

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.

Profitability Index - PI

Profitability Index

The profitability index (PI), or benefit–cost ratio, is the ratio of the present value of the future free cash flows to the initial outlay.

Although the NPV investment criterion gives a measure of the absolute dollar desirability of a project, the profitability index provides a relative measure of an investment proposal's desirability— that is, the ratio of the present value of its future net benefits to its initial cost.

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

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 decision criterion is to accept the project if the PI is greater than or equal to 1.00 and to reject the project if the PI is less than 1.00.

$PI \geq 1.0$: accept

$PI < 1.0$: reject

EXAMPLE 10.3**Calculating the profitability index**

A firm with a 10 percent required rate of return is considering investing in a new machine with an expected life of 6 years. The free cash flows resulting from this investment are given in Table 10-5. Determine the firm's profitability index. According to the profitability index, should the firm accept the investment?

TABLE 10-5 The Free Cash Flows Associated with an Investment in New Machinery

	Free Cash Flow
Initial outlay	−\$50,000
Inflow year 1	15,000
Inflow year 2	8,000
Inflow year 3	10,000
Inflow year 4	12,000
Inflow year 5	14,000
Inflow year 6	16,000

STEP 1: FORMULATE A SOLUTION STRATEGY

The profitability index can be calculated using equation (10-2) as follows:

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

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

Discounting the project's future net free cash flows back to the present yields a present value of \$53,682; dividing this value by the initial outlay of \$50,000 yields a profitability index of 1.0736, as shown in Table 10-6.

STEP 3: ANALYZE YOUR RESULTS

This tells us that the present value of the future benefits accruing from this project is 1.0736 times the level of the initial outlay. Because the profitability index is greater than 1.0, the project should be accepted. In addition, because the profitability index is greater than 1.0 we also know that the *NPV* is positive—that's because the present value of the future benefits is greater than the initial outlay. These two measures always give consistent accept/reject decisions on investment projects.

TABLE 10-6 Calculating the *PI* of an Investment in New Machinery

	Free Cash Flow	×	Present Value Factor at 10 Percent	=	Present Value
Inflow year 1	15,000	×	$\frac{1}{(1 + 0.10)^1}$	=	13,636
Inflow year 2	8,000	×	$\frac{1}{(1 + 0.10)^2}$	=	6,612
Inflow year 3	10,000	×	$\frac{1}{(1 + 0.10)^3}$	=	7,513
Inflow year 4	12,000	×	$\frac{1}{(1 + 0.10)^4}$	=	8,196
Inflow year 5	14,000	×	$\frac{1}{(1 + 0.10)^5}$	=	8,693
Inflow year 6	16,000	×	$\frac{1}{(1 + 0.10)^6}$	=	9,032
$PI = \frac{\frac{FCF_1}{(1 + k)^1} + \frac{FCF_2}{(1 + k)^2} + \dots + \frac{FCF_n}{(1 + k)^n}}{IO}$ $= \frac{\$13,636 + \$6,612 + \$7,513 + \$8,196 + \$8,693 + \$9,032}{\$50,000}$ $= \frac{\$53,682}{\$50,000} = 1.0736$					

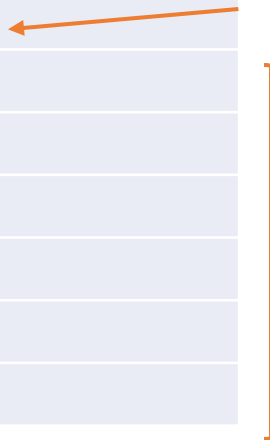
Concept Check
Calculate

1- Profitability
index 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

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



$$\begin{aligned}\text{PI} &= \text{Sum of all discount CASHINFLOWS} / \text{intial cash outflows} \\ &= 101,861 / 80,000 \\ &= 1.273\end{aligned}$$

Internal Rate of Return- IRR

The internal rate of return (IRR)



The internal rate of return (IRR) attempts to answer the question, what rate of return does this project earn?



For computational purposes, the internal rate of return is defined as the discount rate that equates the present value of the project's free cash flows with the project's initial cash outlay.



Mathematically, the internal rate of return is defined as the value IRR in the following equation:
$$\text{IRR} = \text{the rate of return that equates the present value of the project's free cash flows with the initial outlay}$$

IRR

IRR = the rate of return that equates the present value of the project's free cash flows with the initial outlay

$$IO = \frac{FCF_1}{(1 + IRR)^1} + \frac{FCF_2}{(1 + IRR)^2} + \dots + \frac{FCF_n}{(1 + IRR)^n} \quad (10-3)$$

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

IO = the initial cash outlay

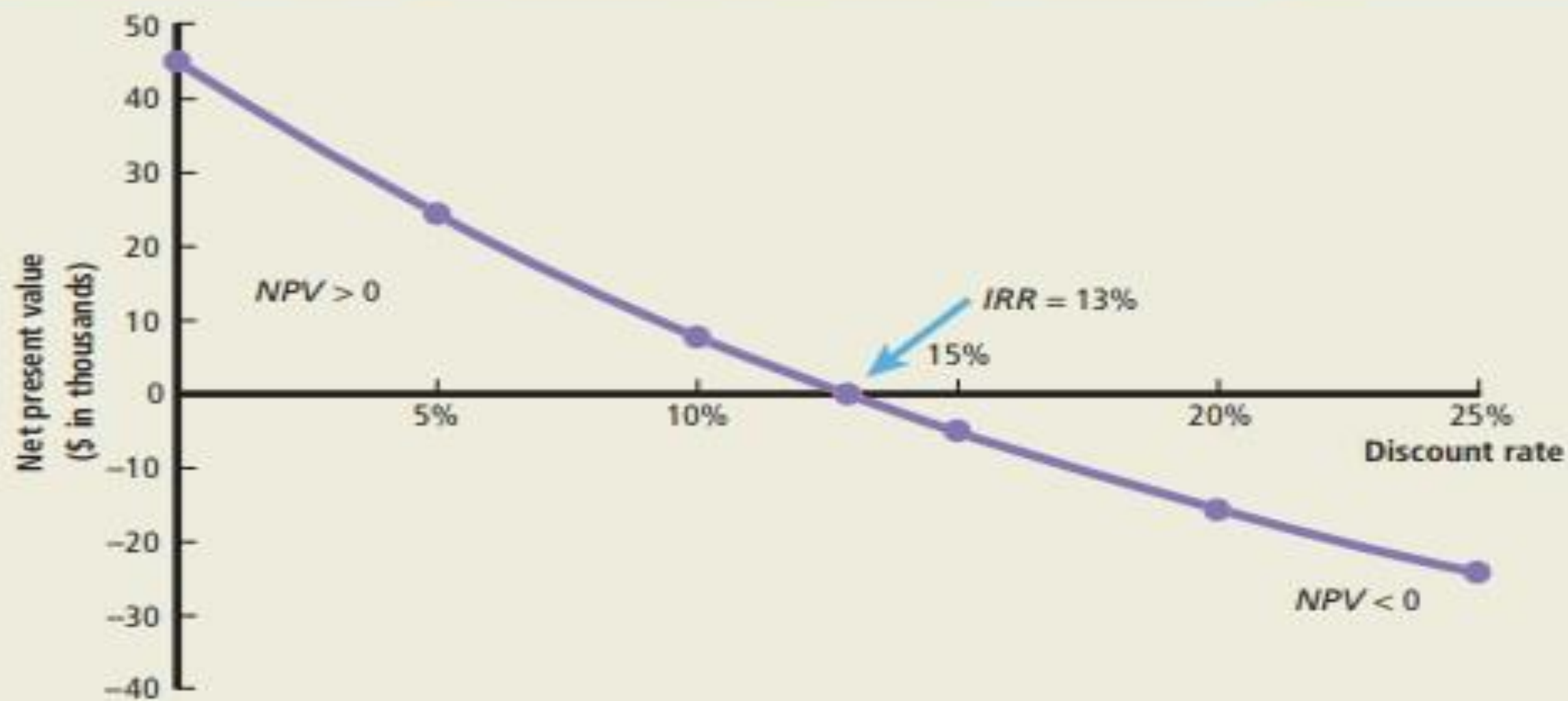
n = the project's expected life

IRR = the project's internal rate of return

Viewing the NPV–IRR Relationship:

- The Net Present Value Profile Perhaps the easiest way to understand the relationship between the IRR and the NPV value is to view it graphically through the use of a net present value profile.
- A net present value profile is simply a graph showing how a project's NPV changes as the discount rate changes.
- To graph a project's net present value profile, you simply need to determine the project's NPV, first using a 0 percent discount rate, then slowly increasing the discount rate until a representative curve has been plotted. How does the IRR enter into the net present value profile? The IRR is the discount rate at which the NPV is zero.
- Let's look at an example of a project that involves an after-tax initial outlay of \$105,517 with free cash flows expected to be \$30,000 per year over the project's 5-year life.

FIGURE 10-1 An Example of the Net Present Value Profile of a Project



Formula

$$\text{Internal Rate of Return} = R1 + \frac{NPV1 \times (R2 - R1)}{(NPV1 - NPV2)}$$

Where:

$R1$ = Lower discount rate

$R2$ = Higher discount rate

$NPV1$ = Higher Net Present Value
(derived from $R1$)

$NPV2$ = Lower Net Present Value
(derived from $R2$)

Viewing the NPV–IRR Relationship:

Example

YEAR	CASH FLOW
0	-50,000
1	15,000
2	8,000
3	10,000
4	12,000
5	14,000
6	16,000

R1= 5 %, NPV1 (Positive NPV)

Year	Cash Flow	Discount Factor @ 5%	DCF
0	-50,000	1	-50000
1	15,000	0.952380952	14286
2	8,000	0.907029478	7256
3	10,000	0.863837599	8638
4	12,000	0.822702475	9872
5	14,000	0.783526166	10969
6	16,000	0.746215397	11939
R1	0.05	NPV 1	12962

R 2 = 20 % , NPV 2 (Negative NPV)

Year	Cash Flow	Discount Factor @ 20%	DCF
0	-50,000	1	-50000
1	15,000	0.8333333333	12500
2	8,000	0.6944444444	5556
3	10,000	0.578703704	5787
4	12,000	0.482253086	5787
5	14,000	0.401877572	5626
6	16,000	0.334897977	5358
R2	0.20	NPV 2	-9386

Formula

$$\text{Internal Rate of Return} = R1 + \frac{NPV1 \times (R2 - R1)}{(NPV1 - NPV2)}$$

Where:

R1 = Lower discount rate

R2 = Higher discount rate

NPV1 = Higher Net Present Value
(derived from R1)

NPV2 = Lower Net Present Value
(derived from R2)

IRR

0.137

13.7%

Note

- IRR manual calculation is an estimate not an accurate number.
- To obtain an exact IRR, you should use excel.



NPV @ IRR

Year	Cash Flow	Discount Factor @ 13.7%	DCF
0	-50,000	1	-50000
1	15,000	0.879507476	13193
2	8,000	0.7735334	6188
3	10,000	0.680328408	6803
4	12,000	0.598353921	7180
5	14,000	0.526256747	7368
6	16,000	0.462846743	7406
R	13.70%	NPV	-1862

Not zero

IRR Excel Function

B7		:	=IRR(B2:B5)
	A		B
1	Period		Cash flow
2	Initial investment		-\$1,000
3	Month 1		\$300
4	Month 2		\$400
5	Month 3		\$500
6			
7	IRR		8.90%

IRR using Excel
is 12.383%

Year	Cash Flow	Discount Factor @ 12.383%	DCF
0	-50,000	1	-50000
1	15,000	0.889810406	13347
2	8,000	0.791762559	6334
3	10,000	0.704518564	7045
4	12,000	0.62688795	7523
5	14,000	0.557811421	7809
6	16,000	0.496346407	7942
R	13.70%	NPV	0

Summary

Capital Budgeting In Practice

- We should consider several investment criteria when making decisions
- NPV and IRR are the most commonly used primary investment criteria
- Payback is a commonly used secondary investment criteria

Summary – DCF Criteria

- Net present value
 - Difference between market value and cost
 - Take the project if the NPV is positive
 - Has no serious problems
 - Preferred decision criterion
- Internal rate of return
 - Discount rate that makes $NPV = 0$
 - Take the project if the IRR is greater than the required return
 - Same decision as NPV with conventional cash flows
 - IRR is unreliable with nonconventional cash flows or mutually exclusive projects
- Profitability Index
 - Benefit-cost ratio
 - Take investment if $PI > 1$
 - Cannot be used to rank mutually exclusive projects
 - May be used to rank projects in the presence of capital rationing

Summary – Payback Criteria

- Payback period
 - Length of time until initial investment is recovered
 - Take the project if it pays back within some specified period
 - Doesn't account for time value of money, and there is an arbitrary cutoff period
- Discounted payback period
 - Length of time until initial investment is recovered on a discounted basis
 - Take the project if it pays back in some specified period
 - There is an arbitrary cutoff period

Concept Check

Case Study

	Accounting book	Economics book
	Annual cash flows	Annual cash flows
Investment at time 0	(450)	(600)
Net cash inflows year 1	160	240
Net cash inflows year 2	160	200
Net cash inflows year 3	160	160
Net cash inflows year 4	100	105
Net cash inflows year 5	100	105
Net cash inflows year 6	50	100

Payback

	Accounting book		Economics book	
	Annual	Cumulative	Annual	Cumulative
	cash flows		cash flows	
	£000	£000	£000	£000
Investment at time 0	(450)	(450)	(600)	(600)
Net cash inflows year 1	160	(290)	240	(360)
Net cash inflows year 2	160	(130)	200	(160)
Net cash inflows year 3	160	30	160	0
Net cash inflows year 4	100	130	105	105
Net cash inflows year 5	100	230	105	210
Year 5 sale of assets	50	280	100	310

Accounting book payback period: 2 years + $(130 \div 160) \times 12$ months = 2 years and 10 months

Economics book payback period: 3 years exactly

Payback: considerations



The Accounting book is clearly preferable on the payback method of investment appraisal, although the Economics book pays back only two months later.



The Economics book does have net cash inflows of £30,000 more than the Accounting book, although these net cash inflows do rely heavily on the sale of the assets for £100,000 at the end of year 5.



Without this final inflow of cash from the sale of the assets, the net cash inflows of the Accounting book would be £230,000 (£280,000 – £50,000 cash from sale of the assets) compared with £210,000 (£310,000 – £100,000 cash from sale of the assets) for the Economics book.

Net present value

NPV for the Accounting book

	Cash flow £000	10% Discount factor	NPV £000
Investment at time 0	(450)	1.0000	(450.00)
Net cash inflows year 1	160	0.9091	145.46
Net cash inflows year 2	160	0.8264	132.22
Net cash inflows year 3	160	0.7513	120.21
Net cash inflows year 4	100	0.6830	68.30
Net cash inflows year 5	100	0.6209	62.09
End of year 5 sale of assets	50	0.6209	31.05
		Project NPV	<u><u>109.33</u></u>

NPV for the Economics book

	Cash flow £000	10% Discount factor	NPV £000
Investment at time 0	(600)	1.0000	(600.00)
Net cash inflows year 1	240	0.9091	218.18
Net cash inflows year 2	200	0.8264	165.28
Net cash inflows year 3	160	0.7513	120.21
Net cash inflows year 4	105	0.6830	71.72
Net cash inflows year 5	105	0.6209	65.19
End of year 5 sale of assets	100	0.6209	62.09
		Project NPV	<u><u>102.67</u></u>

Net present value: considerations



The Accounting book has the higher net present value, so this book should be accepted instead of the Economics book.



The Accounting book breaks even on a net present value basis towards the end of year 4.



The Economics book breaks even on a net present value basis only at the end of year 5.

NPV for the Accounting book discounted at 20 per cent

	Cash flow £000	20% Discount factor	NPV £000
Investment at time 0	(450)	1.0000	(450.00)
Net cash inflows year 1	160	0.8333	133.33
Net cash inflows year 2	160	0.6944	111.10
Net cash inflows year 3	160	0.5787	92.59
Net cash inflows year 4	100	0.4823	48.23
Net cash inflows year 5	100	0.4019	40.19
End of year 5 sale of assets	50	0.4019	20.10
		Project NPV	<u><u>(4.46)</u></u>

Internal rate of return: Accounting book

$$10\% + \frac{109.33}{(109.33 + 4.46)} \times (20\% - 10\%) = 19.61\%$$

NPV for the Economics book discounted at 20 per cent

	Cash flow £000	20% Discount factor	NPV £000
Investment at time 0	(600)	1.0000	(600.00)
Net cash inflows year 1	240	0.8333	199.99
Net cash inflows year 2	200	0.6944	138.88
Net cash inflows year 3	160	0.5787	92.59
Net cash inflows year 4	105	0.4823	50.64
Net cash inflows year 5	105	0.4019	42.20
End of year 5 sale of assets	100	0.4019	40.19
		Project NPV	<u><u>(35.51)</u></u>

Internal rate of return: Economics book

$$10\% + \frac{102.67}{(102.67 + 35.51)} \times (20\% - 10\%) = 17.43\%$$

Internal rate of return: considerations



The Accounting book has the higher internal rate of return.



This internal rate of return is higher than publisher's cost of capital (10 per cent), so the project should be accepted.



The decision under IRR is consistent with the decision under the net present value appraisal method, which is to choose the Accounting book as this project has the higher net present value of the two books.

Case Study 2



Swanson Industries has a project with an initial cost of \$52,125. As a result of this project, cash flow will generate \$12,000/year for the next 8 years.



The company has a cost of capital of 12%.



Given the discount rates and the future cash flows of this project, should the company accept the project?

Payback Method (PB)

- computes the amount of time required to recoup the initial investment
- a cutoff period is established

Advantages:

- easy to use (“quick and dirty” approach)
- emphasizes liquidity

Disadvantages:

- ignores inflows after the cutoff period and fails to consider the time value of money
- is inferior to the other 2 methods

<u>Period</u>	<u>Annual Cash Flows</u>	<u>Discounted @ 12% Cash Flows</u>	<u>Cumulative Cash Flows</u>
0	\$ (52,125)	\$ (52,125.00)	\$ (52,125.00)
1	\$ 12,000	\$ 10,714.29	\$ (41,410.71)
2	\$ 12,000	\$ 9,566.33	\$ (31,844.38)
3	\$ 12,000	\$ 8,541.36	\$ (23,303.02)
4	\$ 12,000	\$ 7,626.22	\$ (15,676.80)
5	\$ 12,000	\$ 6,809.12	\$ (8,867.68)
6	\$ 12,000	\$ 6,079.57	\$ (2,788.11)
7	\$ 12,000	\$ 5,428.19	\$ 2,640.08
8	\$ 12,000	\$ 4,846.60	\$ 7,486.68

Discounted Pay 6 years plus
2788.11/5428.19 0.51 or 6 months

NPV

- the present value of the cash inflows minus the present value of the cash outflows
- the cash inflows are discounted back over the life of the investment
- the basic discount rate is usually the firm's cost of capital (WACC)

<u>Period</u>	<u>Annual Cash Flows</u>	<u>Discounted @ 12% Cash Flows</u>	<u>Cumulative Cash Flows</u>
0	\$ (52,125)	\$ (52,125.00)	\$ (52,125.00)
1	\$ 12,000	\$ 10,714.29	\$ (41,410.71)
2	\$ 12,000	\$ 9,566.33	\$ (31,844.38)
3	\$ 12,000	\$ 8,541.36	\$ (23,303.02)
4	\$ 12,000	\$ 7,626.22	\$ (15,676.80)
5	\$ 12,000	\$ 6,809.12	\$ (8,867.68)
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7	\$ 12,000	\$ 5,428.19	\$ 2,640.08
8	\$ 12,000	\$ 4,846.60	\$ 7,486.68
NPV		\$ 7,486.68	

Profitability Index

- The profitability index (PI), or benefit–cost ratio, is the ratio of the present value of the future free cash flows to the initial outlay.

<u>Period</u>	<u>Annual Cash Flows</u>	<u>Discounted @ 12% Cash Flows</u>	<u>Cumulative Cash Flows</u>
0	\$ (52,125)	\$ (52,125.00)	\$ (52,125.00)
1	\$ 12,000	\$ 10,714.29	\$ (41,410.71)
2	\$ 12,000	\$ 9,566.33	\$ (31,844.38)
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6	\$ 12,000	\$ 6,079.57	\$ (2,788.11)
7	\$ 12,000	\$ 5,428.19	\$ 2,640.08
8	\$ 12,000	\$ 4,846.60	\$ 7,486.68
	PI	\$ 1.05	

- represents a yield on an investment or an interest rate
- requires calculating the interest rate that equates the cash outflows (cost) with the cash inflows
- is the interest rate where the cash outflows equal the cash inflows (or NPV = 0)

Where:

R1 = Lower discount rate

R2 = Higher discount rate

NPV1 = Higher Net Present Value (derived from R1)

NPV2 = Lower Net Present Value (derived from R2)

IRR = $12\% + ((7487) * (20\% - 12\%) / (7487 - (-6079)))$
= 16%

Internal Rate of Return = R1 +	NPV1 x (R2 - R1)
	(NPV1 - NPV2)

Period	Annual Cash Flows	Discounted @ 12% Cash Flows	Discounted @ 20% Cash Flows
0	\$ (52,125)	\$ (52,125)	\$ (52,125)
1	\$ 12,000	\$ 10,714	10000
2	\$ 12,000	\$ 9,566	8333.3333
3	\$ 12,000	\$ 8,541	6944.4444
4	\$ 12,000	\$ 7,626	5787.037
5	\$ 12,000	\$ 6,809	4822.5309
6	\$ 12,000	\$ 6,080	4018.7757
7	\$ 12,000	\$ 5,428	3348.9798
8	\$ 12,000	\$ 4,847	2790.8165
Net Present Value=		\$ 7,487	\$ (6,079)

Thank You

