Capital Budgeting Techniques and Practice

Capital Budgeting: the process of planning for purchases of long-term assets.

- **example**:

Suppose our firm must decide whether to purchase a new plastic molding machine for $125,000. How do we decide?

- Will the machine be **profitable**?
- Will our firm earn a **high rate of return** on the investment?

Decision-making Criteria in Capital Budgeting

How do we decide if a capital investment project should be accepted or rejected?

Decision-making Criteria in Capital Budgeting

- **The Ideal Evaluation Method should:**

a) include <u>all cash flows</u> that occur during the life of the project,

b) consider the <u>time value of money</u>,

c) incorporate the <u>required rate of return</u> on the project.

Payback Period

- How long will it take for the project to generate enough cash to pay for itself?

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(500)	150	150	150	150	150	150	150	150
0	1	2	3	4	5	6	7	8

Payback Period

- How long will it take for the project to generate enough cash to pay for itself?

Year	0	1	2	3	4	5	6	7	8
Cash flow	(500)	150	150	150	150	150	150	150	150

Payback period = 3.33 years.

Payback Period

- Is a **3.33 year** payback period good?
- Is it acceptable?
- Firms that use this method will compare the payback calculation to some standard set by the firm.
- If our senior management had set a cut-off of **5 years** for projects like ours, what would be our decision?
- Accept the project.

Drawbacks of Payback Period

- Firm cutoffs are subjective.
- Does not consider time value of money.
- Does not consider any required rate of return.
- Does not consider all of the project's cash flows.

Drawbacks of Payback Period

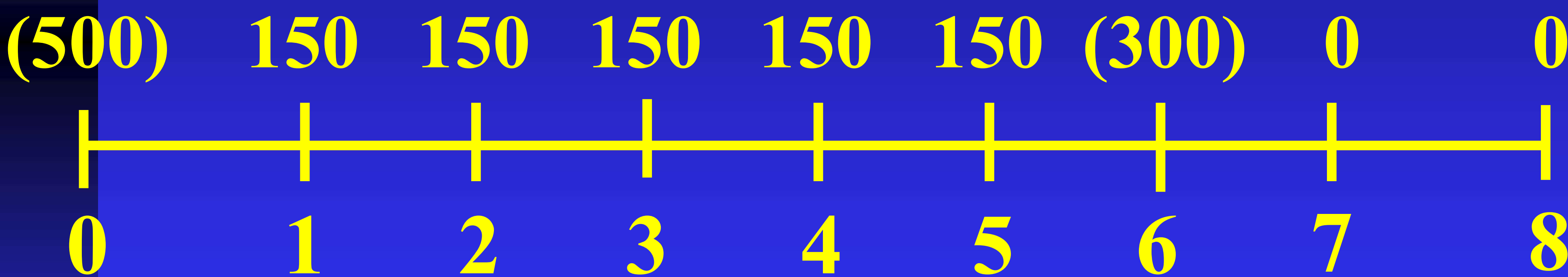
- Does not consider all of the project's cash flows.

(500)	150	150	150	150	150	(300)	0	0
0	1	2	3	4	5	6	7	8

- Consider this cash flow stream!

Drawbacks of Payback Period

- Does not consider all of the project's cash flows.



- This project is clearly unprofitable, but we would <u>accept</u> it based on a 4-year payback criterion!

Other Methods

1) **Net Present Value (NPV)**
2) **Profitability Index (PI)**
3) **Internal Rate of Return (IRR)**

Each of these decision-making criteria:

- Examines all net cash flows,
- Considers the time value of money, and
- Considers the required rate of return.

Net Present Value

- NPV = the total PV of the annual net cash flows - the initial outlay.

$$NPV = \sum_{t=1}^{n} \frac{ACFt}{(1 + k)^{t}} - IO$$

Net Present Value

- **Decision Rule:**

- If NPV is positive, accept.
- If NPV is negative, reject.

NPV Example

- Suppose we are considering a capital investment that costs $250,000 and provides annual net cash flows of $100,000 for five years. The firm's required rate of return is 15%.

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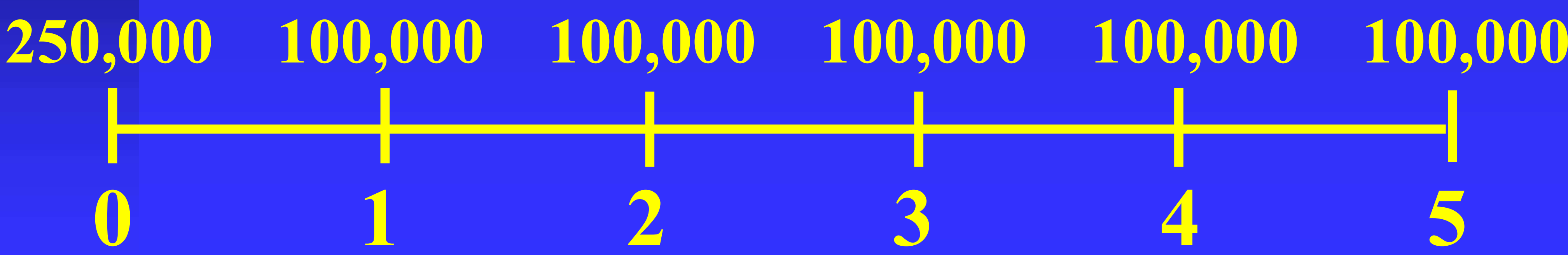

Net Present Value (NPV)

NPV is just the PV of the annual cash flows minus the initial outflow.

Using TVM:

P/Y = 1 N = 5 I = 15

PMT = 100,000

PV of cash flows = $335,216

- Initial outflow: ($250,000)

= Net PV $85,216

Profitability Index

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$$PI = \sum_{t=1}^{n} \frac{ACFt}{(1+k)^{t}} \Big/ IO$$

Profitability Index

- **Decision Rule:**

- **If PI is greater than or equal to 1, accept.**
- **If PI is less than 1, reject.**

Internal Rate of Return (IRR)

- **IRR:** **the return on the firm's invested capital. IRR is simply the rate of return that the firm earns on its capital budgeting projects.**

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$$IRR: \sum_{t=1}^{n} \frac{ACFt}{(1 + IRR)^{t}} = IO$$

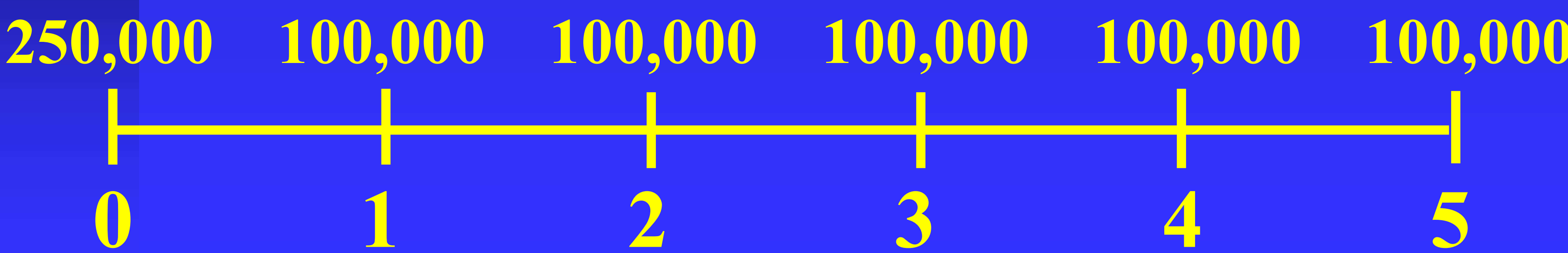
Internal Rate of Return (IRR)

$$\text{IRR: } \sum_{t=1}^{n} \frac{ACFt}{(1 + IRR)^{t}} = IO$$

- IRR is the rate of return that makes the **PV of the cash flows** equal to the **initial outlay**.
- This looks very similar to our Yield to Maturity formula for bonds. In fact, YTM is the IRR of a bond.

Calculating IRR

- Looking again at our problem:
- The IRR is the discount rate that makes the PV of the projected cash flows equal to the initial outlay.



IRR

- Decision Rule:
- If IRR is greater than or equal to the required rate of return, accept.
- If IRR is less than the required rate of return, reject.

- **IRR is a good decision-making tool as long as cash flows are conventional. (- + + + + +)**
- ***Problem:*** **If there are multiple sign changes in the cash flow stream, we could get multiple IRRs. (- + + - + +)**

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0	1	2	3	4	5
(500)	200	100	(200)	400	300

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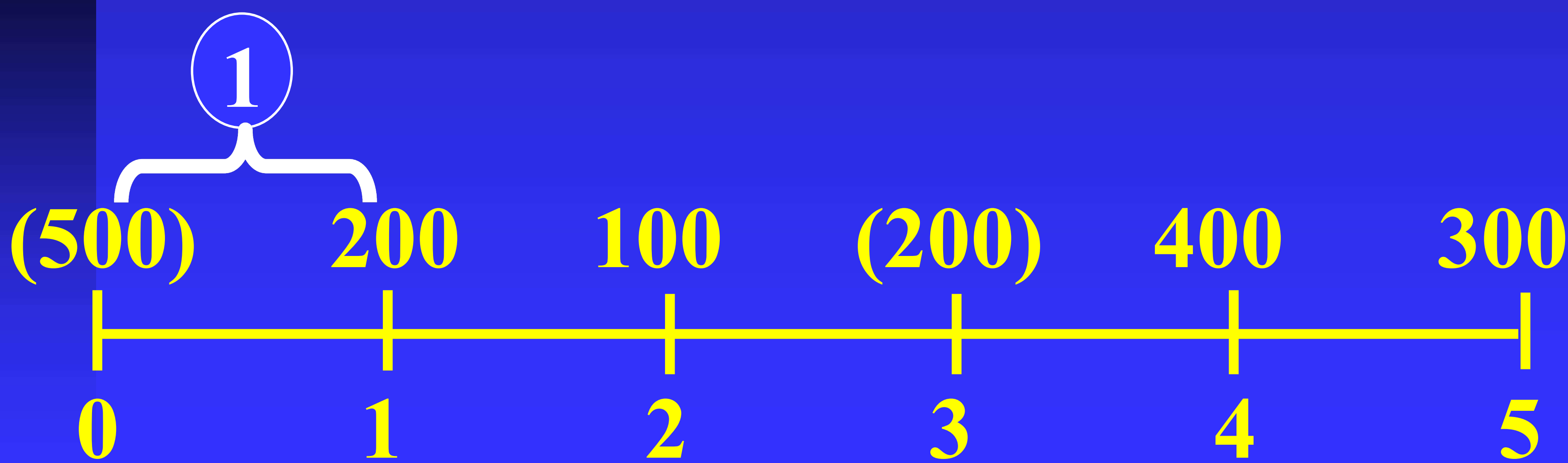
- *Problem:* If there are multiple sign changes in the cash flow stream, we could get multiple IRRs. (- + + - + +)



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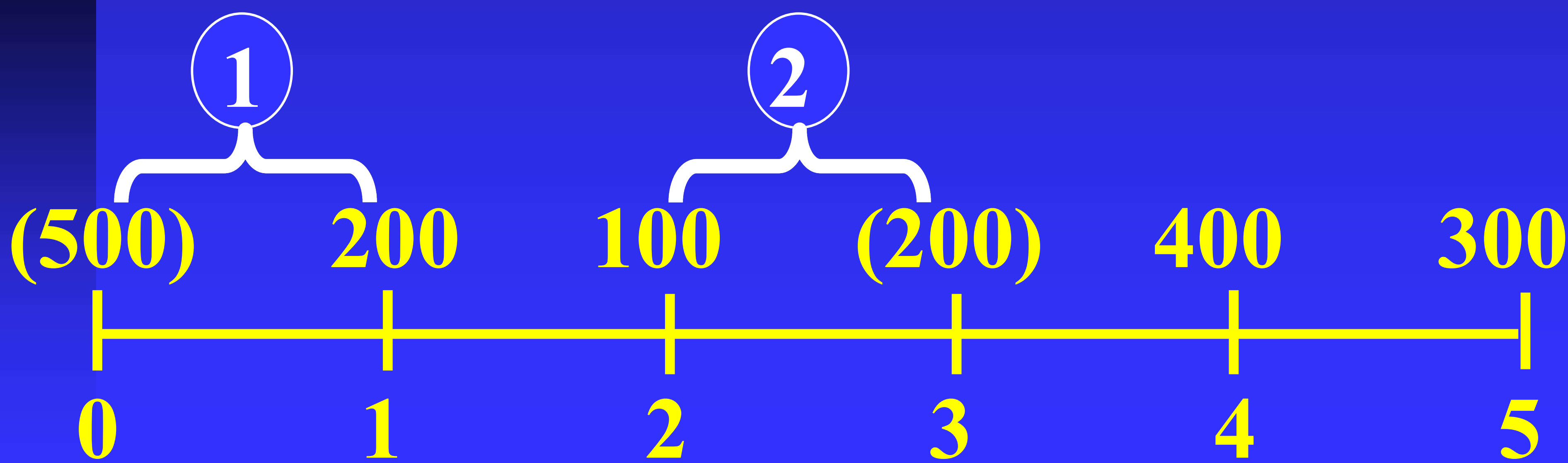

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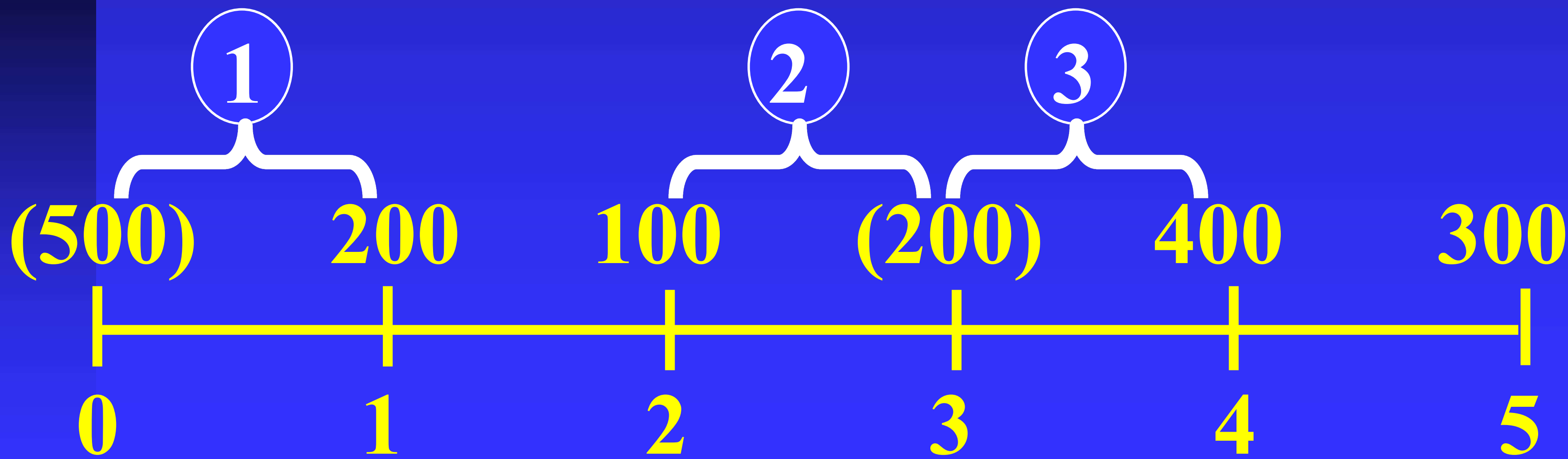
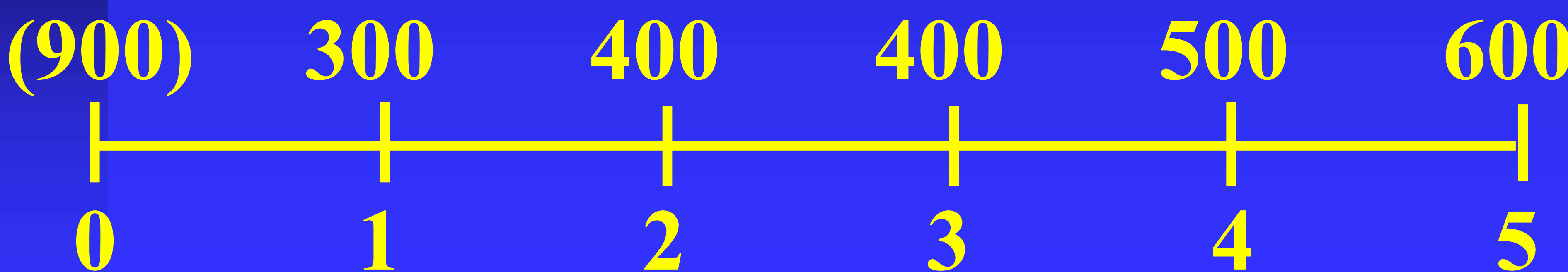


Summary Problem

- Enter the cash flows only once.
- Find the **IRR**.
- Using a discount rate of **15%**, find **NPV**.
- Add back IO and divide by IO to get **PI**.



Summary Problem

- IRR = 34.37%.
- Using a discount rate of 15%,
  NPV = $510.52.
- PI = 1.57.

(900)	300	400	400	500	600
0	1	2	3	4	5

Capital Rationing

- Suppose that you have evaluated 5 capital investment projects for your company.
- Suppose that the VP of Finance has given you a limited capital budget.
- How do you decide which projects to select?

Capital Rationing

- You could rank the projects by IRR:

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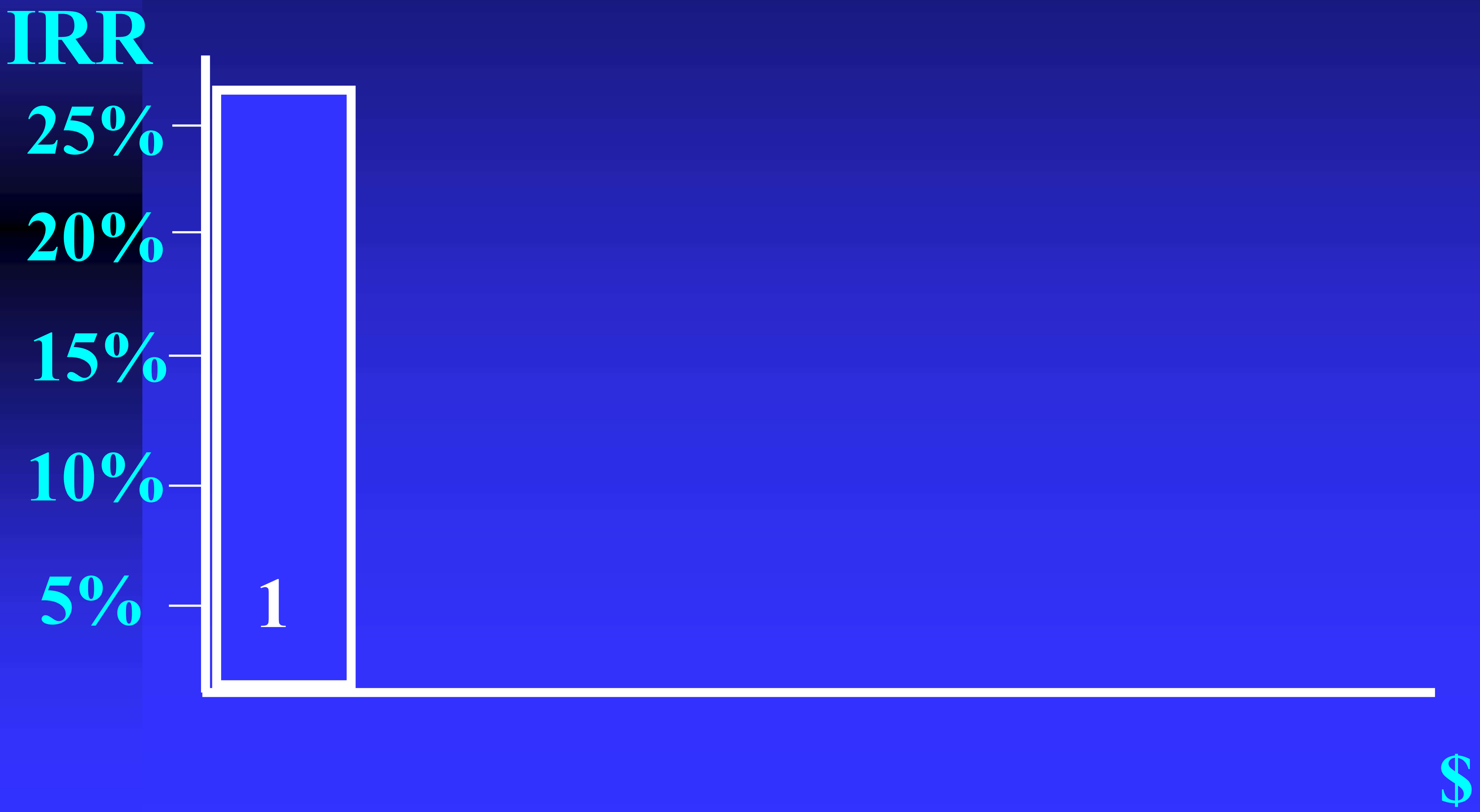

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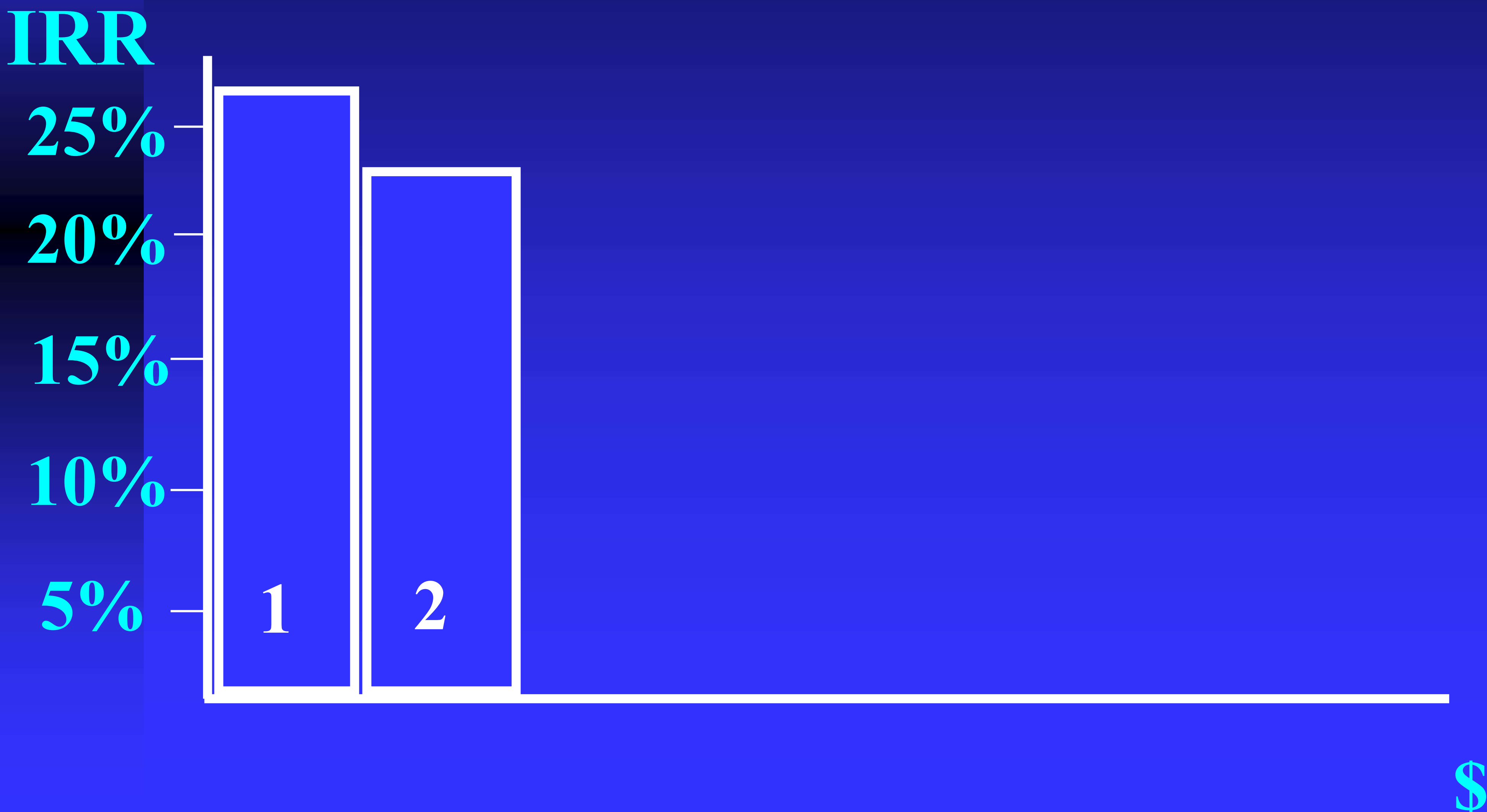

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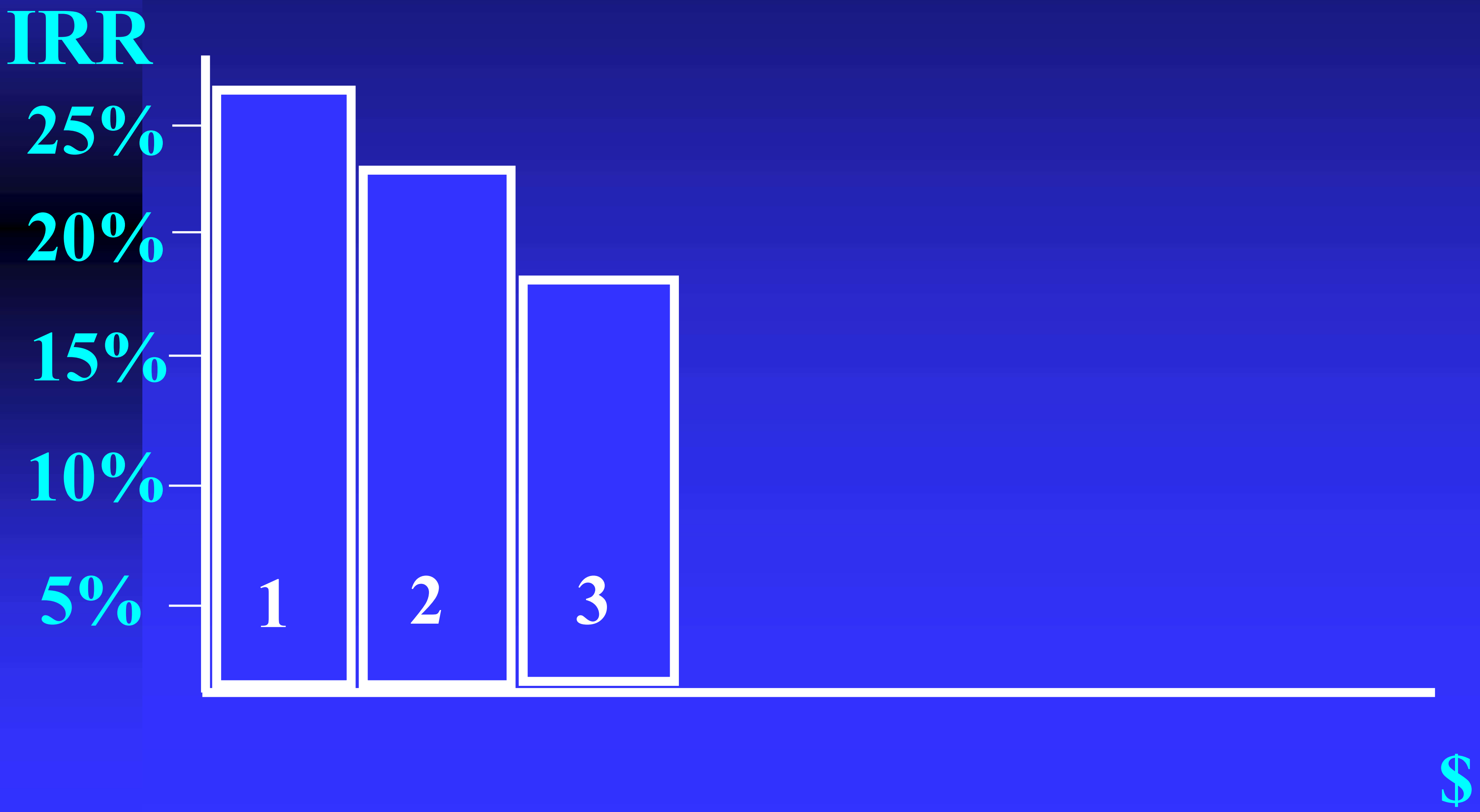

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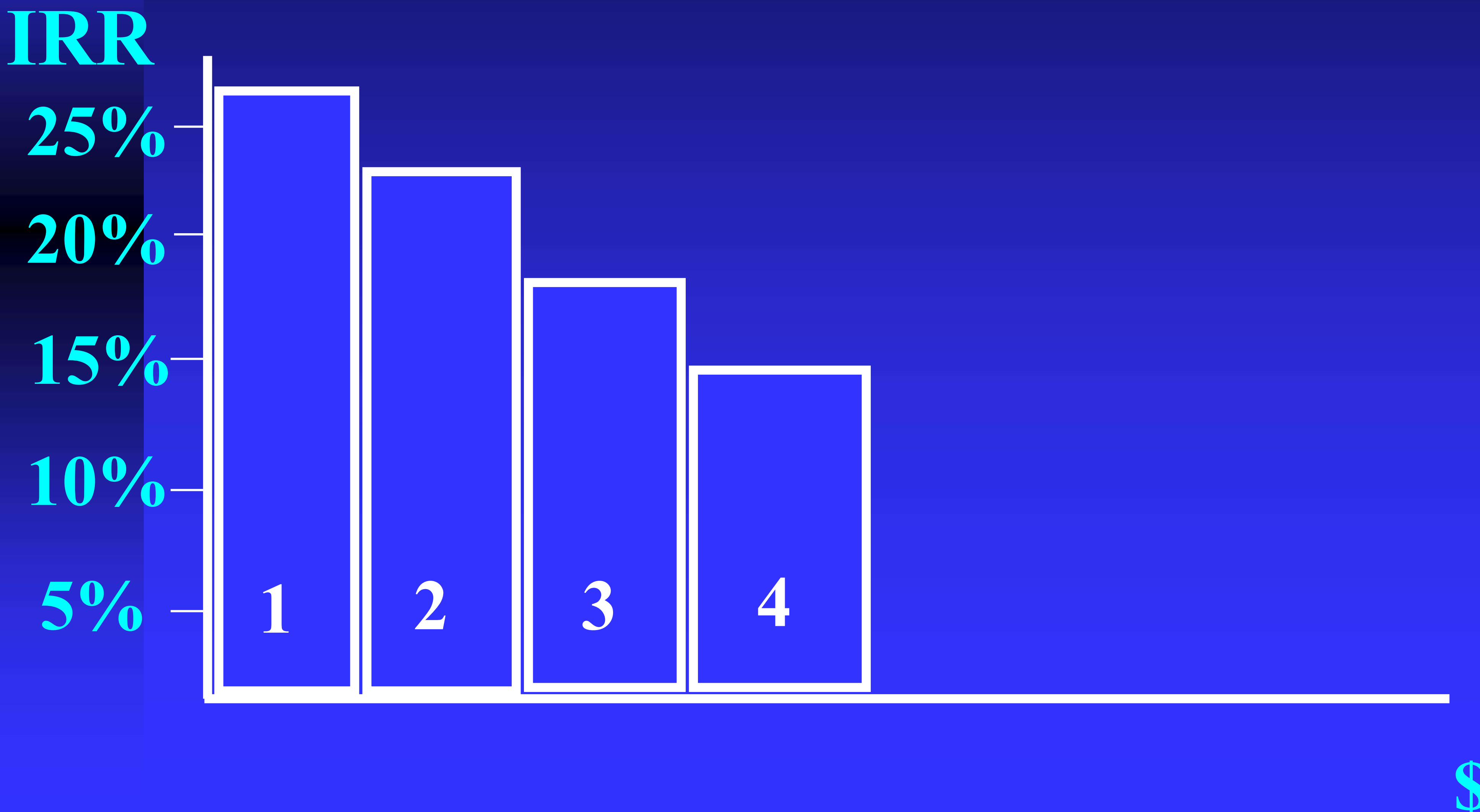

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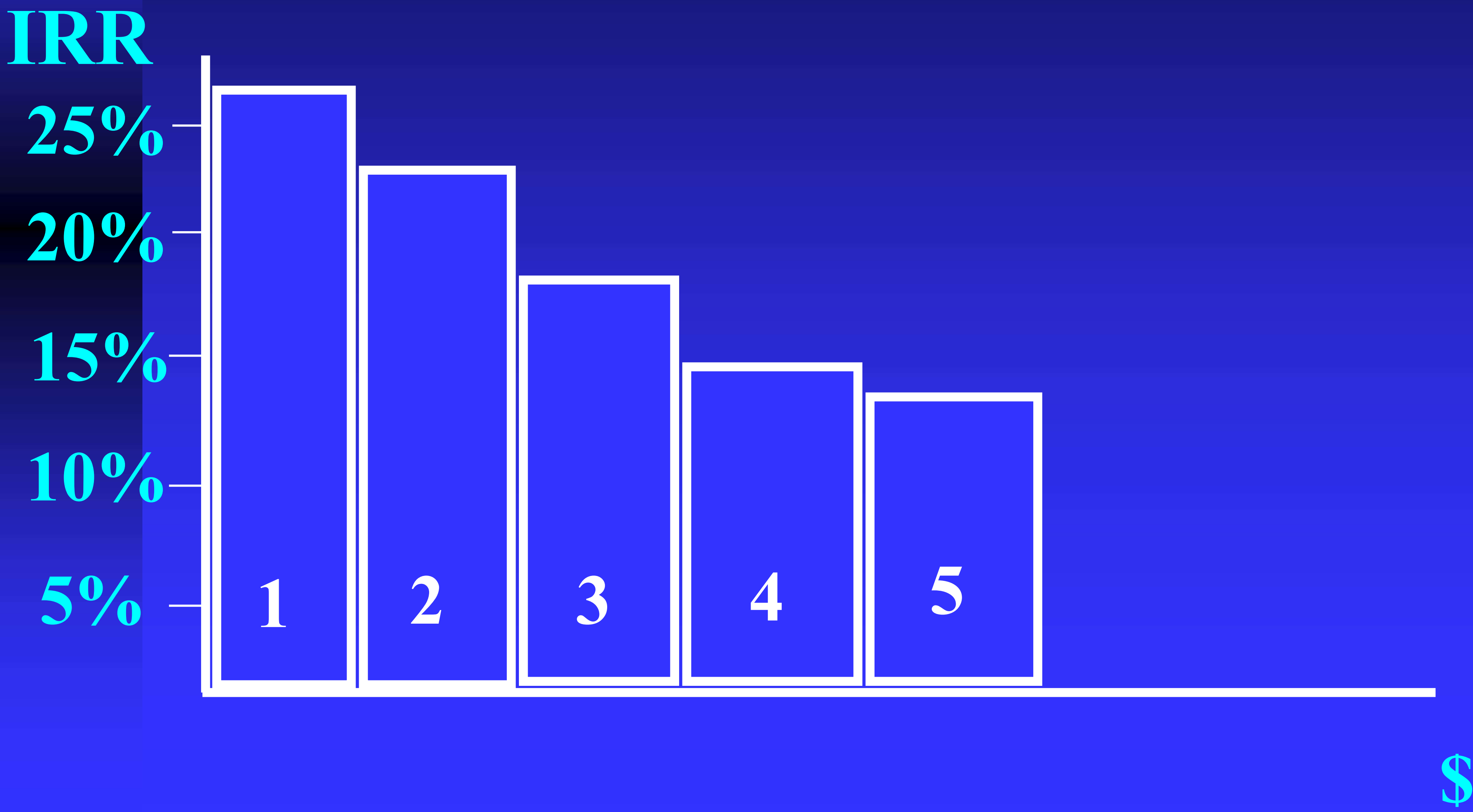

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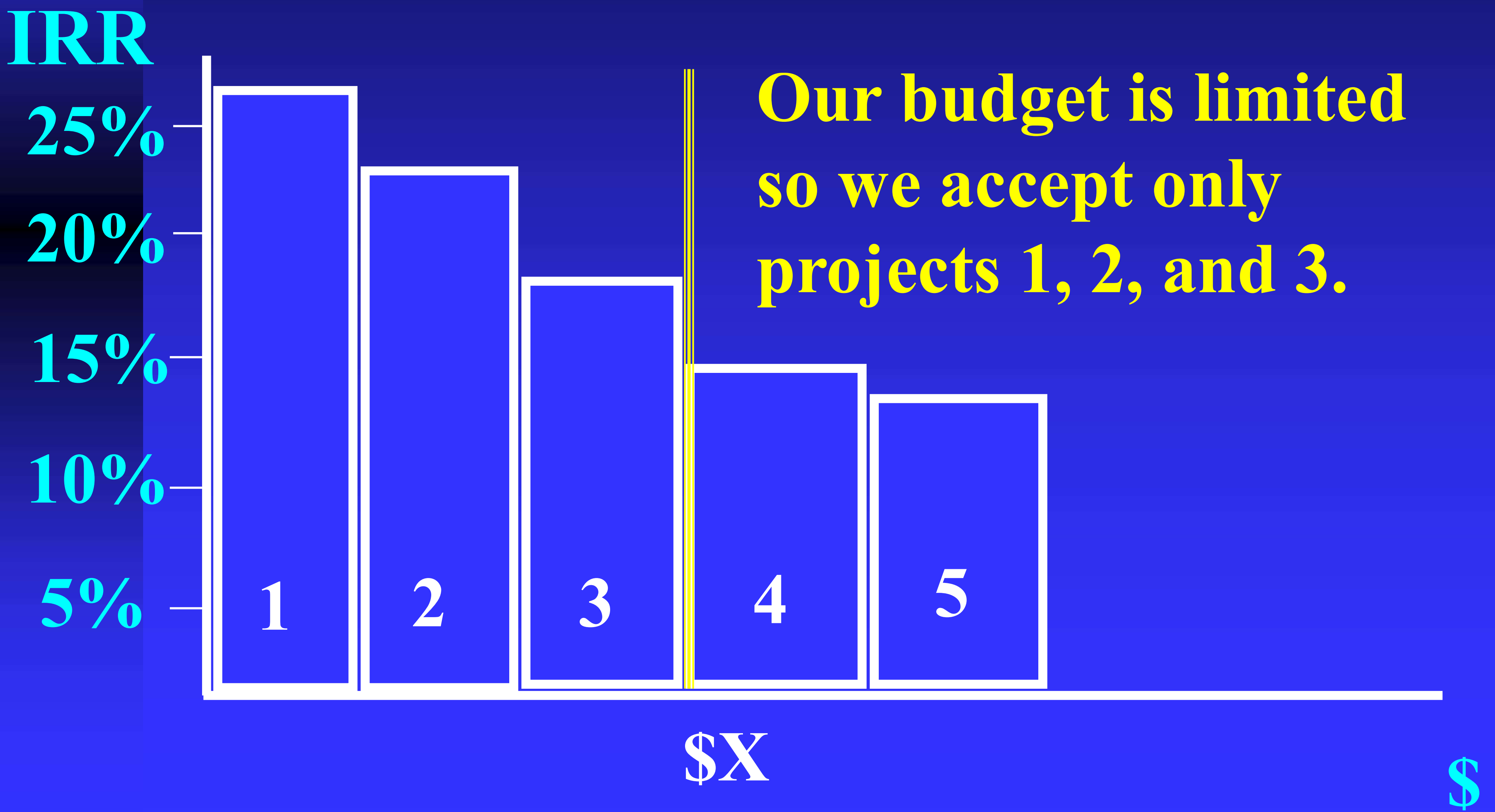

Capital Rationing

- You could rank the projects by IRR:

Our budget is limited so we accept only projects 1, 2, and 3.

Problems with Project Ranking

1) Mutually exclusive projects of unequal size (the size disparity problem)

- The NPV decision may not agree with IRR or PI.
- **Solution:** select the project with the largest NPV.

Size Disparity example

Project A

year	cash flow
0	(135,000)
1	60,000
2	60,000
3	60,000

required return = 12%

IRR = 15.89%

NPV = $9,110

PI = 1.07

Size Disparity example

Project A

year	cash flow
0	(135,000)
1	60,000
2	60,000
3	60,000

required return = 12%

IRR = 15.89%

NPV = $9,110

PI = 1.07

Project B

year	cash flow
0	(30,000)
1	15,000
2	15,000
3	15,000

required return = 12%

IRR = 23.38%

NPV = $6,027

PI = 1.20

Size Disparity example

Project A

year	cash flow
0	(135,000)
1	60,000
2	60,000
3	60,000

required return = 12%

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Project B

year	cash flow
0	(30,000)
1	15,000
2	15,000
3	15,000

required return = 12%

IRR = 23.38%

NPV = $6,027

PI = 1.20

Problems with Project Ranking

2) The time disparity problem with mutually exclusive projects.

- NPV and PI assume cash flows are reinvested at the required rate of return for the project.
- IRR assumes cash flows are reinvested at the IRR.
- The NPV or PI decision may not agree with the IRR.
- **Solution:** select the largest **NPV**.

Time Disparity example

Project A	
year	cash flow
0	(48,000)
1	1,200
2	2,400
3	39,000
4	42,000

required return = 12%

IRR = 18.10%

NPV = $9,436

PI = 1.20

Time Disparity example

Project A

year	cash flow
0	(48,000)
1	1,200
2	2,400
3	39,000
4	42,000

required return = 12%

Project B

year	cash flow
0	(46,500)
1	36,500
2	24,000
3	2,400
4	2,400

required return = 12%

IRR = 18.10%

NPV = $9,436

PI = 1.20

IRR = 25.51%

NPV = $8,455

PI = 1.18

Time Disparity example

Project A year	Project A cash flow	Project B year	Project B cash flow
0	(48,000)	0	(46,500)
1	1,200	1	36,500
2	2,400	2	24,000
3	39,000	3	2,400
4	42,000	4	2,400
required return = 12%		required return = 12%	

Project A:

IRR = 18.10%

NPV = $9,436

PI = 1.20

Project B:

IRR = 25.51%

NPV = $8,455

PI = 1.18

Mutually Exclusive Investments with Unequal Lives

- Suppose our firm is planning to expand and we have to select 1 of 2 machines.
- They differ in terms of economic life and capacity.
- How do we decide which machine to select?

- The after-tax cash flows are:

Year	Machine 1	Machine 2
0	(45,000)	(45,000)
1	20,000	12,000
2	20,000	12,000
3	20,000	12,000
4		12,000
5		12,000
6		12,000

- Assume a required return of 14%.

Step 1: Calculate NPV

- NPV_1 = **$1,433**
- NPV_2 = **$1,664**

- So, does this mean #2 is better?
- No! The two NPVs can't be compared!

Step 2: Equivalent Annual Annuity (EAA) method

- **If we assume that each project will be replaced an infinite number of times in the future, we can convert each NPV to an annuity.**
- **The projects' EAAs can be compared to determine which is the best project!**
- **EAA: Simply annualize the NPV over the project's life.**

- **EAA_1 = $617**
- **EAA_2 = $428**
- **This tells us that:**
- **NPV_1 = annuity of <u>$617</u> per year.**
- **NPV_2 = annuity of <u>$428</u> per year.**
- **So, we've reduced a problem with different time horizons to a couple of annuities.**
- **Decision Rule: Select the highest EAA. We would choose machine #1.**

Step 3: Convert back to NPV_{∞}

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- Assuming infinite replacement, the EAAs are actually perpetuities. Get the PV by dividing the EAA by the required rate of return.

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- $NPV_{\infty 1}$ = 617/.14 = $4,407
- $NPV_{\infty 2}$ = 428/.14 = $3,057

Step 3: Convert back to NPV_{∞}

- Assuming infinite replacement, the EAAs are actually perpetuities. Get the PV by dividing the EAA by the required rate of return.
- $NPV_{\infty 1} = 617/.14 = \$4,407$
- $NPV_{\infty 2} = 428/.14 = \$3,057$
- This doesn't change the answer, of course; it just converts EAA to a NPV that can be compared.