

Master of Financial Technology

FNT 615
Finance Concepts





Capital Budgeting

Chapter 6



Chapter 06

Intended Learning Outcomes

After reading this chapter, you should be able to:

1. Discuss the difficulty encountered in finding profitable projects in competitive markets and the importance of the search.
2. Determine whether a new project should be accepted or rejected using the payback period, the net present value, the profitability index, and the internal rate of return.
3. Explain how the capital-budgeting decision process changes when a dollar limit is placed on the capital budget.

Capital Budgeting

- Capital budgeting is the process a business undertakes to evaluate potential major projects or investments. Construction of a new plant or a big investment in an outside venture are examples of projects that would require capital budgeting before they are approved or rejected.
- As part of capital budgeting, a company might assess a prospective project's lifetime cash inflows and outflows to determine whether the potential returns that would be generated meet a sufficient target benchmark.
- The capital budgeting process is also known as **investment appraisal**.

Capital-Budgeting Decision Criteria



When deciding whether to accept a new project, we focus on cash flows because cash flows represent the benefits generated from accepting a capital-budgeting proposal.



In this chapter we assume a given cash flow is generated by a project and work on determining whether that project should be accepted.



We consider four commonly used criteria for determining the acceptability of investment proposals. The first one is the least sophisticated in that it does not incorporate the time value of money into its calculations; the other three do take it into account.



For the time being, the problem of incorporating risk into the capital-budgeting decision is ignored.

Capital Budgeting Techniques

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



Pay Back period

Payback Period

- When deciding whether to accept a new project, we focus on cash flows because cash flows represent the benefits generated from accepting a capital-budgeting proposal.
- In this chapter we assume a given cash flow is generated by a project and work on determining whether that project should be accepted. We consider four commonly used criteria for determining the acceptability of investment proposals.

$$\text{Payback period} = \text{number of years just prior to complete payback} + \frac{\text{unpaid-back amount at beginning of year}}{\text{free cash flow in year payback is completed}}$$

- The first one is the least sophisticated in that it does not incorporate the time value of money into its calculations; the other three do take it into account. For the time being, the problem of incorporating risk into the capital-budgeting decision is ignored.

Payback Period

- For example, if a firm's maximum desired payback period is 3 years, and an investment proposal requires an initial cash outlay of \$10,000 and yields the following set of annual cash flows, what is its payback period? Should the project be accepted?

YEAR	FREE CASH FLOW
1	\$2,000
2	4,000
3	3,000
4	3,000
5	9,000

Payback Period

- In this case, after 3 years the firm will have recaptured \$9,000 on an initial investment of \$10,000, leaving \$1,000 of the initial investment to be recouped. During the fourth year \$3,000 will be returned from this investment, and, assuming it will flow into the firm at a constant rate over the year, it will take one-third of the year ($\$1,000/\$3,000$) to recapture the remaining \$1,000.
- Thus, the payback period on this project is $3\frac{1}{2}$ years, which is more than the desired payback period. Using the payback period criterion, the firm would reject this project without even considering the \$9,000 cash flow in year 5.

Payback Period

- Although the payback period is used frequently, it does have some rather obvious drawbacks that are best demonstrated through the use of an example.
- Consider two investment projects, A and B, which involve an initial cash outlay of \$10,000 each and produce the annual cash flows shown in Table -1.
- Both projects have a payback period of 2 years; therefore, in terms of the payback criterion both are equally acceptable. However, if we had our choice, it is clear we would select A over B, for at least two reasons.
- First, regardless of what happens after the payback period, project A returns more of our initial investment to us faster within the payback period (\$6,000 in year 1 versus \$5,000).
- Thus, because there is a time value of money, the cash flows occurring within the payback period should not be weighted equally, as they are. In addition, all cash flows that occur after the payback period are ignored.

Payback Period

- This violates the principle that investors desire more in the way of benefits rather than less—a principle that is difficult to deny, especially when we are talking about money.
- Finally, the choice of the maximum desired payback period is arbitrary.
- That is, there is no good reason why the firm should accept projects that have payback periods less than or equal to 3 years rather than 4 years.
- Although these deficiencies limit the value of the payback period as a tool for investment evaluation, the payback period has several positive features.
- First, it deals with cash flows, as opposed to accounting profits, and therefore focuses on the true timing of the project's benefits and costs, even though it does not adjust the cash flows for the time value of money.

Payback Period

Second, it is easy to visualize, quickly understood, and easy to calculate. Third, the payback period may make sense for the capital-constrained firm, that is, the firm that needs funds and is having problems raising additional money.

These firms need cash flows early on to allow them to continue in business and to take advantage of future investments.

Finally, although the payback period has serious deficiencies, it is often used as a rough screening device to eliminate projects whose returns do not materialize until later years.

This method emphasizes the earliest returns, which in all likelihood are less uncertain, and provides for the liquidity needs of the firm.

Although its advantages are certainly significant, its disadvantages severely limit its value as a discriminating capital-budgeting criterion.

Payback Period – Example 1

TABLE 10-1 Payback Period Example

	PROJECTS	
	A	B
Initial cash outlay	−\$10,000	−\$10,000
Annual free cash inflows		
Year 1	\$ 6,000	\$ 5,000
2	4,000	5,000
3	3,000	0
4	2,000	0
5	1,000	0

Payback Period – Example 2

- For example, if a firm's maximum desired payback period is 3 years, and an investment proposal requires an initial cash outlay of \$10,000 and yields the following set of annual cash flows, what is its payback period? Should the project be accepted?

YEAR	FREE CASH FLOW
1	\$2,000
2	4,000
3	3,000
4	3,000
5	9,000

Major Drawbacks



Ignoring the time value of money.



Ignoring any cash flow after the payback period.

Discounted Payback Period

To deal with the criticism that the payback period ignores the time value of money, some firms use the discounted payback period approach.

The discounted payback period method is similar to the traditional payback period except that it uses discounted free cash flows rather than actual undiscounted free cash flows in calculating the payback period.

The discounted payback period is defined as the number of years it takes to recapture a project's initial outlay from the discounted free cash flows.

Discounted Payback Period

$$\begin{array}{l} \text{Discounted} \\ \text{payback} \\ \text{period} \end{array} = \begin{array}{l} \text{number of years just prior} \\ \text{to complete payback} \\ \text{from discounted free} \\ \text{cash flows} \end{array} + \frac{\begin{array}{l} \text{unpaid-back amount at} \\ \text{the beginning} \\ \text{of year} \end{array}}{\begin{array}{l} \text{discounted free cash} \\ \text{flow in year} \\ \text{payback is completed} \end{array}}$$

Discounted Payback Period “Decision Rule”

- The accept/reject criterion then becomes whether the project's discounted payback period is less than or equal to the firm's maximum desired discounted payback period.

Discounted Payback Period

- 2. On project A, after 3 years, only \$74 of the initial outlay remains to be recaptured, whereas year 4 brings in a discounted free cash flow of \$1,068. Thus, if the \$1,068 comes in at a constant rate over the year, it will take about 7/100 of the year ($\$74/\$1,068$) to recapture the remaining \$74. The discounted payback period for project A is 3.07 years, calculated as follows: $\text{Discounted payback period}_A = 3.0 + \$74/\$1,068 = 3.07 \text{ years}$

TABLE 10-2 Discounted Payback, Period Example Using a 17 Percent Required Rate of Return

PROJECT A			
Year	Undiscounted Free Cash Flows	Discounted Free Cash Flows at 17%	Cumulative Discounted Free Cash Flows
0	−\$10,000	−\$10,000	−\$10,000
1	6,000	5,130	−4,870
2	4,000	2,924	−1,946
3	3,000	1,872	−74
4	2,000	1,068	994
5	1,000	456	1,450
PROJECT B			
Year	Undiscounted Free Cash Flows	Discounted Free Cash Flows at 17%	Cumulative Discounted Free Cash Flows
0	−\$10,000	−\$10,000	−\$10,000
1	5,000	4,275	−5,725
2	5,000	3,655	−2,070
3	0	0	−2,070
4	0	0	−2,070
5	0	0	−2,070

Discounted Payback Period

- If project A's discounted payback period was less than the firm's maximum desired discounted payback period, then project A would be accepted. Project B, however, does not have a discounted payback period because it never fully recovers the project's initial cash outlay and thus should be rejected.
- The major problem with the discounted payback period comes in setting the firm's maximum desired discounted payback period. This is an arbitrary decision that affects which projects are accepted and which ones are rejected.
- In addition, cash flows that occur after the discounted payback period are not included in the analysis. Thus, although the discounted payback period is superior to the traditional payback period, in that it accounts for the time value of money in its calculations, its use is limited by the arbitrariness of the process used to select the maximum desired payback period.
- Moreover, as we will soon see, the net present value criterion is theoretically superior and no more difficult to calculate.

FINANCIAL DECISION TOOLS

Name of Tool	Formula	What It Tells You
Payback period	Number of years required to recapture the initial investment from the free cash flows:	- How long it will take to recapture the initial investment - The shorter the payback period, the better - If it is less than the maximum acceptable payback period, it is accepted
	$\text{Payback period} = \text{number of years just prior to complete payback} + \frac{\text{unpaid-back amount at beginning of year}}{\text{free cash flow in year payback is completed}}$	
Discounted payback period	Number of years required to recapture the initial investment from the discounted free cash flows:	- How long it will take to recapture the initial investment from the discounted cash flows - The shorter the discounted payback period, the better - If it is less than the maximum acceptable discounted payback period, it is accepted.
	$\text{Discounted payback period} = \text{number of years just prior to complete payback from discounted free cash flows} + \frac{\text{unpaid-back amount at beginning of year}}{\text{discounted free cash flow in year payback is completed}}$	

Concept Check Calculate

1- Pay Back Period

2- Discounted Payback
period if the discount
rate is 7%

Year	Cash Flow
0	80,000
1	30,000
2	20,000
3	25,000
4	20,000
5	15,000
6	15,000

Payback Period

Year	Cash Flow	Cumulative Cash Flow
0	80,000	-80,000
1	30,000	-50,000
2	20,000	-30,000
3	25,000	-5,000
4	20,000	15,000
5	15,000	30,000
6	15,000	45,000
	0.25 * 12	
3 years	months	
3 Years	3 Months	

Discounted Payback Period

- Step 1: get the discounted cash flow

Year	Cash Flow	Discount Factor ($1 / (1+r)^t$)	Discounted Cash Flow
0	80,000	1.0000	80000
1	30,000	0.9346	28037
2	20,000	0.8734	17469
3	25,000	0.8163	20407
4	20,000	0.7629	15258
5	15,000	0.7130	10695
6	15,000	0.6663	9995

Discounted Payback Period

3 years + (0.923 x 12) = 3
years and 11 months

Year	Cash Flow	Discount Factor (1/ (1+r)^t)	Discounted Cash Flow	Cumulative DCF
0	80,000	1.0000	80000	-80000
1	30,000	0.9346	28037	-51963
2	20,000	0.8734	17469	-34494
3	25,000	0.8163	20407	-14086
4	20,000	0.7629	15258	1172
5	15,000	0.7130	10695	11866
6	15,000	0.6663	9995	21861

Net Present Value - NPV

The net present value (NPV)

- The net present value (NPV) of an investment proposal is equal to the present value of its annual free cash flows less the investment's initial outlay. The net present value can be expressed as follows:

$$\begin{aligned} NPV &= (\text{present value of all the future annual free cash flows}) - (\text{the initial cash outlay}) \\ &= \frac{FCF_1}{(1 + k)^1} + \frac{FCF_2}{(1 + k)^2} + \dots + \frac{FCF_n}{(1 + k)^n} - IO \end{aligned} \quad (10-1)$$

- where FCF_t = the annual free cash flow in time period t (this can take on either positive or negative values)
- k = the firm's required rate of return or cost of capital
- IO = the initial cash outlay
- n = the project's expected life

The net present value (NPV)

- If any of the future free cash flows (FCFs) are cash outflows rather than inflows, say for example that there is another large investment in year 2 that results in the FCF2 being negative, then the FCF2 would take on a negative sign when calculating the project's net present value.
- In effect, the NPV can be thought of as the present value of the benefits minus the present value of the costs,
- $NPV = PV \text{ benefits} - PV \text{ costs}$

The net present value (NPV)

- A project's NPV measures the net value of the investment proposal in terms of today's dollars. Because all cash flows are discounted back to the present, comparing the difference between the present value of the annual cash flows and the investment outlay recognizes the time value of money.
- The difference between the present value of the annual cash flows and the initial outlay determines the net value of the investment proposal.
- Whenever the project's NPV is greater than or equal to zero, we will accept the project; whenever the NPV is negative, we will reject the project. If the project's NPV is zero, then it returns the required rate of return and should be accepted. This accept/reject criterion is represented as follows:
 - NPV more than 0: accept
 - NPV less than 0: reject
- Realize, however, that the worth of the NPV calculation is a function of the accuracy of the cash-flow predictions

The net present value (NPV)

- ski-Doo is considering new machinery that would reduce manufacturing costs associated with its Mach Z snowmobile for which the free cash flows are shown in Table 10-3. If the firm has a 12 percent required rate of return, what is the NPV of the project? Should the company accept the project?
- **STEP 1: FORMULATE A SOLUTION STRATEGY**
- The net present value (NPV) of an investment proposal is equal to the present value of its annual free cash flows less the investment's initial outlay. Given the company's free cash flows information, the NPV can be calculated as:

TABLE 10-3 Ski-Doo's Investment in New Machinery and Its Associated Free Cash Flows

	Free Cash Flow
Initial outlay	−\$40,000
Inflow year 1	15,000
Inflow year 2	14,000
Inflow year 3	13,000
Inflow year 4	12,000
Inflow year 5	11,000

The net
present
value (NPV)

$$\begin{aligned} NPV &= (\text{present value of all the future annual free cash flows}) - (\text{the initial cash outlay}) \\ &= \frac{FCF_1}{(1+k)^1} + \frac{FCF_2}{(1+k)^2} + \cdots + \frac{FCF_n}{(1+k)^n} - IO \end{aligned} \quad (10-1)$$

where FCF_t = the annual free cash flow in time period t (this can take on either positive or negative values)

k = the firm's required rate of return or cost of capital

IO = the initial cash outlay

n = the project's expected life

STEP 2: CRUNCH THE NUMBERS

- If the firm has a 12 percent required rate of return, the present value of the free cash flow is \$47,675, as calculated in Table 10-4. Subtracting the \$40,000 initial outlay leaves an NPV of \$7,675.

TABLE 10-4 Calculating the NPV of Ski-Doo's Investment in New Machinery					
	PRESENT VALUE				
	Free Cash Flow	×	Factor at 12 Percent	=	Present Value
Inflow year 1	\$15,000	×	$\frac{1}{(1 + 0.12)^1}$	=	\$13,393
Inflow year 2	14,000	×	$\frac{1}{(1 + 0.12)^2}$	=	11,161
Inflow year 3	13,000	×	$\frac{1}{(1 + 0.12)^3}$	=	9,253
Inflow year 4	12,000	×	$\frac{1}{(1 + 0.12)^4}$	=	7,626
Inflow year 5	11,000	×	$\frac{1}{(1 + 0.12)^5}$	=	<u>6,242</u>
Present value of free cash flows					\$47,675
Initial outlay					<u>-40,000</u>
Net present value					<u>\$ 7,675</u>

STEP 3: ANALYZE YOUR RESULTS

- The NPV tells us how much value is created if the project is accepted, and if the NPV is positive, value is created; if the NPV is negative, the project destroys value.
- In this case because this value is greater than zero, this project creates value and should be accepted

The net present value (NPV)

- The NPV criterion is the capital-budgeting decision tool we find most favorable for several reasons. First of all, it deals with free cash flows rather than accounting profits. In this regard it is sensitive to the true timing of the benefits resulting from the project.
- Moreover, recognizing the time value of money allows the benefits and costs to be compared in a logical manner.
- Finally, because projects are accepted only if a positive NPV is associated with them, the acceptance of a project using this criterion will increase the value of the firm, which is consistent with the goal of maximizing the shareholders' wealth. The disadvantage of the NPV method stems from the need for detailed, long-term forecasts of the free cash flows accruing from the project's acceptance.
- Despite this drawback, the NPV is the most theoretically correct criterion that we will examine.

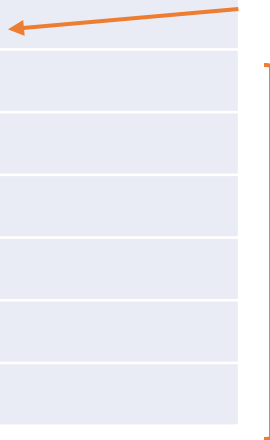
Concept Check Calculate

1- NPV if discount rate is 7 %

Year	Cash Flow
0	80,000
1	30,000
2	20,000
3	25,000
4	20,000
5	15,000
6	15,000

Concept Check

Year	Cash Flow	Discount Factor ($1 / (1+r)^t$)	Discounted Cash Flow
0	80,000	1.0000	-80000
1	30,000	0.9346	28037
2	20,000	0.8734	17469
3	25,000	0.8163	20407
4	20,000	0.7629	15258
5	15,000	0.7130	10695
6	15,000	0.6663	9995



$$\begin{aligned}\text{NPV} &= \text{Sum of all discount CASHINFLOWS} - \text{intial cash outflows} \\ &= 101,861 - 80,000 \\ &= 21,861\end{aligned}$$

Bonus Question

Year	Cash Flow - Project A	Cash Flow - Project B		
0	100,000	100,000		
1	30,000	60,000		
2	20,000	40,000		
3	10,000	20,000		
4	70,000	10,000		
5	30,000	10,000		
6	10,000	15,000		
	The Company has 2 projects and you are required to perform an investment appraisal to both project using payback period, discounted payback period, and NPV to help the company select the optimal project given that the company required payback period is 4 years and the discount rate is 8 %			

Payback Period					
Project A			Project B		
Year	Cash Flow	Cumulative Cash Flow	Year	Cash Flow	Cumulative Cash Flow
0	100,000		0	100,000	
1	30,000		1	60,000	
2	20,000		2	40,000	
3	10,000		3	20,000	
4	70,000		4	10,000	
5	30,000		5	10,000	
6	10,000		6	15,000	

Pay Back Period

Payback Period					
Project A			Project B		
Year	Cash Flow	Cumulative Cash Flow	Year	Cash Flow	Cumulative Cash Flow
0	100,000	-100,000	0	100,000	-100,000
1	30,000	-70,000	1	60,000	-40,000
2	20,000	-50,000	2	40,000	0
3	10,000	-40,000	3	20,000	20,000
4	70,000	30,000	4	10,000	30,000
5	30,000	60,000	5	10,000	40,000
6	10,000	70,000	6	15,000	55,000
				2 YEARS	
3 YEARS	6.857142857				

Discounted Pay Back Period & NPV

Discounted Payback Period									
Project A					Project B				
Year	Cash Flow	Discount Factor	DCF	Cumulative DCF	Year	Cash Flow	Discount Factor	DCF	Cumulative DCF
0	100,000	1.0000	100,000	-100,000	0	100,000	1.00	100,000	-100,000
1	30,000	0.9259	27,778	-72,222	1	60,000	0.93	55,556	-44,444
2	20,000	0.8573	17,147	-55,075	2	40,000	0.86	34,294	-10,151
3	10,000	0.7938	7,938	-47,137	3	20,000	0.79	15,877	5,726
4	70,000	0.7350	51,452	4,315	4	10,000	0.74	7,350	13,076
5	30,000	0.6806	20,417	24,732	5	10,000	0.68	6,806	19,882
6	10,000	0.6302	6,302	31,034	6	15,000	0.63	9,453	29,334
NPV			31,034		NPV			29,334	
					2 YEARS				
3 YEARS	8.08065								

Conclusion

	Project A	Project B
Pay Back Period	3 Years & 6 months	2 years
Discounted Payback Period	3 years & 8 monthd	2 years & 7 months
NPV	31,034	29,334

Thank You

