Capital Budgeting

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Capital Budgeting Agenda

- **Define** the capital budgeting process, **explain** the administrative steps of the process and **categorize** the capital projects which can be evaluated
- **Summarize** and **explain** the principles of capital budgeting, including the choice of the proper cash flows and the identification of the proper discount rate.
- **Explain** the implications of:
  - (1) independent versus mutually exclusive projects,
  - (2) project sequencing, and
  - (3) unlimited funds versus capital rationing

- **Explore widely used capital budgeting techniques such as**
  - Net Present Value (NPV),
  - Internal Rate of Return (IRR),
  - Payback Period,
  - Discounted Payback Period,
  - Average Accounting Rate of Return (AAR), and
  - Profitability Index (PI)
- **Explain** the NPV profile, **compare** and **contrast** the NPV and IRR methods when evaluating more than one capital project, and describe the multiple IRR problem and no-IRR problems that can arise when calculating an IRR.

- **Describe** the relative popularity of the various capital budgeting methods and **explain** the importance of the NPV in estimating the value of a stock price.

Capital Budgeting Process

- Generating ideas—the most important part of the process.
- Analyzing individual proposals—including forecasting cash flows and evaluating the project.
- Planning the capital budget—this will take into account a firm's financial and real resource constraints; it will decide which projects fit into the firm's strategies.
- Monitoring and post-auditing—comparing actual results with predicted results and explaining the differences. This is very important; it helps improve the forecasting process and focuses attention on costs or revenues that are not meeting expectations.

Capital Budgeting Process

Proposal Generation → **Review & Analysis** → **Decision Making** → **Implementation and Follow-up**

Proposal Generation is the origination of proposed capital projects for the firm by individuals at various levels of the organization.

is the formal process of assessing the appropriateness and economic viability of the project in light of the firm's overall objectives. This is done by estimating cash flows arising from the project and evaluating them through capital budgeting techniques. Risk factors are also incorporated into the analysis phase.

Decision making is the step where the proposal is compared against predetermined criteria and either accepted or rejected.

Implementation of the project begins after the project has been accepted and funding is made available.
Follow-up is the post-implementation audit of expected and actual costs and revenues generated from the project to determine if the return on the proposal meets pre-implementation projections

Project Classifications

- **Replacement**, when the maintenance of business requires the replacement of equipment or when cost savings are possible if out-of-date equipment is replaced. These replacement decisions are often amenable to very detailed analysis, and you might have a lot of confidence in the final decision.
- **Expansion** of existing products or markets- expansion decisions may involve more uncertainties than replacement decisions, and they should be more carefully considered.
- **New products and services**- these decisions are more complex and will involve more people in the decision - making process.
- **Regulatory, safety and/or environmental** projects, in many cases these are mandatory projects.
- **Others-**pet projects or high risk projects such as major R&D efforts which may be difficult to analyze by using standard techniques

Basic Assumptions in Capital Budgeting

- Decisions are based on cash flows and not accounting profits. Intangibles are often ignored since it is assumed that the benefits or costs will eventually be reflected in cash flows.
- Timing of cash flows is critical.
- Cash flows incorporate opportunity costs. We use **incremental** cash flows; these are the total cash flows that occur as a direct result of taking on a specific project.
- Cash flows are on an after-tax basis; taxes should be incorporated in the analysis
- In the analysis we use cash flows that accrue to the project that is used to pay the capital providers to the project.
- Financing costs are ignored in the cash flows as they are accounted for in the weighted-average cost of capital being used to discount the cash flows.

Important Capital Budgeting Concepts

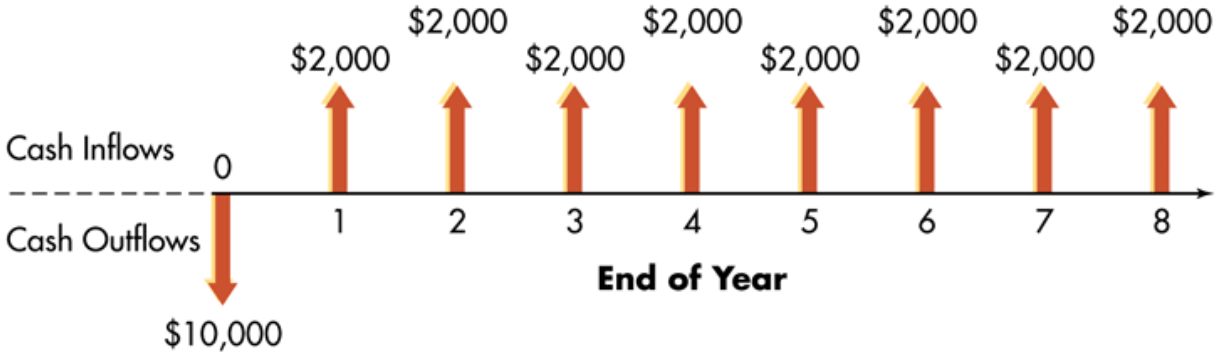
- **Sunk costs**
  - These refer to costs that have already been paid or been committed to, regardless of whether a project is taken on or not. For instance, consulting fees paid to prepare a report on the feasibility of a project is a sunk cost! These should **not** to be included as a cost.
- **Opportunity costs**
  - These refer to the cash flows that could be generated from an asset if it was not used in the project. For example, if a project is going to use premises that could be used for other purposes by the company. Opportunity costs should be taken into account in the cash flows used.
- **Externalities**
  - The impact of a project on other parts of a firm should be taken into account, whether positive or negative. This includes **cannibalization,** when sales of another side of the firm will be switched to the new area if a new project goes ahead.
- **Conventional versus nonconventional cash flows**
  - A conventional cash flow pattern is when you see negative cash flows for the first year (or longer) representing initial outlays, followed by a series of cash inflows. Unconventional cash flows occur when inflows change to outflows again, or vice versa, if this happens two or more times it is unconventional.

Incremental Cash Flow Concept and Replacement Decisions

Initial investment	=	Initial investment needed to acquire new asset	—	After-tax cash inflows from liquidation of old asset
Operating cash inflows	=	Operating cash inflows from new asset	—	Operating cash inflows from old asset
Terminal cash flow	=	After-tax cash flows from termination of new asset	—	After-tax cash flows from termination of old asset

Conventional & Non-Conventional Cash Flows

Conventional Cash Flows



Non-Conventional Cash Flows

Independent and Mutually Exclusive Projects

- **Independent projects** are projects whose cash flows are independent of each other. If projects meet the set criteria, they can be implemented provided that they are within the resource constraints of the firm.
- **Mutually exclusive projects** compete directly with each other. For example, if Projects A and B are mutually exclusive, you can choose A or B, but you cannot choose both.
- Sometimes there are several mutually exclusive projects, and you can choose only one from the group.

Project Sequencing

- Many projects are sequenced through time so that investing in a project creates the option to invest in future projects.
- For example, you might invest in a project today and then in one year invest in a second project if the financial results of the first project or new economic conditions are favorable.
- If the results of the first project or new economic conditions are not favorable, investment in the second project is avoided.

Capital Rationing

- If the firm has unlimited funds for making investments, then all independent projects that provide returns greater than some specified level can be accepted and implemented.
  - The **accept-reject approach** involves the evaluation of capital expenditure proposals to determine whether they meet the firm's minimum acceptance criteria.
- However, in most cases firms face **capital rationing** restrictions since they only have a given amount of funds to invest in potential investment projects at any given time.
  - The **ranking approach involves** the ranking of capital expenditures on the basis of some predetermined measure, such as the rate of return. The funds must be allocated to achieve the maximum shareholder value subject to the funding constraints.

Capital Budgeting Methods

- Net Present Value (NPV),
- Internal Rate of Return (IRR),
- Payback Period,
- Discounted Payback Period,
- Average Accounting Rate of Return (AAR), and
- Profitability Index (PI)

NPV Method

- For a simple project with one investment outlay, made initially, the net present value (NPV) is the present value of the future after - tax cash flows minus the investment outlay, or :

$$\text{NPV} = \sum_{t=1}^{n} \frac{\text{CF}_t}{(1+r)^t} - \text{Outlay}$$

CF_t = after-tax cash flow at time t

r = required rate of return for the investment

Outlay = investment cash flow at time 0

INVESTMENT RULE: Invest if NPV>0 //Do not invest if NPV<0

A more general model for NPV

- Many investments have cash flow patterns in which outflows may occur not only at time 0, but also at future dates. It is useful to consider the NPV to be the present value of all cash flows:

$$\text{NPV} = \text{CF}_0 + \frac{\text{CF}_1}{(1+r)^1} + \frac{\text{CF}_2}{(1+r)^2} + \ldots + \frac{\text{CF}_n}{(1+r)^n}$$

$$\text{NPV} = \sum_{t=0}^{n} \frac{\text{CF}_t}{(1+r)^t}$$

Characteristics of NPV

- NPV measures present value of a project's expected cash-flow stream at its cost of capital.
  - PV of cash flows essentially estimate how much the project would sell for if a market existed for it
- NPV of an investment project represents the immediate change in the wealth of the firm's owners if the project is accepted
  - If positive, the project creates value for the firm's owners; if negative, it destroys value
- The NPV rule takes into consideration the timing of the expected future cash flows. The method attributes higher value to earlier cash flows.

Timing Matters : Projects with Equal Total Cash Inflows

- Assume that both projects require $1m cash outflow at time T=0. Do projects A and B worth the same?

Year	Project A	Project-B
0	(1,000,000)	(1,000,000)
1	800,000	100,000
2	600,000	200,000
3	400,000	400,000
4	200,000	600,000
5	100,000	800,000
Total Cash Inflows	2,100,000	2,100,000

Mutually Exclusive Projects with Equal Total Cash Inflows

Year	Project A	Project-B
0	(1,000,000)	(1,000,000)
1	800,000	100,000
2	600,000	200,000
3	400,000	400,000
4	200,000	600,000
5	100,000	800,000
Total Cash Inflows	2,100,000	2,100,000
Cost of Capital	10%	10%
Project NPV	**$722,361.24**	**$463,269.40**

Both project A and B generate total cash inflows of $2.1m and cost $1m. However, project A generates larger inflows at the early stages of project as compared project B. NPV method favors project A over project B.

NPV ignores embedded options in the project

- A project that can adjust easily and at a low cost to significant changes such as:
  - Marketability of the product
  - Selling price
  - Risk of obsolescence
  - Manufacturing technology
  - Economic, regulatory, and tax environments
- Flexibility is likely to contribute more to the firm value, but NPV method does not account for managerial options that can be exercised during the useful life of the project. In other words, NPV underestimates the value of projects with significant flexibility options.

Internal Rate of Return

- The internal rate of return (IRR) is one of the most frequently used techniques in capital budgeting and in security analysis. The IRR is the rate of return that makes the present value of the future after - tax cash flows equal to investment outlay.
- In other words, the IRR is the solution to the following equation:

$$\sum_{t=1}^{n} \frac{CF_t}{(1 + IRR)^t} = \text{Outlay}$$

IRR for Projects A and B

Year	Project A	Project-B
0	(1,000,000)	(1,000,000)
1	800,000	100,000
2	600,000	200,000
3	400,000	400,000
4	200,000	600,000
5	100,000	800,000

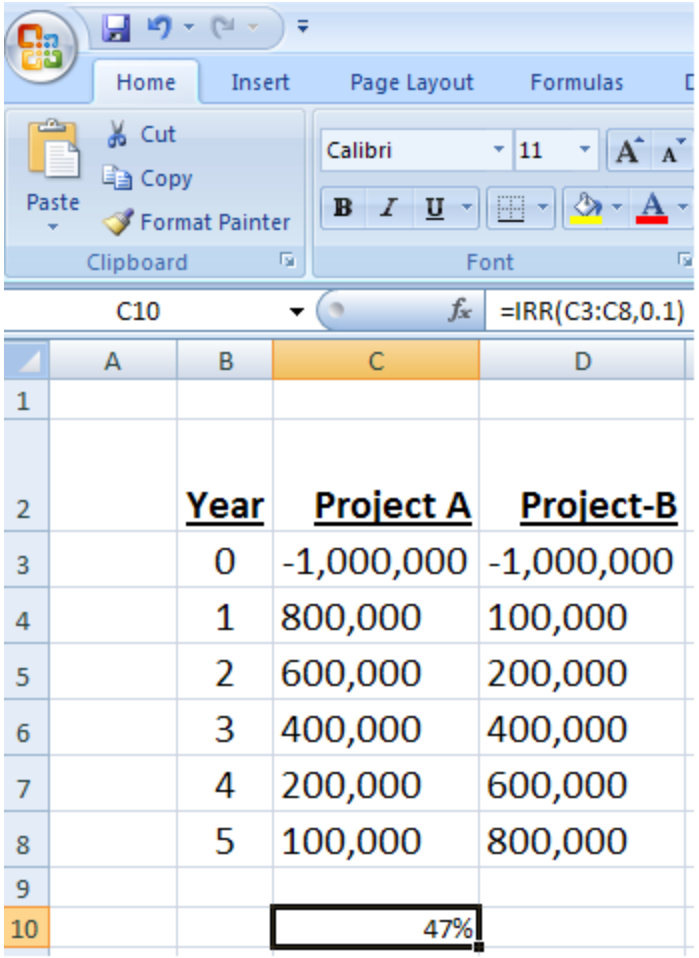
IRR for project A will be the rate of return that satisfies the following equation:.

$$-1,000,000+\frac{800,000}{(1+IRR)}+\frac{600,000}{(1+IRR)^2}+\frac{400,000}{(1+IRR)^3}+\frac{200,000}{(1+IRR)^4}+\frac{100,000}{(1+IRR)^5}=0$$

Note that algebraically, this equation would be very difficult to solve. We normally resort to trial and error, systematically choosing various discount rates until we find one, the IRR, that satisfies the equation.

IRR Solution by Using Excel

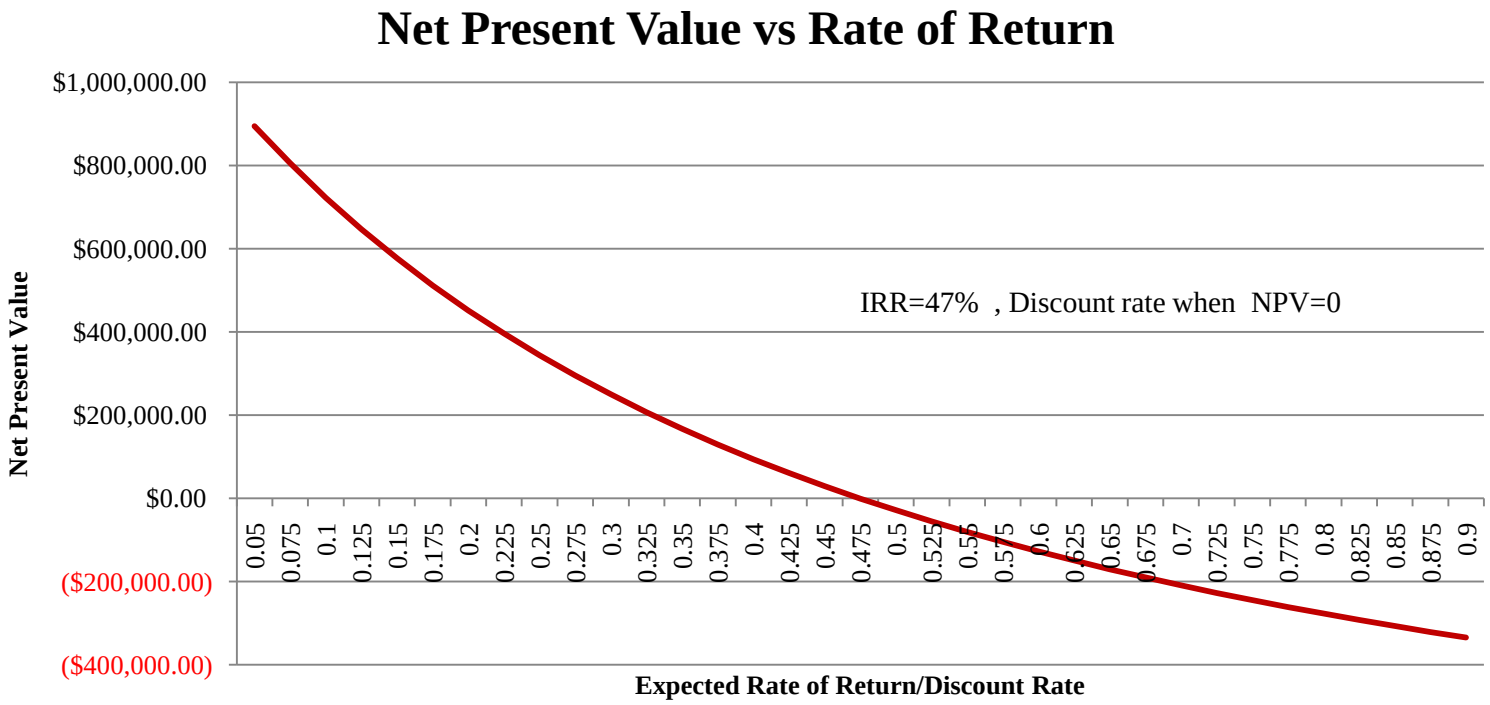
- We can solve the IRR by using Excel in a number of ways. One easy solution is to use IRR function.
- Simply type @IRR in excel and select the input variables:
- @IRR(Cash Flow Range, rate)
- Rate can be an arbitrary rate of return, any number will work
- Cash Flow range should include all the cash flows of the project. Cash outflows should have a negative sign, and inflows should have a positive sign.
- IRR has a built in algorithm which starts with the rate you enter and reaches to IRR.



	A	B	C	D
1				
2		Year	Project A	Project-B
3		0	-1,000,000	-1,000,000
4		1	800,000	100,000
5		2	600,000	200,000
6		3	400,000	400,000
7		4	200,000	600,000
8		5	100,000	800,000
9				
10			47%	

- We can also solve for IRR by using NPV function and Goal Seek. We can calculate the NPV in a sell by using cost of capital as rate of return.
- Then ask Goal Seek to set the NPV function to value zero by changing cost of capital/rate of return.
- Goal seek produces the rate of return that equates the NPV of the project to zero which is by definition the IRR of the project.

IRR for Project A



Graphically IRR is the rate of return at the point the line crosses the horizontal axis. At this point NPV=0 → INVESMENT RULE: Invest when IRR>Cost of Capital

The IRR Rule

- An investment 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

Is IRR a good investment decision Rule?

- Adjustment for the timing of cash flows?
  - Considers the time value of money
- Consider investments A and B
  - Investment A is preferable to B because its largest cash flow occurs earlier
  - IRR rule indicates the same preference as NPV because the IRR of investment A (47% percent) is higher than the IRR of investment B (22 percent)
- An important limitation of IRR is the assumed re-investment rate. IRR assumes that cash inflows can be reinvested at the IRR. This may overstate the viability of the project!

IRR like NPV accounts for the timing of the cash flows

Year	Project A	Project-B
0	(1,000,000)	(1,000,000)
1	800,000	100,000
2	600,000	200,000
3	400,000	400,000
4	200,000	600,000
5	100,000	800,000
Cash Inflows	2,100,000	2,100,000
Cost of Capital	10%	10%
Project NPV	$722,361.24	$463,269.40
IRR	47%	22%

The Payback Period

- A project's payback period is the number of periods required for the project's cash flows to recover its initial cash outlay
- 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.
- Payback period is usually measured in years

Expected and Cumulative Cash Flows for Investment A

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.

Payback Period= 3 years

It takes three years for the project cash flows to fully recover the initial outlay!

Another Example

0	1	2	3	4	5
(1,000,000)	325,000	325,000	325,000	325,000	325,000
Cumulative Cash Flows	325,000	650,000	975,000	1,300,000	1,625,000

In the above example, the initial investment is recovered somewhere between 3rd and 4th year. 975,000 of 1m initial outlay is recovered in year 3. Only 25,000 Is recovered in year 4. The total cash inflows in year 4 is 325,000. This means that it takes about 25,000/325,000 =0.076 yrs to recover the remaining amount. The payback period then is expressed as 3+0.076=3.076 yrs.

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 ;
    - Timing of cash flows are not considered; projects with early large cash flows are favored
  - Adjustment for risk?
    - Ignores risk! Low risk and high risk projects may have equal payback periods

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

Flaws of PB Period: Payback Period and NPV

	Cash Flows					
Year	Project A	Project B	Project C	Project D	Project E	Project F
0	−1,000	−1,000	−1,000	−1,000	−1,000	−1,000
1	1,000	100	400	500	400	500
2		200	300	500	400	500
3		300	200	500	400	10,000
4		400	100		400	
5		500	500		400	
Payback period	1.0	4.0	4.0	2.0	2.5	2.0
NPV	−90.91	65.26	140.60	243.43	516.31	7,380.92

Note that payback period favors project A, which is a negative NPV project! It also favors Project D over Project E, which has much larger NPV.

Why Do Managers Use the Payback Period Rule?

- Simple and easy to apply for small, repetitive investments
- Favors projects that “pay back quickly” ; 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
- 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

The Discounted Payback Period

- The discounted payback period, or economic payback period is the 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 . It may result in a different project ranking
- The *discounted payback period rule* says that a project is acceptable if its 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 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
  - Adjustment for risk?
    - The rule considers risk

- The discounted payback does account for the time value of money and risk within the discounted payback period, but it ignores cash flows after the discounted payback period is reached.
- This drawback has two consequences.
  - First, the discounted payback period is not a good measure of profitability (like the NPV or IRR) because it ignores these cash flows.
  - A second idiosyncrasy of the discounted payback period comes from the possibility of negative cash flows after the discounted payback period is reached. It is possible for a project to have a negative NPV but to have a positive cumulative discounted cash flow in the middle of its life and thus a reasonable discounted payback period.
- The NPV and IRR, which consider all of a project ' s cash flows, do not suffer from this problem.

Maximization of the firm's equity value?

- If a project's discounted payback period is shorter than the cutoff period, the project's NPV, when estimated with cash flows up to the cutoff period, is always positive
- If the project's NPV is negative, it will not have a discounted payback period!
- The rule is biased against long-term projects

The Discounted PPR Versus the Ordinary PPR

- 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

Average Accounting Rate of Return

- AAR calculated by using average net income and average book value during the life of the project,

$$\text{AAR} = \frac{\text{Average net income}}{\text{Average book value}}$$

- Unlike the other capital budgeting criteria AAR is based on accounting numbers, not on cash flows. This is an important conceptual and practical limitation.
- The AAR also does not account for the time value of money, and there is no conceptually sound cutoff for the AAR that distinguishes between profitable and unprofitable investments.
- The AAR is frequently calculated in different ways, so the analyst should verify the formula behind any AAR numbers that are supplied by someone else.
- Analysts should know the AAR and its potential limitations in practice, but they should rely on more economically sound methods like the NPV and IRR.

Profitability Index

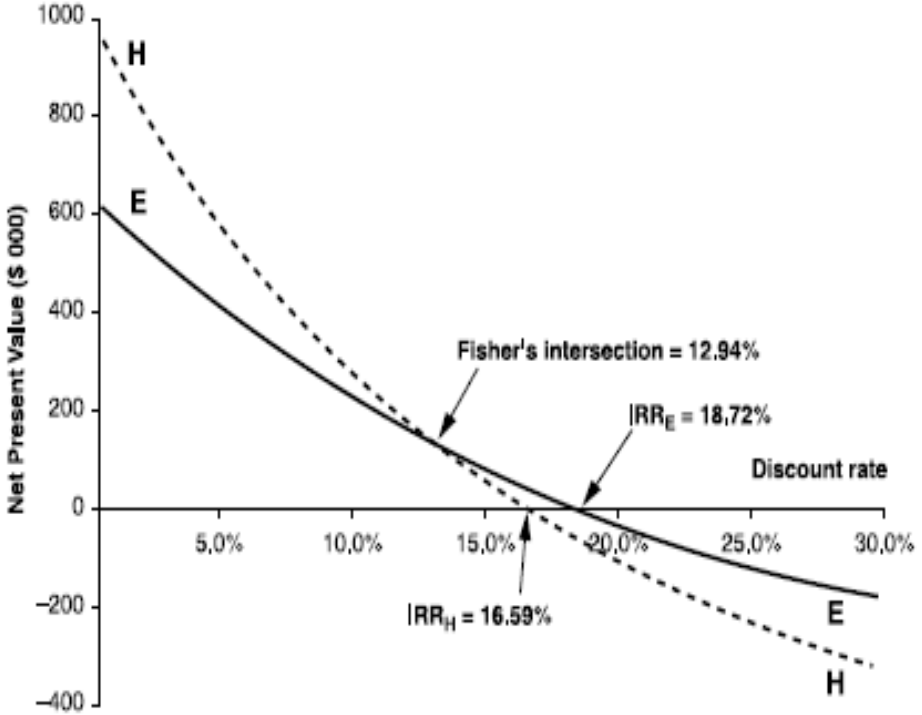
- The profitability index (PI) is the present value of a project's future cash flows divided by the initial investment.

$$\text{PI} = \frac{\text{PV of future cash flows}}{\text{Initial investment}} = 1 + \frac{\text{NPV}}{\text{Initial investment}}$$

- PI is closely related to the NPV. The PI is the ratio of the PV of future cash flows to the initial investment, while an NPV is the difference between the PV of future cash-flows and the initial investment.
- Whenever the NPV is positive, the PI will be greater than 1.0, and conversely, whenever the NPV is negative, the PI will be less than 1.0
- Investment Rule:
  - Invest if PI >1.0
  - Do not invest if PI <1.0

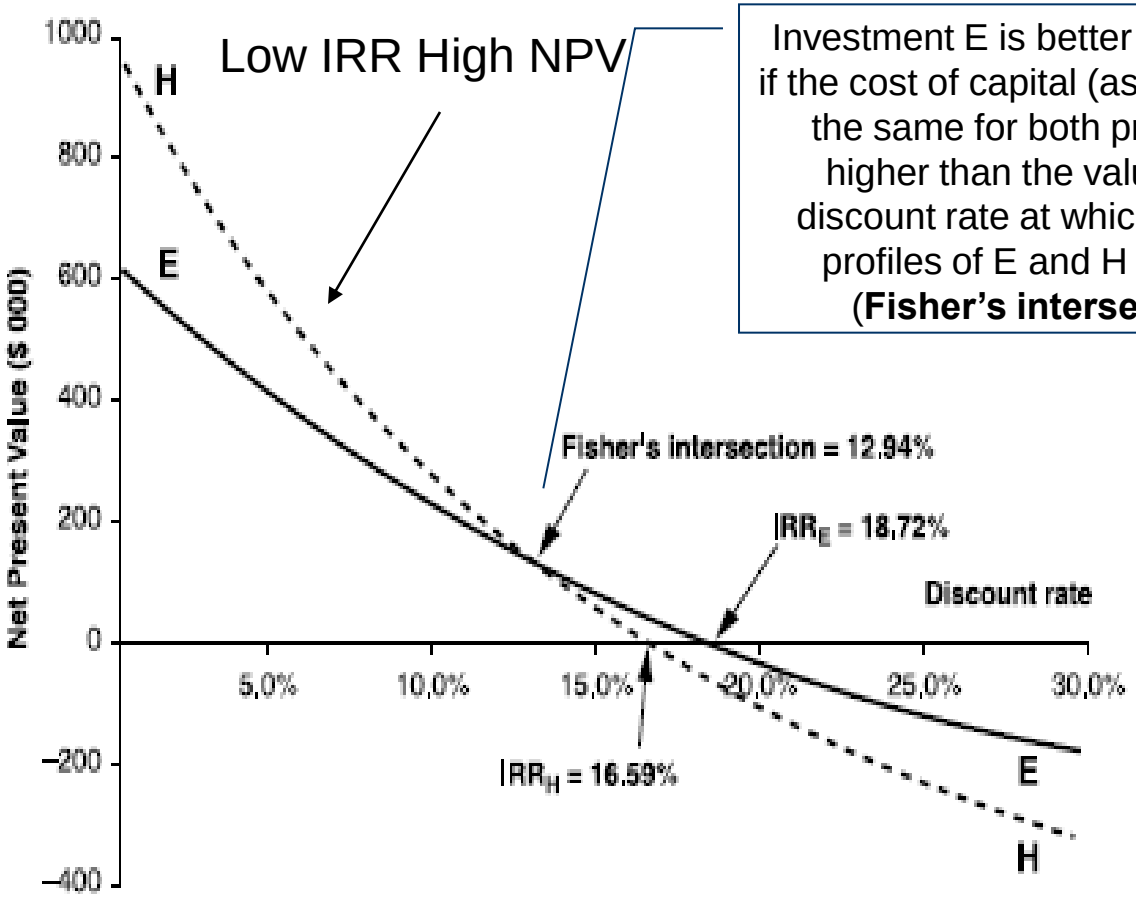
NPV Profile and IRR

	Project E	Project H
	-1,000,000	-1,000,000
	325,000	100,000
	325,000	100,000
	325,000	100,000
	325,000	150,000
	325,000	1,500,000
NPV	$232,005.70	$282,519.20
IRR	18.72%	16.59%



Note that Project E has higher IRR than Project H. However, project H higher NPV when cost of capital is below 12.94%. If the cost of capital is below 12.94% as in this example, NPV and IRR rules conflict!

The NPV Profiles of Investments E and H.



Investment 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.

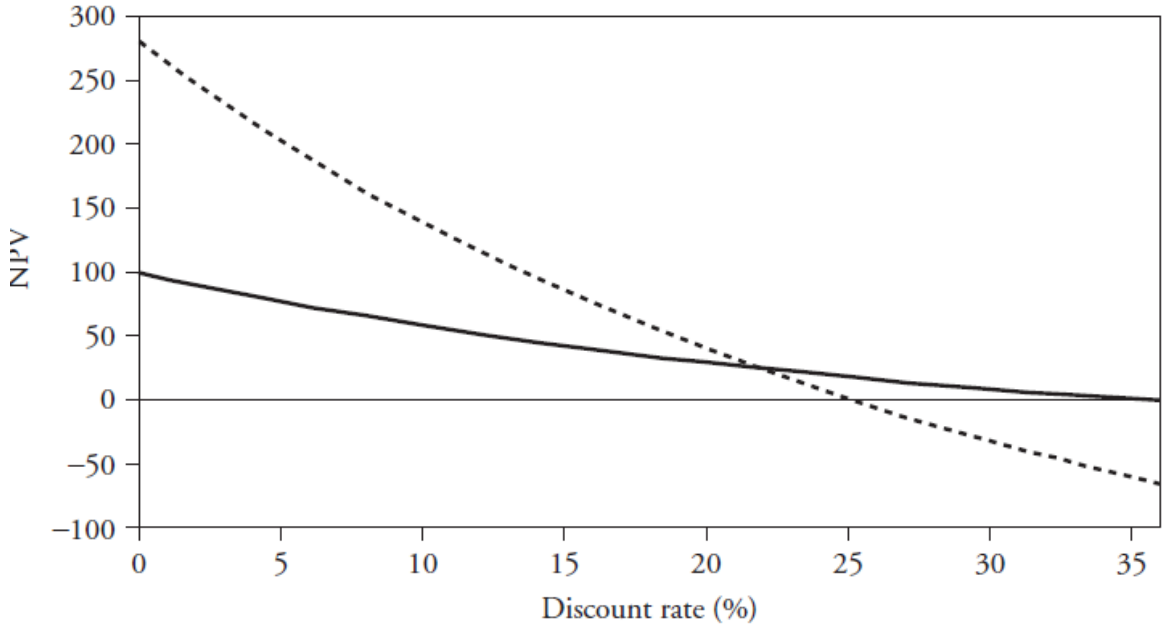
IRR rule may lead to suboptimal decisions

NPV and IRR Conflict

- As in the previous example, differing cash flow patterns can cause two projects to rank differently with the NPV and IRR.
- When two rules are in conflict, one should rely on NPV rule simply because of the assumed opportunity cost or more realistic reinvestment rates.
- Another circumstance that frequently causes mutually exclusive projects to be ranked differently by NPV and IRR criteria is project scale — the sizes of the projects. Would you rather have a small project with a higher rate of return or a large project with a lower rate of return? Sometimes, the larger, low rate of return project has the better NPV.

Project Scale and IRR-NPV Conflict

	Cash Flows						
Year	0	1	2	3	4	NPV	IRR
Project A	−100	50	50	50	50	58.49	34.90%
Project B	−400	170	170	170	170	138.88	25.21%



As the NPV profile Shows, project B has higher NPV for discount rates between 0 and 21.83%

Multiple IRR Problem

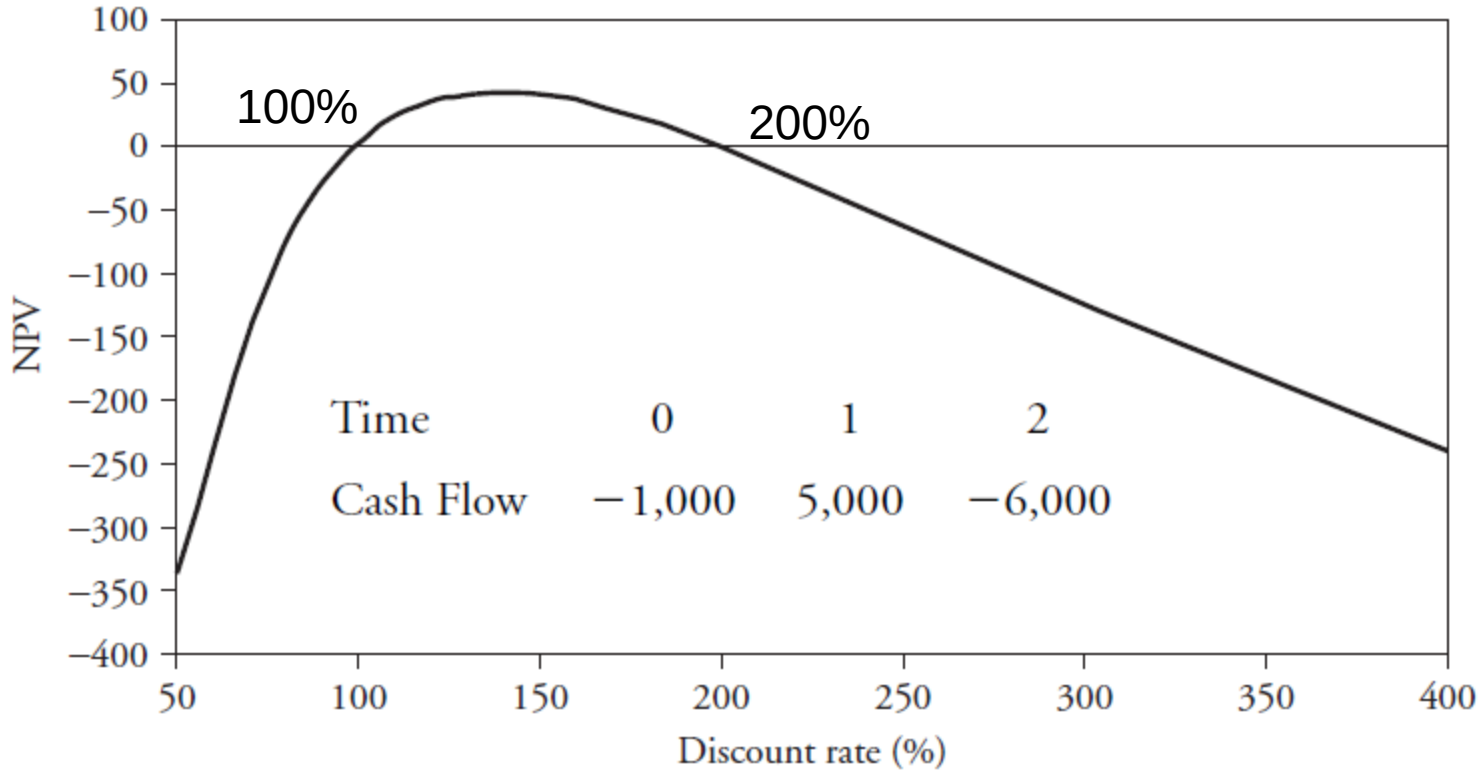
Unconventional cash flows where the sign of cash flows change more than once, produce multiple IRRs. For instance the following cash flow pattern leads and IRR of 100% and 200%.

Time	0	1	2
Cash Flow	−1,000	5,000	−6,000

$$-1{,}000+\frac{5{,}000}{(1+\text{IRR})^{1}}+\frac{-6{,}000}{(1+\text{IRR})^{2}}=0$$

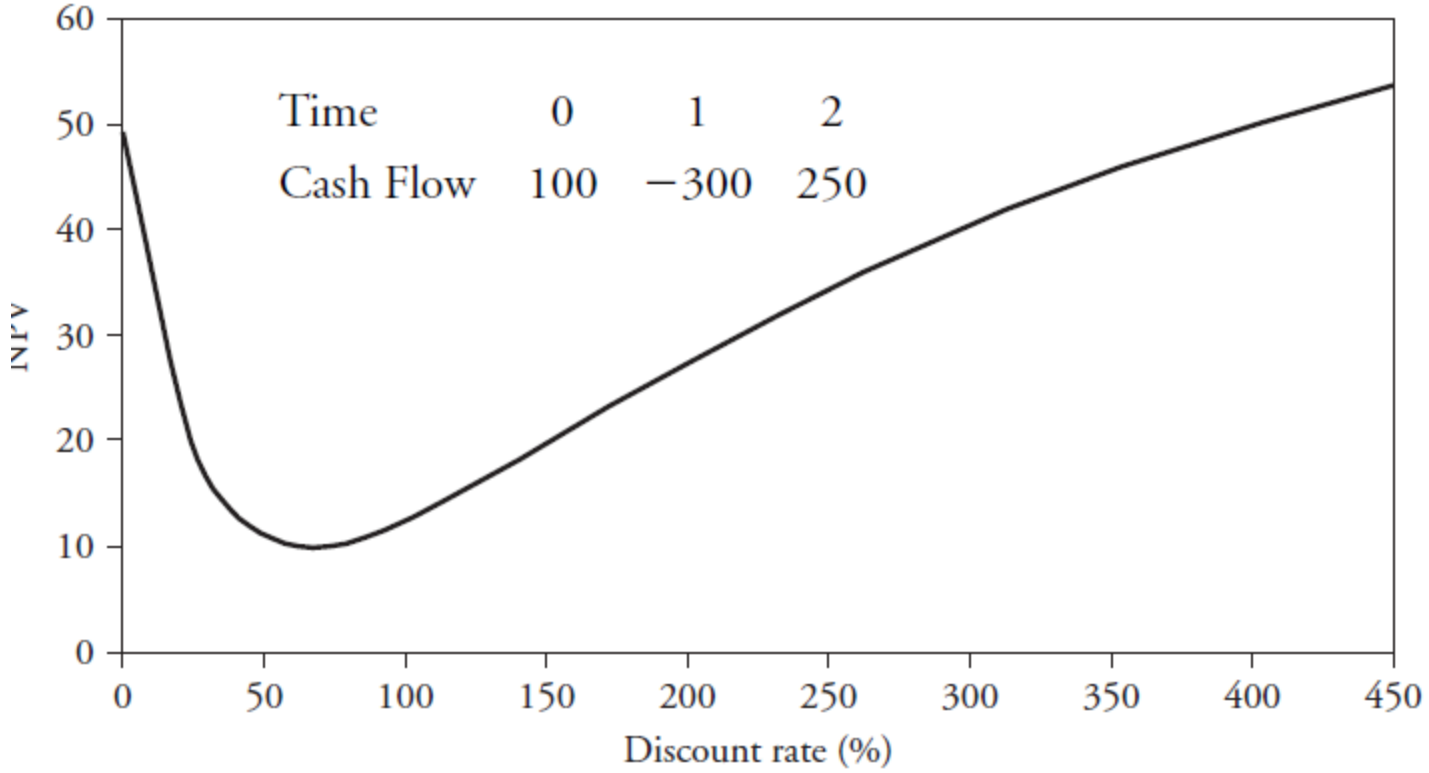
In this case NPV profile of the project intersects the horizontal line twice: at discount rate 100% and discount rate 200%.

Multiple IRR Problem



No IRR Problem

In some cases, NPV profile may never cross the horizontal axis.

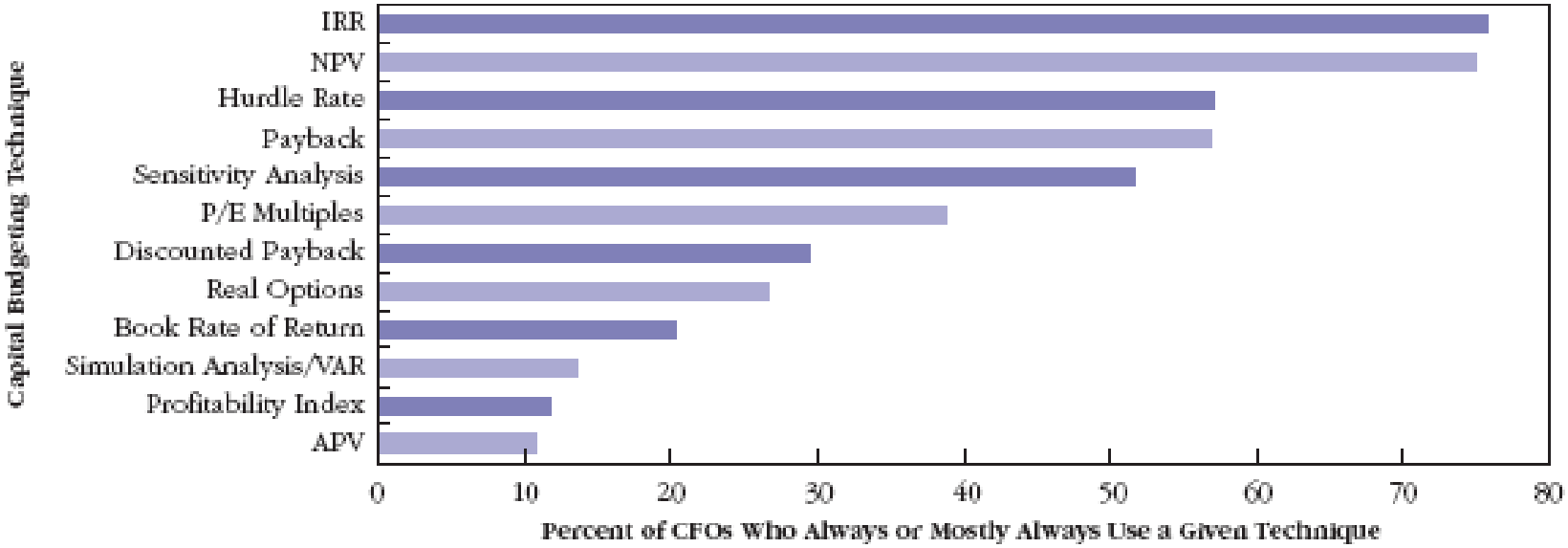


Survey Evidence

- A Survey of CFOs who belong to Financial Executives International revealed the following:
- 75% of CFOs report using IRR and 75% NPV.
  - On a scale of 0 to 4, where 4 is very important, mean responses associated with both were 3.1.
- 57% of CFOs reported using the payback rule.
  - Used by older, longer-tenure CEOs without MBAs.
  - Payback most intuitive, NPV least intuitive.

Duke-FEI Survey Results

FIGURE 1 ■ SURVEY EVIDENCE ON THE POPULARITY OF DIFFERENT CAPITAL BUDGETING METHODS*



International Preferences-Mean Responses

4=Used very frequently 0=Never used

	U.S.	U.K.	Netherlands	Germany	France
Internal rate of return*	3.09	2.31	2.36	2.15	2.27
Net present value*	3.08	2.32	2.76	2.26	1.86
Payback period*	2.53	2.77	2.53	2.29	2.46
Hurdle rate	2.13	1.35	1.98	1.61	0.73
Sensitivity analysis	2.31	2.21	1.84	1.65	0.79
Earnings multiple approach	1.89	1.81	1.61	1.25	1.70
Discounted payback period*	1.56	1.49	1.25	1.59	0.87
Real options approach	1.47	1.65	1.49	2.24	2.20
Accounting rate of return*	1.34	1.79	1.40	1.63	1.11
Value at risk	0.95	0.85	0.51	1.45	1.68
Adjusted present value	0.85	0.78	0.78	0.71	1.11
Profitability index*	0.85	1.00	0.78	1.04	1.64