Module 7

ALTERNATIVES TO THE NPV RULE

Background

- Module examines four alternatives to the NPV method
  - Ordinary payback period
  - Discounted payback period
  - Internal rate of return
  - Profitability index
- After reading this Module, you should understand
  - The four alternatives to NPV method and how to calculate them
  - How to apply the alternative rules to screen investment proposals
  - Major shortcomings of the alternative rules
  - Why these rules are still used even though they are not as reliable to the NPV rule

Projects Examined

- Six different investment projects are utilized to illustrate how these rules are applied
  - Each alternative is evaluated as to whether it satisfies the conditions of a good investment decision
    - Does it adjust for the timing of the cash flows?
    - Does it take risk into consideration?
    - Does it maximize the firm's equity value?
- The projects on the following slides are evaluated using the four alternatives

EXHIBIT 7.1a:
Expected Cash-Flow Streams and the Cost of Capital in Alternative Investment Proposals.

All investments are five years long and require an initial cash outlay of $1 million

INVESTMENTS A AND B

END OF YEAR	INVESTMENT A	INVESTMENT B
1	$600,000	$100,000
2	300,000	300,000
3	100,000	600,000
4	200,000	200,000
5	300,000	300,000
Total Cash Flows	$1,500,000	$1,500,000
Cost of Capital	10%	10%
NPV	$191,399	$112,511

EXHIBIT 7.1b:
Expected Cash-Flow Streams and the Cost of Capital in Alternative Investment Proposals.

All investments are five years long and require an initial cash outlay of $1 million

INVESTMENTS C AND D

END OF YEAR	INVESTMENT C	INVESTMENT D
1	$250,000	$250,000
2	250,000	250,000
3	250,000	250,000
4	250,000	250,000
5	250,000	250,000
Total Cash Flows	$1,250,000	$1,250,000
Cost of Capital	5%	10%
NPV	$82,369	–$52,303

EXHIBIT 7.1c:
Expected Cash-Flow Streams and the Cost of Capital in Alternative Investment Proposals.

All investments are five years long and require an initial cash outlay of $1 million

INVESTMENTS E AND F

END OF YEAR	INVESTMENT E	INVESTMENT F
1	$325,000	$ 325,000
2	325,000	325,000
3	325,000	325,000
4	325,000	325,000
5	325,000	975,000
Total Cash Flows	$1,625,000	$2,275,000
Cost of Capital	10%	10%
NPV	$232,006	$635,605

The Payback Period

- A project's payback period is the number of periods required for the sum of the project's cash flows to equal its initial cash outlay
  - Usually measured in years

EXHIBIT 7.2:
Expected and Cumulative Cash Flows for Investment A.

Expected cash flows from Exhibit 7.1

END OF YEAR	EXPECTED CASH FLOWS	CUMULATIVE CASH FLOWS
1	$600,000	$ 600,000
2	300,000	900,000
3	100,000	1,000,000
4	200,000	1,200,000
5	300,000	1,500, 000

A's cash outlay was $1,000,000. This amount is fully recovered at the end of year 3.

EXHIBIT 7.3:
Payback Periods for Six Investments in Exhibit 7.1.

INVESTMENT	A	B	C	D	E	F
Payback period (in years)	3.00	3.00	4.00	4.00	3.08	3.08

The Payback Period Rule

- According to this rule, a project is acceptable if its payback period is shorter than or equal to the cutoff period
  - For mutually exclusive projects, the one with the shortest payback period should be accepted

The Payback Period Rule

- Does the payback period rule meet the conditions of a good investment decision?
  - **Adjustment for the timing of cash flows?**
    - Ignores the time value of money
      - Both Investments A and B require the same initial cash outlay, have the same useful life, and carry the same risk
        - Timing differs but their payback periods are the same
  - **Adjustment for risk?**
    - Ignores risk
      - Both Investments C and D are five-year projects and have the same initial cash outlay and expected annual cash flows
        - Even though D is riskier than C their payback periods are the same

The Payback Period Rule

- **Maximization of the firm's equity value?**
  - No objective reason to believe that there exists a particular cutoff period that is consistent with the maximization of the market value of the firm's equity
  - The choice of a cutoff period is always *arbitrary*
  - The rule is biased against long-term projects
    - Both E and F have the same payback period (3.08 years)
      - F is preferable to E because, at the end of year 5, F is expected to generate a cash inflow that is three times larger than the one generated by E

Why Do Managers Use The Payback Period Rule?

- Payback period rule is used by many managers
  - Often in addition to other approaches
- Redeeming qualities of this rule
  - Simple and easy to apply for small, repetitive investments
  - Favors projects that “pay back quickly”
    - Thus, contribute to the firm’s overall liquidity
      - Can be particularly important for small firms
  - Makes sense to apply the payback period rule to two investments that have the same NPV
    - See **Exhibit 7.4**, which compares two such investments
  - Because it favors short-term investments, the rule is often employed when future events are difficult to quantify
    - Such as for projects subject to political risk

EXHIBIT 7.4:
Comparison of Two Investments with the Same NPV and Different Payback Periods.

END OF YEAR	INVESTMENT A	INVESTMENT G
Now	–$1,000,000	–$1,000,000
1	600,000	200,000
2	300,000	200,000
3	100,000	300,000
4	200,000	300,000
5	300,000	666,740
NPV (AT 10%)	$191,399	$191,399
PAYBACK PERIOD	3 YEARS	4 YEARS

The Discounted Payback Period

- The **discounted payback period,** or **economic payback period**
  - Number of periods required for the sum of the *present values* of the project's expected cash flows to equal its initial cash outlay
    - Compared to ordinary payback periods
      - Discounted payback periods are longer
        - May result in a different project ranking

EXHIBIT 7.5:
Discounted Payback Period Calculations for Investment A.

Expected Cash Flows from Exhibit 7.1

END OF YEAR	EXPECTED CASH FLOWS	DISCOUNT FACTOR AT 10%	PRESENT VALUE	CUMULATIVE PRESENT VALUE OF CASH FLOWS
1	$600,000	0.9091	$545,455	$545,455
2	300,000	0.8264	247,934	793,389
3	100,000	0.7513	75,131	868,520
4	200,000	0.6830	136,603	1,005,123
5	300,000	0.6209	186,276	1,191,399

EXHIBIT 7.6:
Discounted Payback Periods for Six Investments in Exhibit 7.1.

INVESTMENT	A	B	C	D	E	F
Discounted payback period (in years)	3.96	4.40	4.58	> 5	3.86	3.86

The Discounted Payback Period Rule

- The discounted payback period rule says that a project is acceptable
  - If discounted payback period is shorter or equal to the cutoff period
- Among several projects, the one with the shortest period should be accepted

The Discounted Payback Period Rule

- Does the discounted payback period rule meet the conditions of a good investment decision?
  - **Adjustment for the timing of cash flows?**
    - The rule considers the time value of money
      - Both Investments A and B differ in terms of the timing of the cash flows
        - Their discounted payback periods are different (3.96 years vs. 4.40 years).
  - **Adjustment for risk?**
    - The rule considers risk
      - Both Investments C and D have identical cash flow streams
        - D is riskier than C and the discounted payback periods are different

The Discounted Payback Period Rule

- **Maximization of the firm's equity value?**
  - If a project's discounted payback period is shorter than the cutoff period
    - Project's NPV when estimated with cash flows up to the cutoff period is always positive
  - The rule is biased against long-term projects
    - Consider projects E and F that both have the same discounted payback period (3.86 years)
      - The discounted payback period rule cannot discriminate between the two investments
      - It ignores the fifth year's cash flow, which is three times larger for F than for E

The Discounted Payback Period Rule Versus The Ordinary Payback Period Rule

- The discounted payback period rule is superior to the ordinary payback period rule
  - Considers the time value of money
  - Considers the risk of the investment's expected cash flows
- However, the discounted payback period rule is more difficult to apply
  - Requires the same inputs as the NPV rule
  - Used less than the ordinary payback period rule

The Internal Rate Of Return (IRR)

- A project's **internal rate of return** (**IRR**) is the discount rate that makes the net present value (NPV) of the project equal to zero
  - The IRRs of the six projects being considered are presented in **Exhibit 7.7**
- An investment's IRR summarizes its expected cash flow stream with a single rate of return that is called *internal*
  - Because it only considers the expected cash flows related to the investment
    - Does not depend on rates that can be earned on alternative investments

EXHIBIT 7.7:
IRR for Six Investments in Exhibit 7.1.

INVESTMENT	A	B	C	D	E	F
IRR	19.05%	13.92%	7.93%	7.93%	18.72%	28.52%

The IRR Rule

- A project should be accepted if its IRR is higher than its cost of capital and rejected if it is lower
  - If a project's IRR is lower than its cost of capital, the project does not earn its cost of capital and should be rejected
- Does the IRR rule meet the conditions of a good investment decision?
  - **Adjustment for the timing of cash flows?**
    - Considers the time value of money
      - Consider investments A and B
        - A is preferable to B because its largest cash flow occurs earlier
        - IRR rule indicates the same preference because the IRR of A (19.05 percent) is higher than the IRR of B (13.92 percent)

The IRR Rule

- **Adjustment for risk?**
  - The rule takes risk into consideration
    - Consider investments C and D which have the same expected cash-flow stream, but D is riskier than C
      - Both have the same IRR (7.93 percent)
      - The IRR rule takes the risk of the two investments into consideration *indirectly* by comparing the investment's IRR with its cost of capital
      - The IRR of C (7.93 percent) is greater than its cost of capital (5 percent)--should be accepted
      - Investment D should be rejected because its IRR (7.93 percent) is lower than its cost of capital (10 percent)
      - The risk of an investment does not enter into the *computation* of its IRR, but the IRR *rule* does consider the risk of the investment because it compares the project's IRR with the minimum required rate of return--a measure of the risk of the investment

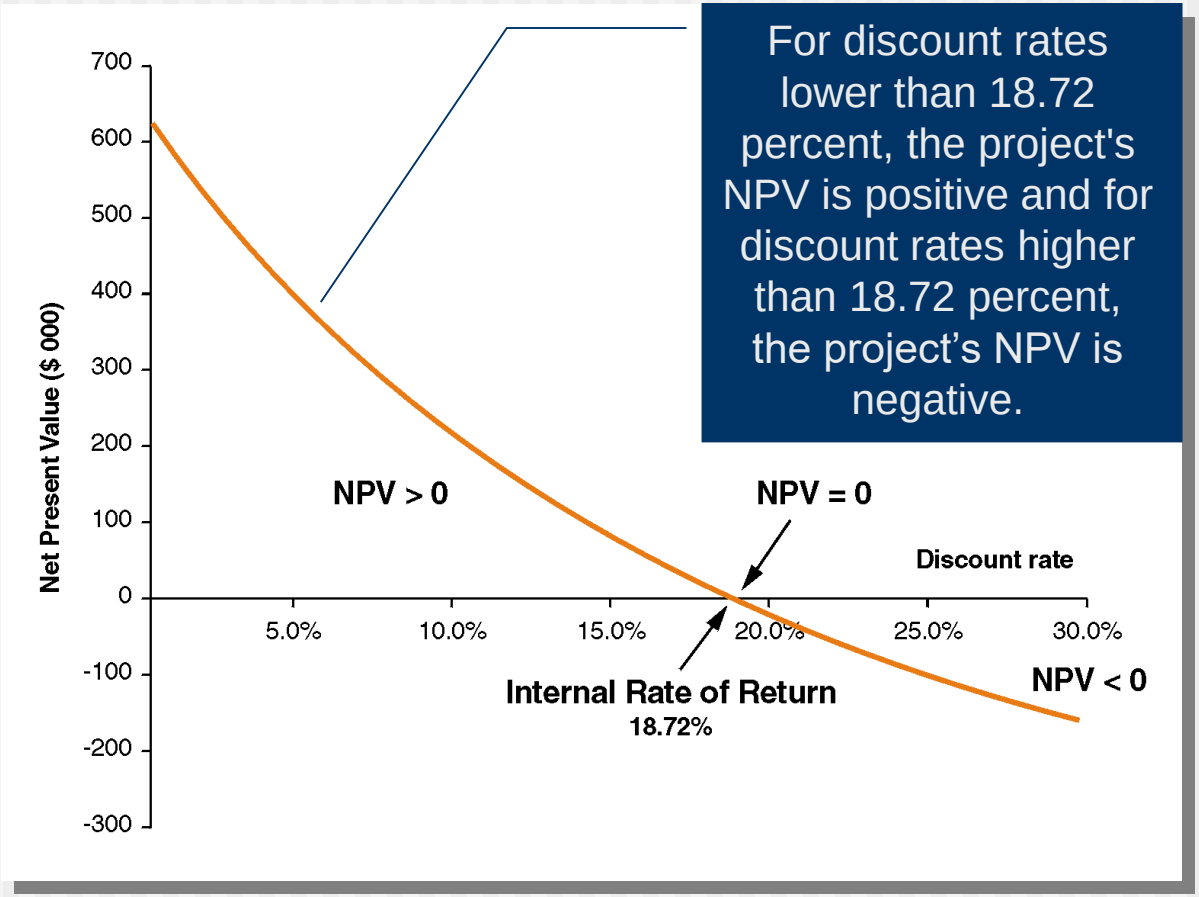
The IRR Rule

- **Maximization of the firm's equity value?**
  - Exhibit 7.8 provides investment E's NPV for various discount rates.
    - It shows, as does the graph (**NPV profile)** in Exhibit 7.9, an *inverse* relationship between NPV and the discount rate.

EXHIBIT 7.8:
Net Present Value of Investment E for Various Discount Rates.

DISCOUNT RATE	0%	5%	10%	15%	20%	25%	30%
NPV(E)	$625,000	$407,080	$232,006	$89,450	–$28,051	–$125,984	–$208,440

EXHIBIT 7.9:
The NPV Profile of Investment E.



- According to the IRR rule, E should be accepted if its cost of capital is lower than its IRR of 18.72 percent and rejected if its cost of capital is higher.
- When the NPV is positive, the IRR is higher than the cost of capital and when it is negative, the IRR is lower than the cost of capital.

The IRR Rule May Be Unreliable

- The IRR rule may lead to an *incorrect* investment decision when
  - Two mutually exclusive projects are considered
  - A project's cash flow stream changes sign more than once

EXHIBIT 7.10:
Comparison of Two Mutually Exclusive Investments with Different Expected Cash Flows and IRR.

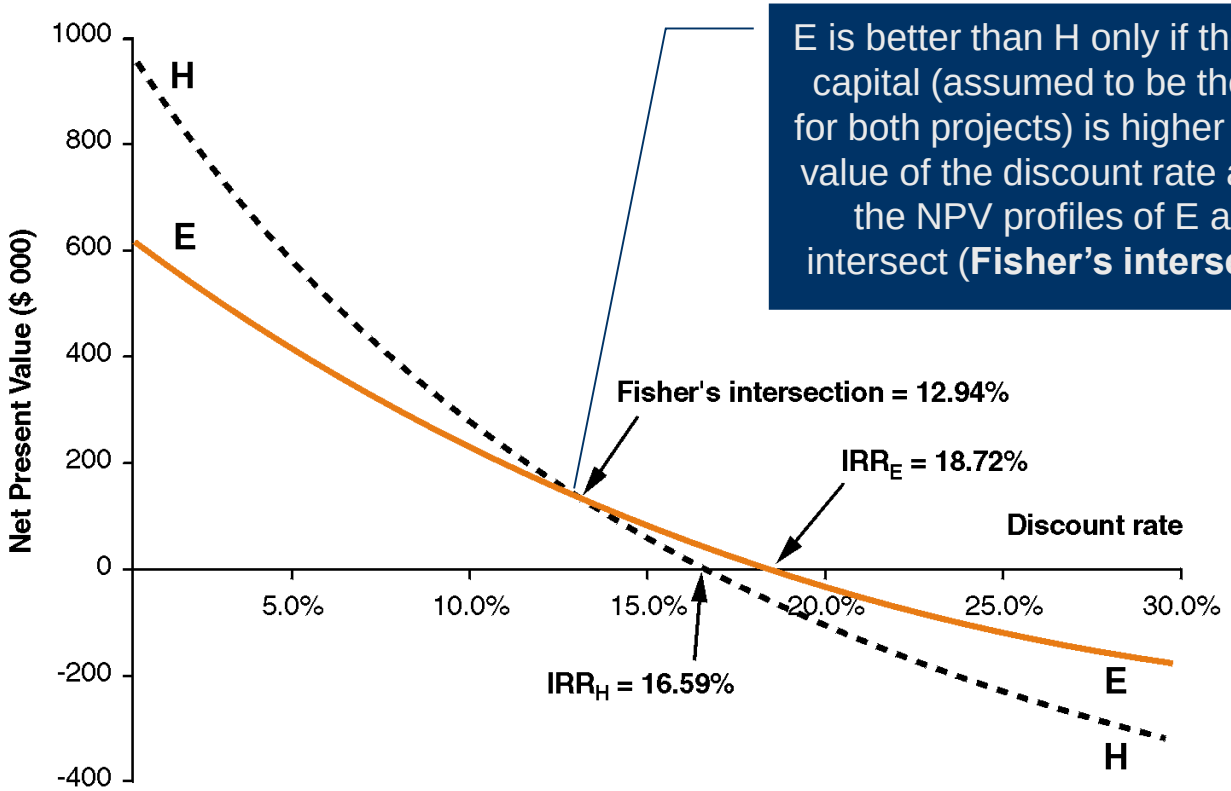
Useful life = 5 years; $1 million initial cash outlay; *k* = 0.10.

INVESTMENTS E AND F

END OF YEAR	INVESTMENT E	INVESTMENT H
1	$325,000	$100,000
2	325,000	100,000
3	325,000	100,000
4	325,000	150,000
5	325,000	1,500, 000
IRR	18.72%	16.59%

Exhibit 7.10 compares investments E and H as two mutually exclusive projects.

EXHIBIT 7.11:
The NPV Profiles of Investments E and H.



E is better than H only if the cost of capital (assumed to be the same for both projects) is higher than the value of the discount rate at which the NPV profiles of E and H intersect (**Fisher's intersection).**

If the cost of capital is lower than the discount rate at the Fisher's intersection, choosing the project with the highest IRR means selecting the project which contributes the least to the firm's equity value.

Investments With Some Negative Future Cash Flows

- Negative cash flows can occur when an investment requires the construction of several facilities that are built at different times
- When negative cash flows occur a project may have multiple IRRs or none at all
  - Firm should ignore the IRR rule and use the NPV rule instead

EXHIBIT 7.12:
Expected Cash Flows, IRR, and NPV of a Project with Negative Cash Flows and *k* = 0.20.

END OF YEAR	CASH FLOW
Now	–$1,000,000
1	+$2,450,000
2	–$1,470,000
IRR	5% and 40%
NPV (at 20%)	+$20,833

Exhibit 7.12 presents the case of an investment that includes negative cash flows.

Why Do Managers Usually Prefer The IRR Rule To The NPV Rule?

- IRR *calculation* requires only a single input (the cash flow stream)
  - However, applying the IRR *rule* still requires a second input—the cost of capital
    - When a project's cost of capital is uncertain, the IRR method may be the answer
- Most managers find the IRR easier to understand
  - Managers usually have a good understanding of what an investment should "return"
- Authors' advice: Compute both a project's IRR and NPV
  - If they agree, use the IRR
  - If they disagree, trust the NPV rule

The Profitability Index (PI)

- The profitability index
  - Benefit-to-cost ratio equal to the ratio of the present value of a project's expected cash flows to its initial cash outlay

EXHIBIT 7.13:
Profitability Indexes for Six Investments in Exhibit 7.1.

INVESTMENT	A	B	C	D	E	F
Profitability index	1.19	1.11	1.08	0.95	1.23	1.64

The Profitability Index Rule

- According to the PI rule a project should be accepted if its profitability index is greater than one and rejected if it is less than one
  - Does the PI rule meet the conditions of a good investment decision?
    - **Adjustment for the timing of cash flows?**
      - Takes into account the time value of money
        - Project's expected cash flows are discounted at their cost of capital
        - Consider projects A and B--PI rule favours project A over project B (as does the NPV and IRR rules)—the only difference between these two projects is the timing of their respective expected cash flows

The Profitability Index Rule

- **Adjustment for risk?**
  - The PI rule considers risk because it uses the cost of capital as the discount rate
  - Consider projects C and D
    - Like the NPV and IRR rules, the profitability index rule chooses investment C over investment D
      - D is the riskier of the two investments

The Profitability Index Rule

- **Maximization of the firm's equity value?**
  - When a project's PI > 1 the project's NPV > 0 and vice-versa
    - Thus, it may appear that PI is a substitute for the NPV rule
      - Unfortunately, the PI rule may lead to a faulty decision when applied to mutually exclusive investments with different initial cash outlays
      - Consider investments A and K in **Exhibit 7.14**

EXHIBIT 7.14:
Comparison of Two Mutually Exclusive Investments with Different Initial Cash Outlays and Expected Cash Flows.

END OF YEAR	INVESTMENT A	INVESTMENT K
Now	–$1,000,000	–$2,000,000
1	600,000	100,000
2	300,000	300,000
3	100,000	600,000
4	200,000	200,000
5	300,000	2,100,000
NPV (at 10%)	$191,399	$230,169
Profitability Index	1.19	1.12

K has the same useful life (5 years) and the same cost of capital (10 percent) as A, but requires twice the initial cash outlay and has a different cash-flow stream.

A has a higher profitability index than K--thus, the PI rule is not consistent with the firm's value maximization goal

Use Of The Profitability Index Rule

- The PI is a *relative* measure of an investment's value
  - NPV is an *absolute* measure
- Thus, the PI rule can be a useful substitute for the NPV rule when presenting a project's benefits *per dollar* of investment