAGE VALUE

Salvage value is the amount that can be recovered at the end of the project if the equipment purchased for the project is sold. Assume in our example that the equipment used to produce the drinks could be sold for $10,000 (after taxes have been collected on the gain) at the conclusion of the project in 3 years. The project's cash flows become:

	Year 0	Year 1	Year 2	Year 3
OCF		$51,780	$51,780	$51,780
ΔNWC	–$20,000			+$20,000
Capital Spending	–$90,000			
Aftertax Salvage Value				+$10,000
Total Project Cash Flow	–$110,000	$51,780	$51,780	$81,780

Evaluating Investments

We've now identified the incremental and relevant cash flows associated with a firm's projects. Next, we consider how we might evaluate these cash flows. Are a project's cash flows worth its costs? We will consider 5 techniques:

1. Net Present Value (NPV)
2. Internal Rate of Return (IRR)
3. Payback Period
4. Discounted Payback Period
5. Profitability Index

Net Present Value (NPV)

The **Net Present Value (NPV)** is the difference between an investment's market value and its cost. It is a measure of how much value is created or destroyed, taking into account the cash outflows and inflows.

Capital budgeting projects and investments with a *positive NPV should be accepted* and undertaken by the firm. Capital budgeting projects and investments with a *negative NPV should be rejected* by the firm.

To compute a project's NPV, we subtract the intial cost of a project from the present value of the incremental and relevant cash flows.

Example: Given the timeline below, determine the NPV of the project. Should the firm undertake such a project? Assume these cash flows are discounted at 15% given the riskiness of the project.

Time	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*
Initial Cost	–$30								
Incremental CF		$6	$6	$6	$6	$6	$6	$6	$6
Salvage Value									$2
Net Cash Flow	–$30	$6	$6	$6	$6	$6	$6	$6	$8

SOLUTION:

$$NPV = PV\ of\ Incremental\ CF - Initial\ Cost$$

$$NPV = \left(\frac{6}{(1.15)^1} + \frac{6}{(1.15)^2} + \frac{6}{(1.15)^3} + \frac{6}{(1.15)^4} + \frac{6}{(1.15)^5} + \frac{6}{(1.15)^6} + \frac{6}{(1.15)^7} + \frac{8}{(1.15)^8}\right) - 30$$

$$NPV = -\$2.422$$

In the calculator:

Keystrokes	**Explanation**
CF	The "cash flow" key, ***CFo=*** appears on the screen
2ND CLR WORK	"Clear worksheet" (above **CE|C** key)
CFo = – 30 Enter ⇩	Cash flow at time 0: –$30, the initial cost
C01 = 6 Enter ⇩	Cash flow at time 1: $6, a cash inflow
F01 = 7 Enter ⇩	Frequency of the $6 cash flow is 7 times
C02 = 8 Enter ⇩	Remaining cash flow is 8, which includes salvage value
F02 = 1 Enter ⇩	Frequency of the $8 cash flow is once
NPV	"Net Present Value" button
I = 15 Enter ⇩	The discount rate
CPT NPV	Compute the "Net *Present* Value" = **–$2.422**

INTERPRETATION: Here, signs matter, and cash flows need to be properly identified as positive (inflows for the firm) or negative (capital expenditures or costs by the firm). Given the project would have a *net* present value of –$2.422, the positive cash flows the project yields aren't enough to offset its cost.

NPVs are only an estimate. Firms *forecast* the cash flows. Realized cash flows for projects can vary substantially from what the firm projected, causing seemingly positive NPV projects to result in a net loss for the firm.

Similarly, the discount rate is vital. The higher the rate, the riskier the project, which can reduce the present value of the project's cash flow. This rate may be chosen based on the opportunity cost of the project, or the rate that the initial investment could have grown if invested in the best alternative.

PRACTICE: What is the NPV of the Whole Foods example from above, assuming a discount rate of 10%, payments at the end of the periods, and an after-tax salvage value of $10,000? Should Whole Foods accept or reject the project?

SOLUTION: Given the cash flows we computed:

0	1	2	3
–$110,000	$51,780	$51,780	$81,780

We plug the following into our calculator:

CFo	CF1	CF2	CF3
–$110,000	$51,780	$51,780	$81,780

And assuming I = 10%, **CPT** **NPV** = _____. Therefore Whole Foods should _____ the project.

INTERPRETATION: If the NPV is positive, the firm should undertake the project. If the NPV is negative, the firm should not undertake the project. An NPV exactly equal to zero implies no value creation for undertaking the project.

Keep in mind there are additional applications NPV. For example, suppose a firm is thinking about overhauling its software systems (a $500,000 investment) that would result in cost savings of $100,000 per year. While the $100,000 per year is not necessarily a new source of revenue (because sales won't increase), the firm can still consider $100,000 per year savings as an incremental and relevant cash flow and use NPV to determine whether upgrading their software is worth the costs.

INTERNAL RATE OF RETURN (IRR)

The **Internal Rate of Return (IRR)** is the discount rate that makes the NPV of an investment exactly equal to zero. The rate is "internal" to the project or investment itself.

Suppose you invest $100 and earn $10 on that investment over a year. Your IRR = 10%. Whether that was a good investment depends on what your required return was, or what you wanted to get out of that investment given the investment's level of risk. If the investment was extraordinarily risky, you might have wanted to earn 25% for taking the bet. But if it was very safe, you might be content to accept the 10%.

Capital budgeting projects and investments with an *IRR more than a required rate of return should be accepted* and undertaken by the firm. Capital budgeting projects and investments with an *IRR below a required rate of return should be rejected* by the firm. However, the IRR is subject to certain limitations.

PRACTICE: What is the IRR of the Whole Foods example from above, assuming payments at the end of the periods, and an after-tax salvage value of $10,000? Should Whole Foods accept or reject the project if, given the project's riskiness, management wants to achieve a 10% rate of return?

SOLUTION: Give the cash flows:

0	1	2	3
–$110,000	$51,780	$51,780	$81,780

The IRR can be found as:

$$NPV = 0 = -110{,}000 + \frac{51780}{(1+IRR)^1} + \frac{51780}{(1+IRR)^2} + \frac{81780}{(1+IRR)^3}$$

which generally can only be found with trial and error or with a calculator:

CFo	CF1	CF2	CF3
–$110,000	$51,780	$51,780	$81,780

Then press **IRR** (above the **PMT** key) **CPT** = _____

INTERPRETATION: Because the IRR is _____ than the required rate of 10%,

the project should be _____.

⚠ A firm will reach the same conclusion by using either the NPV or IRR method, assuming three conditions are met:

1. The *required return* the firm compares to an IRR is the same as the *discount rate* used to discount the cash flows in the NPV calculation.

2. The project has **conventional cash flows**. That is, the time zero cash flow is negative and the remaining cash flows are positive.

3. Projects under evaluation are ***not*** **mutually exclusive**.

Required Returns and Discount Rates

In all cases, the **required return** for a project should be exactly equal to the **discount rate** applied to the cash flows. The discount rate reflects the risk of the project and should represent the rate that an investor would expect, or require, given that risk. The higher the risk, the higher the discount rate and required rate of return.

Unconventional Cash Flows

Unconventional cash flows exist when there are "sign changes" of the cash flows throughout the life of the project. In these scenarios, IRR will not be an adequate method of project evaluation, and the NPV method should be used instead.

EXAMPLE: A gold mining operation requires an initial investment to set up the site, but requires an investment in Year 2 to restore the mine. What is the IRR of the project with these cash flows? Should they accept if their required rate of return is 28%?

Year 0	– $60
Year 1	+ $155
Year 2	– $100

SOLUTION: We need to solve the following via trial-and-error:

$$NPV = 0 = -60 + \frac{155}{(1+IRR)^1} + \frac{-100}{(1+IRR)^2}$$

We get IRR = 25% or IRR = 33.33%:

$$NPV = 0 = -60 + \frac{155}{(1+0.25)^1} + \frac{-100}{(1+0.25)^2}$$ ✓

$$NPV = 0 = -60 + \frac{155}{(1+0.3333)^1} + \frac{-100}{(1+0.3333)^2}$$ ✓

INTERPRETATION: Both equations are true! But neither is unambiguously correct. If the firm chooses a required rate of return of 28%, they might *accept* by one computation and *reject* by another. Financial calculators and software might default to the lower IRR or randomly select one, but this isn't an adequate answer.

This is known as the **multiple IRR problem**.[1] Fortunately, the NPV still works in these cases. Some projects won't even have an IRR. In your calculator, try an investment of $51 today, receiving $100 in one year, then investing another $50 in the second year. This implies that there is no possible rate where the NPV will equal exactly zero.

Mutually Exclusive Projects

Projects are **mutually exclusive** if pursuing one implies that the other cannot be done. If, for example a retailer has land that they must decide to build either (1) a store or (2) a distribution center on, they must choose one or the other.

⚠ The IRR cannot be used to compare mutually exclusive projects. In these cases, accept the project with the higher NPV.

EXAMPLE: The Ford Motor Company wishes to reintroduce an electric version of one of its classic cars to its lineup, either the Model T or the Model A. Ford will only be able to produce one type of vehicle, not both. Whichever model it chooses, it will be for a limited time only (4 years). Calculate the IRR for each project.

Incremental Cash Flows		
Year	Model T	Model A
0	–$100 M	–$100 M
1	50 M	20 M
2	40 M	40 M
3	40 M	50 M
4	30 M	60 M

SOLUTION: For the Model T, the cash flows and IRR can be obtained by:

CFo	CF1	CF2	CF3	CF4	<CPT> IRR
-$100	$50	$40	$40	$30	24.00%

For the Model A:

CFo	CF1	CF2	CF3	CF4	<CPT> IRR
-$100	$20	$40	$50	$60	21.03%

INTERPRETATION: Should Ford produce the Model T, given it has the higher IRR? Let's summarize the NPV of each project, assuming we choose required rates of return ranging from 0% to 25% (which you can verify in your calculator):

Discount (Required) Rate	NPV Model T (IRR = 24%)	NPV Model A (IRR = 21.03%)
0%	$60	$70
5%	$43.13	$47.88
10%	$29.06	$29.79
15%	$17.18	$14.82
20%	$7.06	$2.31
25%	- $1.63	- $8.22

Notice that the NPV is positive in all cases where the IRR is greater than the required rate of return. When the required rate of return is higher than the IRR, the NPV is negative. This is expected, since the IRR and NPV will reach the same conclusion for conventional cash flows.

However, if we choose a 5% discount rate for both projects, The Model A has the higher NPV. If we choose a 20% discount rate for both projects, The Model T has the higher NPV. The Model A may have greater cash flows, but it pays more slowly, leading to these differing conclusions given different discount rates. Therefore, use the NPV to rank and select mutually exclusive projects.

In general, do not use IRR to rank projects, even if they seem independent. Use NPV.

Payback and Discounted Payback

The **payback period** is the amount of time required for an investment to generate cash sufficient to cover its costs. While a "back-of-the-envelope" or "quick" approach, this method is used by large firms for smaller day-to-day decisions. For example, the firm might require a two-year payback for projects under $10,000. Computation is relatively straightforward.

Practice: A restaurant is interested in opening a new location. The cost will be $500k, with projected incremental cash flows of $150k, $250k, $350k, and *negative* $950k over the next few years. If the restaurant wants to be paid back in 4 years, will they accept this project?

Solution: We need to see how long until the firm recovers its investment of $500,000. If it can do so under 4 years, the project should be accepted by this rule.

Year	Cash Flow	Rolling Cash Flow
0	–500,000	–500,000
1	+150,000	–500,000 + 150,000= –350,000
2	+250,000	–350,000 + 250,000= –100,000
3	+350,000	–100,000 + 350,000= 250,000

INTERPRETATION: This project pays back sometime in year 2. In year 2, we only need $100,000, but the project earns $350,000. It's payback period is *2 + (100,000/350,000) = 2.28*. This is less than the 4 year requirement, and should be accepted by the payback period rule.

Notice the large negative cash flow of $950,000 in year 4 implies that this would be a *negative* NPV project that should be rejected. Use the payback period with caution!

The **discounted payback** technique is similar, but this method discounts the payments by a chosen discount rate:

PRACTICE: Assume the same series of cashflows in the above restaurant example, but with a 12% discount rate.

SOLUTION: Our table becomes:

Year	Cash Flow	Present Value of Cash Flow	Rolling Cash Flow
0	–500k		–500,000
1	150k	$150k/(1.12)^1 = 133,928.57$	–500,000 + 133,928.57= –366,071.42
2	250k	$250k/(1.12)^2 = 199,298.47$	–366,071.42 + 199,298.47= –166,772.95
3	350k	$350k/(1.12)^3 = 249,123.09$	–166,772.95 + 249,123.09= 82,350.14

INTERPRETATION: This project pays back sometime in year 2. This is less than the 4 year requirement. Again, the project should be accepted under this rule, but note again that a large negative outflow in year 4 of the project implies we'd accept a negative NPV project.

Calculating fractional years is not commonly done in the discounted payback case as it is in the "undiscounted" payback case.

The payback method is simple to compute and intuitive. The discounted payback is an improvement in that it considers the time value of money, but both suffer from the assignment of an arbitrary cutoff period. And if discounted payback requires discounting, why not just use NPV? Both methods could result in accepting negative NPV projects.

Capital budgeting projects with a *payback or discounted payback period less than a chosen time period should be accepted* by the firm. Capital budgeting projects with a *payback or discounted payback period longer than the chosen time period should be rejected* by the firm. While intuitive, these methods may result in rejecting positive NPV projects (or accepting negative ones).

PROFITABILITY INDEX

The **profitability index** or **benefit-cost ratio** is defined as the present value of a project's cash flows divided by the (absolute value of) the initial investment:

$$Profitability\ Index = \frac{Present\ Value\ of\ Project\ Cash\ Flows}{Initial\ Investment}$$

Notice the numerator is just the present value, not the NPV, of the cash flows. You can find the sum of the future cash flows by using the NPV function on your calculator while leaving **CFo** blank, just as you would find the present value of any series of cash flows.

If the profitability index is greater than 1, accept. Below 1, reject. For example, a profitability index equal to 1.2 means the project creates $1.20 for every $1 invested. A profitability index equal to 0.8 means the project creates $0.80 for every dollar invested.

Capital budgeting projects and investments with a *profitability index greater than 1 should be accepted* by the firm. Capital budgeting projects with a *profitability index less than 1 should be rejected* by the firm. However, this method should not be used to rank projects (similar rationale as IRR).

IN SUMMARY

THE PRACTICE OF CAPITAL BUDGETING

The NPV is conceptually the best procedure to use. However, other methods are important to a financial manager. Being able to speak in terms of returns (IRR) or knowing when a project pays back (payback period and discounted payback period) is important. Notably, IRR is the metric of choice for private equity.

Keep in mind that NPV is built on *estimates* or future sales, costs, and project lifespan. The hardest part of capital investing, then, is identifying projects and producing the forecasts (which here we take as a given!) Evaluating investments using multiple criteria becomes a must given the uncertainty inherent in projects.

The Excel file *Investment Criteria* at www.josephfarizo.com/fin360.html provides examples and practice problems for each technique of evaluating investments.

Table 2: Summary of Investment Criteria Rules

Method	Summary	Percent Use[2]
NPV	Compare incremental cash flows to cost. Accept if positive, reject if negative, indifferent if zero. Heavily used. No serious cons.	75%
IRR	The discount rate resulting in a zero NPV: accept (reject) if exceeding (below) required rate of return. Heavily used, but subject to multiple IRR, cannot be used for unconventional cash flows, and cannot be used for mutually exclusive projects.	76%
Payback Period	Length of time until cash flows pay off costs. Accept if period is less than a chosen cutoff. Very intuitive, but it doesn't take into account risk or time value of money and may reject positive NPV projects if they don't pay back in time.	57%
Discounted Payback Period	Length of time until cash flows pay off costs. Accept if period is less than a chosen cutoff. Intuitive, but one might as well compute the NPV if discounting cash flows anyway, and it may reject positive NPV projects if they don't pay back in time.	29%
Profitability Index	The present value of incremental cash flows divided by initial cost. Accept if >1. May not be effective for mutually exclusive projects.	12%

CRITICAL THINKING & CONCEPTUAL QUESTIONS

1. A firm owns land that it purchased for $2.8 million 10 years ago, hoping to build a theme park. The park was never built, and the land could be sold today for $3.8 million. Now, they are reconsidering the theme park project. Building the park would cost $325 million, and would require $2 million in permitting and licensing fees. The land was cleared at the time of the land purchase for $500,000 and costs an additional $20,000 per year to keep clear from overgrowth. An estimated $400,000 in ticket sales per year at this new theme park would be from guests pulled away from the nearby competitor's park, and $2,800,000 in ticket sales would be from guests that have never been to the competitor's park. The firm acquires several hundreds of thousands of dollars' worth of merchandise inventory to sell in the park's gift shop. Identify each of the incremental and relevant cash flows in this example.
2. A manager knows that a new project is expected to produce sales of $100,000 per year, but that $20,000 of those sales will be from existing customers that switch to the new product. How should they incorporate this into their NPV analysis?
3. Explain how an investment in net working capital is a cash outflow at the beginning of a project and why it is "recovered" at the end.
4. If firms borrow, they will incur financing costs through interest expense. Why do we not consider these expenses *relevant* or *incremental* cash flows?
5. Explain the concepts of erosion and synergy. Why are they considered relevant and incremental cash flows?
6. If a firm's depreciation expense increases, what happens to its tax bill, assuming all else is held constant?
7. Explain how a $10 increase in depreciation affects the three financial statements.
8. What are the pros and cons of each of the 5 methods we've looked at to evaluate investments? Which one should always be used at a minimum?
9. Regarding the 5 methods, if one method is superior to the others, why consider other methods at all?
10. Could the payback method and discounted payback reach different conclusions (holding constant the number of years it has to pay back?)
11. If we increase the discount rate for cash flows, will the discounted payback period shorten or lengthen? Why?
12. As the discount rate chosen in an NPV analysis rises, what happens to the likelihood a project will be accepted? Why?
13. In general terms, how do firms choose an appropriate required rate of return or "discount rate" for NPV computations?
14. Describe the multiple IRR problem and why it exists.
15. Explain how IRR affects decisions involving mutually exclusive projects.
16. Explain how a project can satisfy the "accept" criteria for all 5 evaluations and *still* be a bad investment.
17. Will the discounted payback period be more or less than the payback period given a positive discount rate?
18. Explain how the payback period method may contradict decisions based on NPV or IRR.

19. All else equal, which increases the chances of a project having a positive NPV? Why?
    a. High cash flows earlier in the project that steadily decline
    b. Low cash flows earlier in the project that steadily rise
20. Two employees at your firm compute different NPVs for the same project. Both used the same formulas and did their computations correctly. How is this possible? What implications might this have for the firm's choice to pursue the project?
21. Two employees at your firm compute different IRRs for the same project. Both used the same formulas and did their computations correctly. How is this possible? What implications might this have for the firm's choice to pursue the project?
22. You are considering going to grad school to get your MBA. How might you use an NPV analysis to determine if that is a good idea?
23. For which type of projects might a payback period or discounted payback period be best?
24. Why shouldn't the profitability index be used to rank projects?

ANALYTICAL QUESTIONS

On January 17, 2023, Fission Uranium Corp issued a press release, which you can read in full here.[3] In summary:

- Fission Uranium Corp. engages in uranium exploration and development. It owns a "high grade and near surface uranium deposit" in Canada.
- The company has yet to earn revenue.
- The Patterson Lake South (PLS) property is a uranium exploration and development project located in Athabasca Basin.
- PLS is owned 100% by Fission Uranium Corp.
- Fission Uranium Corp wishes to build a mine to extract uranium at PLS.
- A feasibility study was conducted that concluded:
    - Substantial uranium deposits are present at PLS.
    - The uranium can be efficiently obtained, with extraction rates above 90%.
    - The uranium mine has a life of 10 years, longer than originally predicted.
    - Annual cash flows from the project are estimated to be $2.8 billion after tax.
    - The project has an NPV of $1.204 billion assuming an 8% discount rate.
    - The project has an IRR of 27.2%.
    - The project has a payback period of 2.6 years
- The initial investment (which they refer to as CAPEX for "capital expenditure") required for this project is expected to be lower than originally predicted.
- Fission has engagement agreements with all the Indigenous groups with the potential for impacts to their traditional land use and treaty rights due to the project.

Ross McElroy, President and CEO of Fission said:

"*With greatly enhanced economics, including an increase of 42% to the mine life, an incredible 71.5% increase in post-tax NPV and a 10.2% growth in post-tax IRR, this feasibility study confirms the Tier 1 PLS project as one of the most economically significant and elite uranium development projects in the world. Showing CAPEX to be lower than in the 2019 Prefeasibility report, particularly with the pressures of high global inflation, is a remarkable achievement and speaks volumes regarding the team's design and planning abilities. Beyond the economics, the shallow, high-grade nature of our deposit gives us a very small environmental footprint – an advantage that we have built on with comprehensive monitoring since the start of drilling in 2012 and increasing Indigenous engagement. Going forward, thanks to the strength of this feasibility study and the success of our ongoing social engagement, we will continue advancing through the Environmental Assessment and on towards a construction decision.*"

Given the information in the press release and the CEO's quote, answer the following questions:

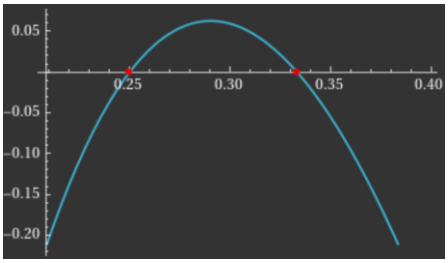
1.) The forecasted CAPEX fell from the original estimate. What do we think happened to the new estimates of NPV, IRR, and payback period relative to their old estimates, assuming the projected cash flows remained the same?
2.) What does a longer mine life than originally projected imply about the NPV, IRR, and payback estimates?
3.) Given the NPV and IRR that Fission computed, should the project be accepted?
4.) How do you feel about the choice of an 8% discount rate? Keep in mind that a well-diversified portfolio in large and mature stocks returns about 10% per year. Think about the risk associated with this project. Do you think the discount rate should be higher or lower?
5.) Who are stakeholders that the CEO refers to in his quote? How might they be affected by this project?
6.) What might a "reduced environmental impact" and "increasing Indigenous engagement" that the press release refers to mean for the discount rate?

NOTES & REFERENCES

[1] Multiple IRRs may occur because the polynomials can have multiple solutions. If, for example, we graph

$$0 = -60 + \frac{155}{(1+x)^1} - \frac{100}{(1+x)^2}$$

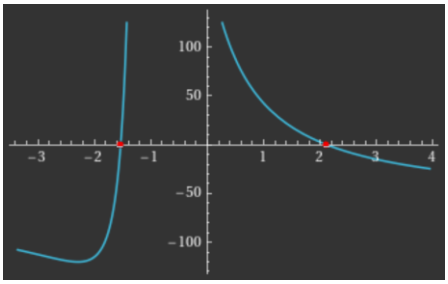
we get the following plot, which clearly shows that both 25% and 33.33% are possible solutions:



If we change the cash flow to a positive, the equation becomes:

$$0 = -60 + \frac{155}{(1+x)^1} + \frac{100}{(1+x)^2}$$

For which there is only one positive solution, I = 211.78%



[2] Percentage of CFOs who "always" or "almost always" use this capital budgeting valuation technique, from "The Theory and Practice of Corporate Finance: Evidence from the Field" by J.R. Graham and C.R. Harvey in the Journal of Financial Economics, 2001.

[3] The press release is available at https://www.prnewswire.com/news-releases/fission-announces-tier-1-economics-for-pls-with-feasibility-study-lower-initial-capex-increased-mine-life-npv-and-irr-301723039.html.