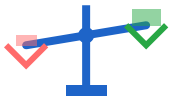
Cost-benefit Analysis

Costs		Benefits	
Initial Investment	-$500K	Productivity Gain	+$450K/yr
Training Time	-$120K	Quality Improvement	+$280K/yr
Infrastructure	-$200K	Risk Reduction	+$320K/yr
Maintenance	-$80K/yr	Indirect Benefits	+$180K/yr



ROI
185%
3 years

Payback Period
18 months

Key Principles of Cost-Benefit Analysis

1 Net Present Value (NPV)

NPV calculates the difference between the present value of benefits and costs over time. It accounts for the time value of money, recognizing that a dollar today is worth more than a dollar in the future due to its earning potential.

```
NPV = Σ [(Benefits - Costs) / (1 + r)^t]
```

Example: Software Implementation Project

A company invests $500K in new software with expected annual benefits of $300K for 3 years. Using a 10% discount rate:

Year 0: -$500K (initial cost)
Year 1: $300K / (1.10)^1 = $272.7K
Year 2: $300K / (1.10)^2 = $247.9K
Year 3: $300K / (1.10)^3 = $225.4K

NPV = -$500K + $272.7K + $247.9K + $225.4K = $246K

Since NPV is positive, the project is economically viable.

Total Benefits (PV)	Total Costs (PV)
$746K	$500K

2 Benefit-Cost Ratio (BCR)

The BCR compares the total present value of benefits to the total present value of costs. A ratio greater than 1.0 indicates that benefits exceed costs, making the project worthwhile.

```
BCR = Present Value of Benefits / Present Value of Costs
```

BCR Decision Framework

BCR < 1.0	BCR = 1.0	BCR > 1.0
❌ Reject Project	⚠️ Break-even	✅ Accept Project
Costs exceed benefits	No net gain	Benefits exceed costs

Example: Infrastructure Upgrade

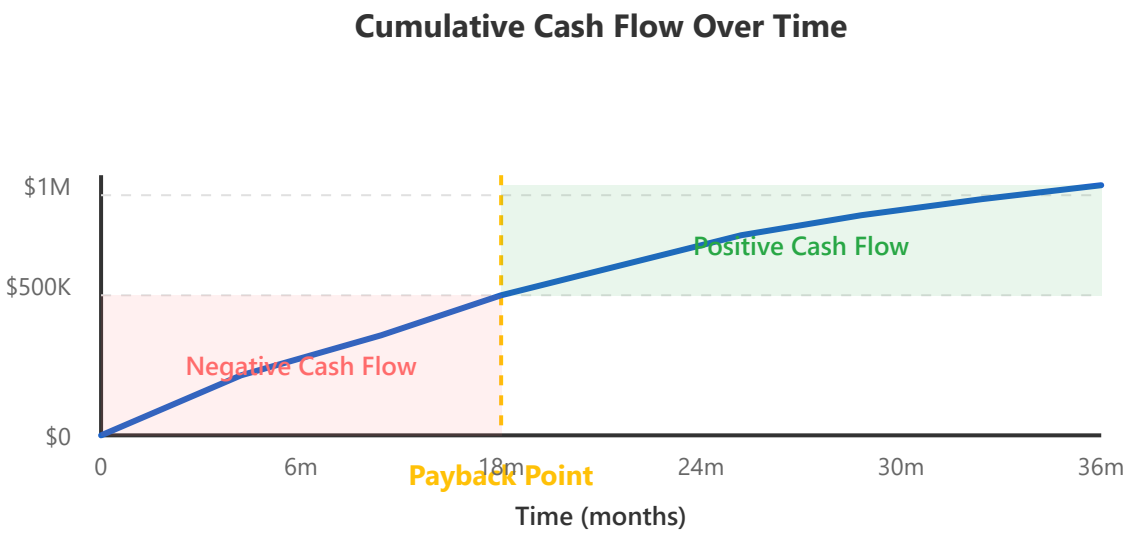
An infrastructure upgrade costs $900K with total benefits valued at $2.565M over its lifetime:

BCR = $2,565K / $900K = 2.85

For every dollar invested, the project returns $2.85 in benefits. This is a highly favorable investment with an 185% return rate.

3 Payback Period

The payback period measures how long it takes for cumulative benefits to equal the initial investment. Shorter payback periods indicate faster returns and lower risk.



Example: Automation System

An automation system costs $900K with annual net benefits of $600K:

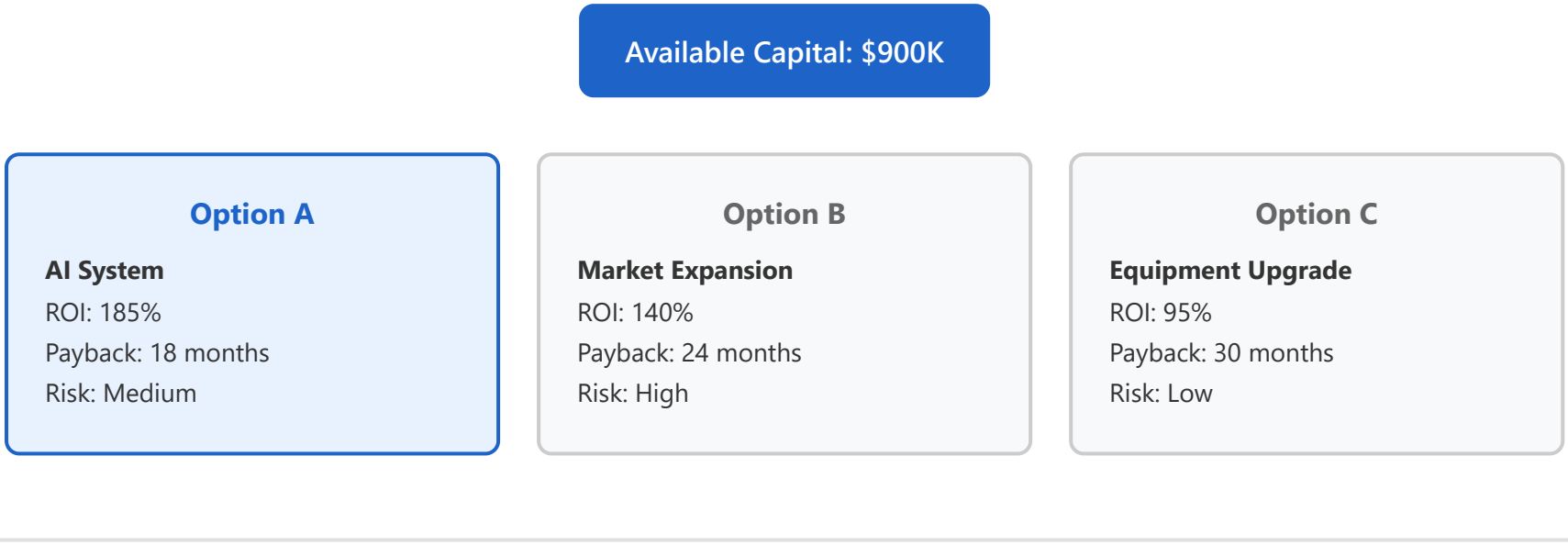
Payback Period = $900K / $600K per year = 1.5 years (18 months)

After 18 months, the project has recovered its initial investment. Any benefits beyond this point represent pure profit.

4 Opportunity Cost

Opportunity cost represents the value of the next best alternative foregone when making a decision. In cost-benefit analysis, resources allocated to one project cannot be used elsewhere.

Opportunity Cost Decision Tree



Example: Investment Decision

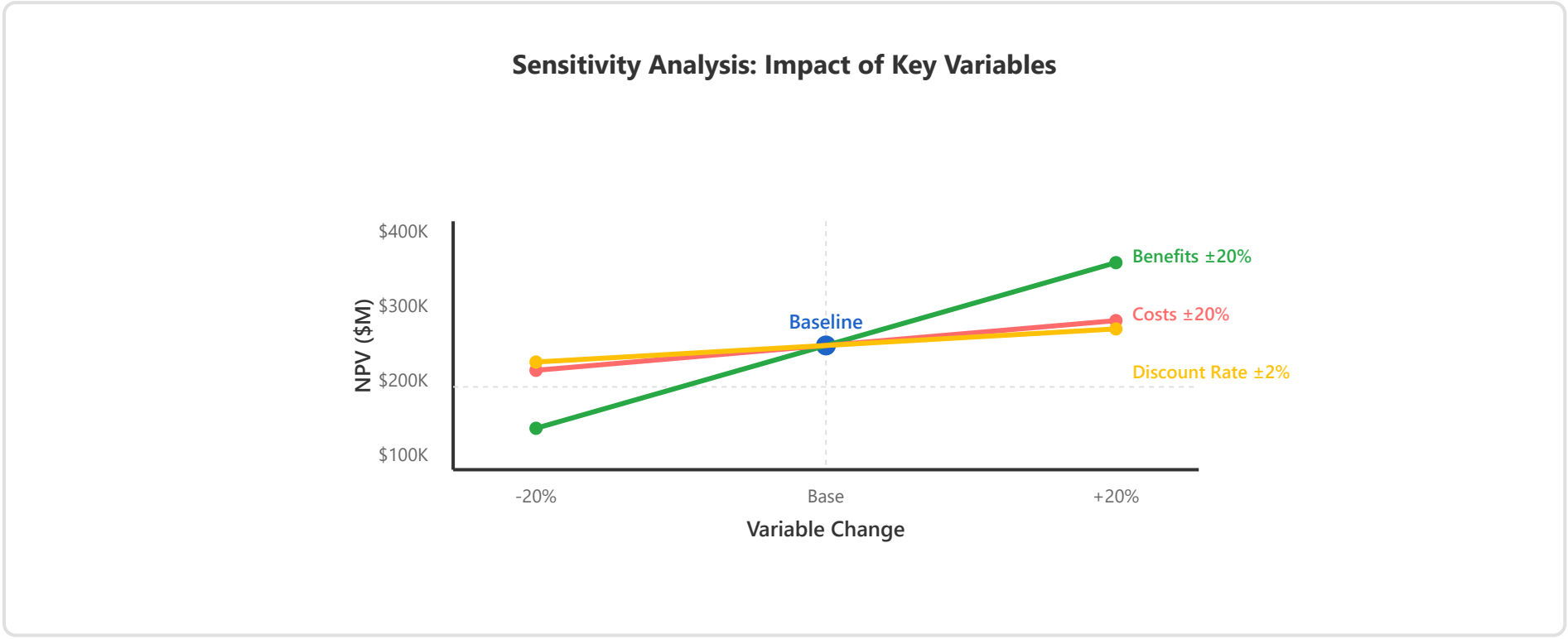
Choosing Option A (AI System with 185% ROI) means forgoing Option B (Market Expansion with 140% ROI).

Opportunity Cost = 140% ROI from Option B

However, since Option A provides a higher return (185% vs. 140%), it is the optimal choice. The net gain from making the right choice is 45% additional ROI compared to the next best alternative.

5 Risk Assessment & Sensitivity Analysis

Risk assessment evaluates the uncertainty and variability in projected costs and benefits. Sensitivity analysis tests how changes in key assumptions affect the project's viability.



Example: Sensitivity Testing

For our $900K project with baseline NPV of $246K:

If benefits decrease by 20%: NPV = $96K (still positive, project viable)
If costs increase by 20%: NPV = $146K (still positive, project viable)
If discount rate increases to 15%: NPV = $167K (still positive, project viable)

The analysis shows the project remains viable under various adverse scenarios, indicating **low risk** and robust returns. Benefits changes have the highest impact on NPV.

🎯 Key Takeaways for Risk Assessment

- **Most sensitive variable:** Benefits (steepest slope) - focus on accurate benefit estimation
- **Break-even threshold:** Benefits can drop 30% before NPV becomes negative
- **Risk mitigation:** Diversify benefit sources to reduce sensitivity
- **Contingency planning:** Build in 15-20% cost buffer for unexpected expenses