

L2: Investment Decision Rules

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Financial Decision-Making (1st Quarter)

What do we look for in a decision rule?

- Accounts for the time value of money.
- Accounts for risk.
- Does the rule tell us how much value the project creates?

Example project

- Throughout this lecture, we'll consider a project. Let's call it **Project A**.
- The cash flows generated by project A are as follows:
 - Invest \$100 at $t = 0$.
 - Receive \$30 each year after until $t = 5$ inclusive, (i.e. for $t = 1, 2, 3, 4, 5$).

Method 1: NPV rule (1)

- The big daddy of decision rules.
- Weighs up the marginal cost and benefit associated with a particular project after discounting.
- Rule:
 - Accept the project if $NPV \geq 0$
 - Reject the project if $NPV < 0$
- $$NPV = \sum_{t=0}^T \frac{CF_t}{(1+r_t)^t}$$
- The NPV captures exactly the additional value created by the project for the firm.
- The value of the firm is the sum of the NPVs of all of its projects.

Method 1: NPV rule (2)

| | A | B | C | D | E | F |
|---|----------------------|-------|-------------------|---|-----|-------------|
| 1 | Evaluating project A | | | | | |
| 2 | | | | | r | 0.05 |
| 3 | t | CF(t) | PV CF(t) | | NPV | =SUM(C4:C9) |
| 4 | 0 | -100 | =B4/(1+\$F\$2)^A4 | | | |
| 5 | 1 | 30 | =B5/(1+\$F\$2)^A5 | | | |
| 6 | 2 | 30 | =B6/(1+\$F\$2)^A6 | | | |
| 7 | 3 | 30 | =B7/(1+\$F\$2)^A7 | | | |
| 8 | 4 | 30 | =B8/(1+\$F\$2)^A8 | | | |
| 9 | 5 | 30 | =B9/(1+\$F\$2)^A9 | | | |

Method 2: IRR rule (1)

- A commonly used decision rule in the private sector.
- The internal rate of return (IRR) is the discount rate such that the NPV of the project is set to zero.
- $$\sum_{t=0}^T \frac{CF_t}{(1+IRR)^t} = 0.$$
- Rule:
 - Accept project if $IRR \geq$ required rate of return.
 - Reject project if $IRR <$ required rate of return.
- Intuitively, if the IRR rule leads to acceptance, then the project is generating you a return higher than the next best use of your funds.

Method 2: IRR rule (2)

- Use Solver in excel.
 - Found under Data \Rightarrow Analysis \Rightarrow Solver.

The screenshot displays an Excel spreadsheet and the Solver Parameters dialog box. The spreadsheet is titled "Evaluating project A" and contains the following data:

| t | CF(t) | PV CF(t) | r | NPV |
|---|-------|----------|------|---------|
| 0 | -100 | -100 | 0.05 | 29.8843 |
| 1 | 30 | 28.57143 | | |
| 2 | 30 | 27.21088 | | |
| 3 | 30 | 25.91513 | | |
| 4 | 30 | 24.68107 | | |
| 5 | 30 | 23.50578 | | |

The Solver Parameters dialog box is open, showing the following settings:

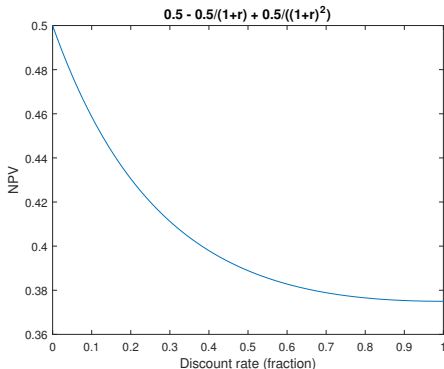
- Set Objective:** \$F\$4
- To:** Max Min Value Of: 0
- By Changing Variable Cells:** \$F\$2
- Subject to the Constraints:** (Empty list)
- Make Unconstrained Variables Non-Negative
- Select a Solving Method:** GRG Nonlinear
- Solving Method:** Select the GRG Nonlinear engine for Solver Problems that are smooth nonlinear. Select the LP Simplex engine for linear Solver Problems, and select the Evolutionary engine for Solver problems that are non-smooth.

Method 2: IRR rule (3)

- This decision rule is intuitive, but it has problems!
 - Can have **multiple** IRRs.
 - IRR may **not exist!**
- The warning sign is cash flows that alternate in sign many times between periods.
- Obviously also if the cash flows **never** change sign!

Method 2: IRR rule (4)

- Consider the following example:
 - Receive \$0.5 at $t = 0$.
 - Pay \$0.5 at $t = 1$.
 - Receive \$0.5 at $t = 2$.
 - $NPV = 0.5 - \frac{0.5}{1+r} + \frac{0.5}{(1+r)^2}$.
 - NPV function never crosses the r axis for any $r \in [0, 1]$.



Method 3: payback rule (1)

- The amount of time required for an investment to generate after-tax cash flows that are sufficient to cover the initial cost.
- This method is evil. It doesn't take account of the time value of money or risk!
- Very intuitive though.
- Rule:
 - Accept if the payback period is less than some specified amount of time.
 - Reject if the payback period is greater than some specified amount of time.

Method 3: payback rule (2)

- Just look for the year such that the total positive cashflows exceed the initial investment.
- Payback period for project A is between four and five years.
- We'd accept the project if the cutoff was 5 years or above.

| Evaluating project A | | | |
|----------------------|-------|-------------------|------------------|
| t | CF(t) | Amount to be made | Cumulative CF(t) |
| 0 | -100 | 100 | |
| 1 | 30 | 100 | 30 |
| 2 | 30 | 100 | 60 |
| 3 | 30 | 100 | 90 |
| 4 | 30 | 100 | 120 |
| 5 | 30 | 100 | 150 |

Method 4: discounted payback rule (1)

- The length of time for the discounted cash flow receipts to offset the initial cost.
- Rule:
 - Accept if discounted payback year is less than specified cutoff year.
 - Reject if discounted payback year is above specified cutoff year.
- Again we require an arbitrary cutoff year.
- At least this method accounts for discounting though!

Method 4: discounted payback rule (2)

- Again the discounted payback period is between four and five years.
- Same conclusion as payback rule.

| Evaluating project A | | | | | | r | 0.05 |
|----------------------|-------|-------------------|----------|------------------|--|-----|---------|
| t | CF(t) | Amount to be made | PV CF(t) | Cumulative PV CF | | NPV | 29.8843 |
| 0 | -100 | 100 | -100 | | | | |
| 1 | 30 | 100 | 28.57143 | 28.57142857 | | | |
| 2 | 30 | 100 | 27.21088 | 55.78231293 | | | |
| 3 | 30 | 100 | 25.91513 | 81.69744088 | | | |
| 4 | 30 | 100 | 24.68107 | 106.3785151 | | | |
| 5 | 30 | 100 | 23.50578 | 129.8843001 | | | |

Method 5: profitability index (1)

- Measures the benefit per unit of upfront cost.
- $PI = \frac{PV_1}{C_0}$ where PV_1 is the present value of positive cash flows starting next period onwards and C_0 is upfront cost.
- A PI value of 1.2 means that we create an additional \$0.2 of value per dollar of investment up front.
- Rule:
 - Accept if $PI \geq 1$ (creates value).
 - Reject if $PI < 1$ (destroys value).
- Not getting an idea of the absolute value created though.

Method 5: profitability index (2)

- Would accept project A under the PI rule.

| Evaluating project A | | | | |
|----------------------|-------|----------|----|----------|
| | | | r | 0.05 |
| t | CF(t) | PV CF(t) | PI | 1.298843 |
| 0 | -100 | -100 | | |
| 1 | 30 | 28.57143 | | |
| 2 | 30 | 27.21088 | | |
| 3 | 30 | 25.91513 | | |
| 4 | 30 | 24.68107 | | |
| 5 | 30 | 23.50578 | | |

Takeaways

- NPV rule is supreme!
- Other rules though can be inconclusive or lead to **wrong** investment decisions being made.
- Payback **can** be badass (see below), but not when it comes to decision-making!

