Part I

Project Valuation and Structuring

MOTIVATING EXAMPLE

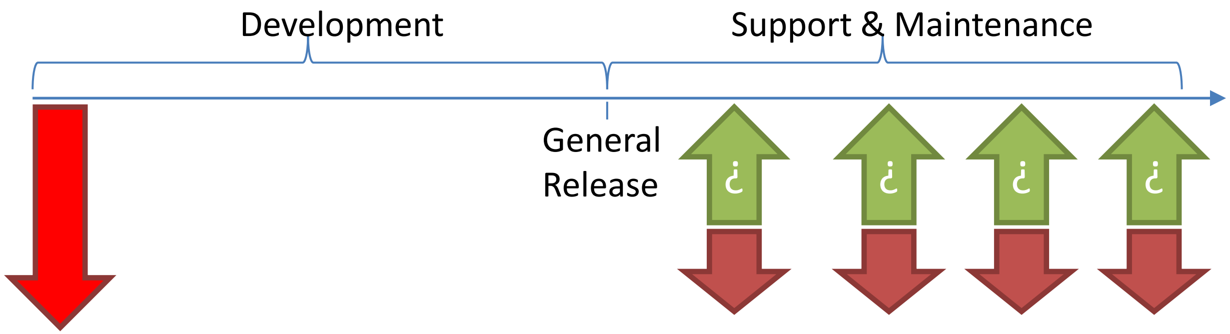
Trialweb

- New web-based service to support data automation and patient tracking for large clinical trials
- Subscription model
- Two strategies with different cost-benefit structure, flexibility, risk, and schedule:
  - A: Single general release targeted to the whole market: less work, more risky
  - B: First a custom release for a lead client with favourable terms, followed by a general release: more work, less risky
- Which strategy is more valuable?

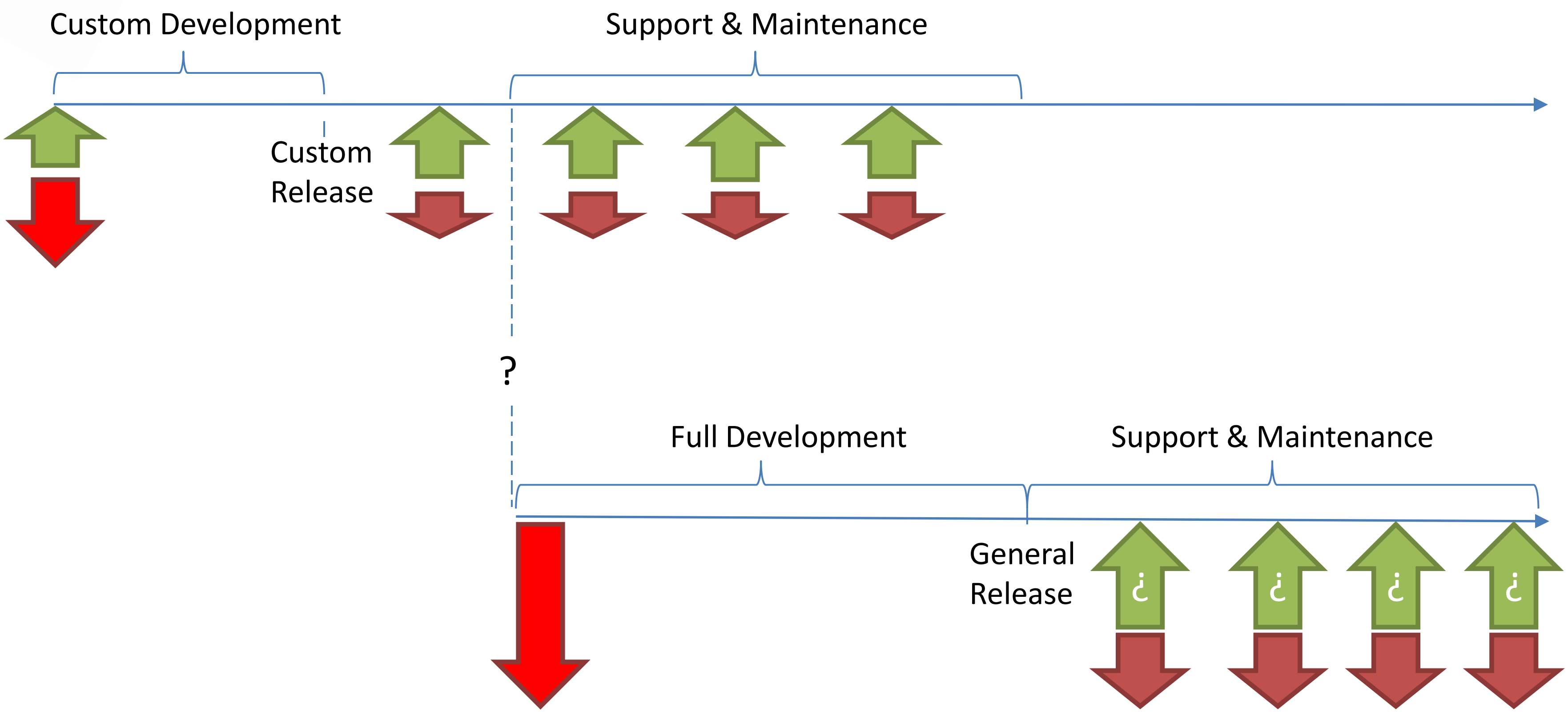
Why Lead Customer?

- Resolve uncertainty
  - Understand requirements
  - Resolve technical risks
    - System architecture
    - Usability
    - Underlying technologies
    - Performance

Strategy A: A Linear Project



Strategy B: A Staged Project

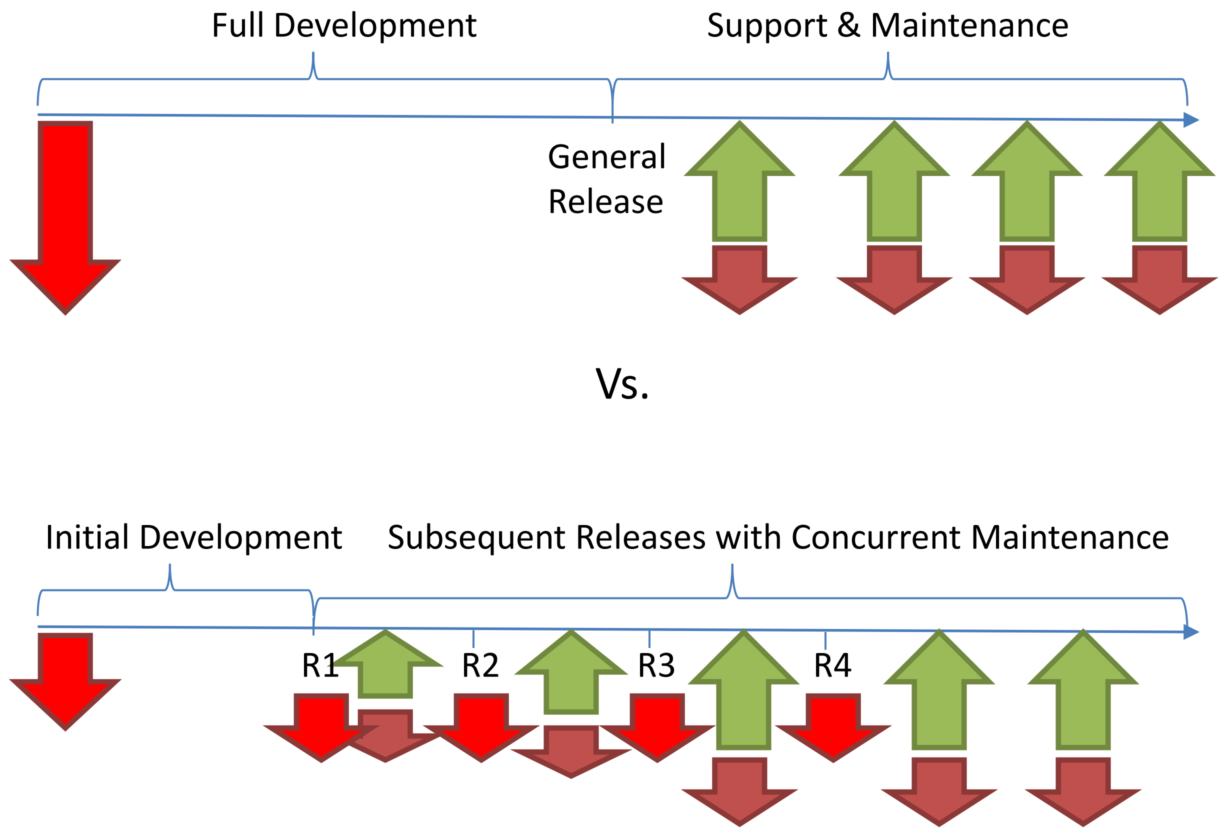


Drilling Down: A Sub-strategy

Must full development proceed in a single release?

Big-bang

Incremental



PART I KEY QUESTIONS AND ASSUMPTIONS

Key Questions

- What are the proper methods and indicators for valuing risky software projects?
  - to make go/no-go decisions
  - to choose among multiple alternatives

- How to structure risky software projects to maximize their value?
  - Why is incremental development good?
  - Why is staging good?

Key Assumption

It’s possible to estimate costs and benefits of a software project

They don’t need to be certain, but we have an idea about how uncertain they are

PRINCIPLES OF VALUATION

Project

- Activity requiring specific resources to produce a desired outcome with specific benefits
  - development of a new software package to be sold
  - an in-house enterprise IT venture to improve productivity
  - a software improvement initiative
  - development of a new framework for a future product line

- A project
  - has a beginning
  - often has an end, but may also run indefinitely

Project Value

- Net economic contribution of an activity
- Measured by Benefits – Costs
  - Costs: a function of activity's inputs
  - Benefits: a function of activity's outputs
  - Net Value = Benefits – Costs
    - *Ex-ante* (estimated, expected)
      or *ex-post* (realized, actual)
    - When *ex-ante* adjusted according to risk and time

Net Value Rule

If all relevant and important costs and benefits are accounted for:

NV[A] > 0 => A is economically feasible

In general:

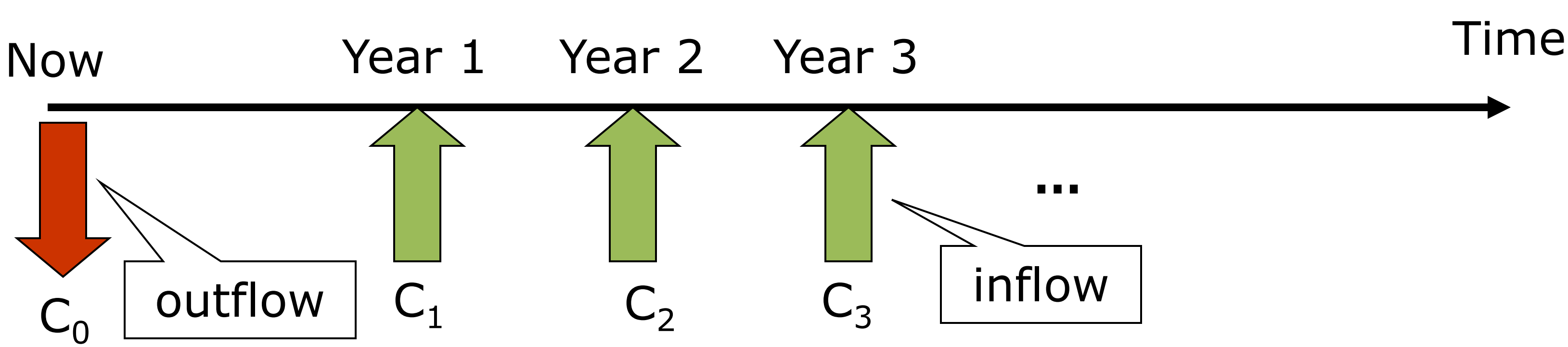
If NV[A] > NV[B] then

- A is more economically feasible than B
- A is preferable to B if they are interchangeable

Project Valuation

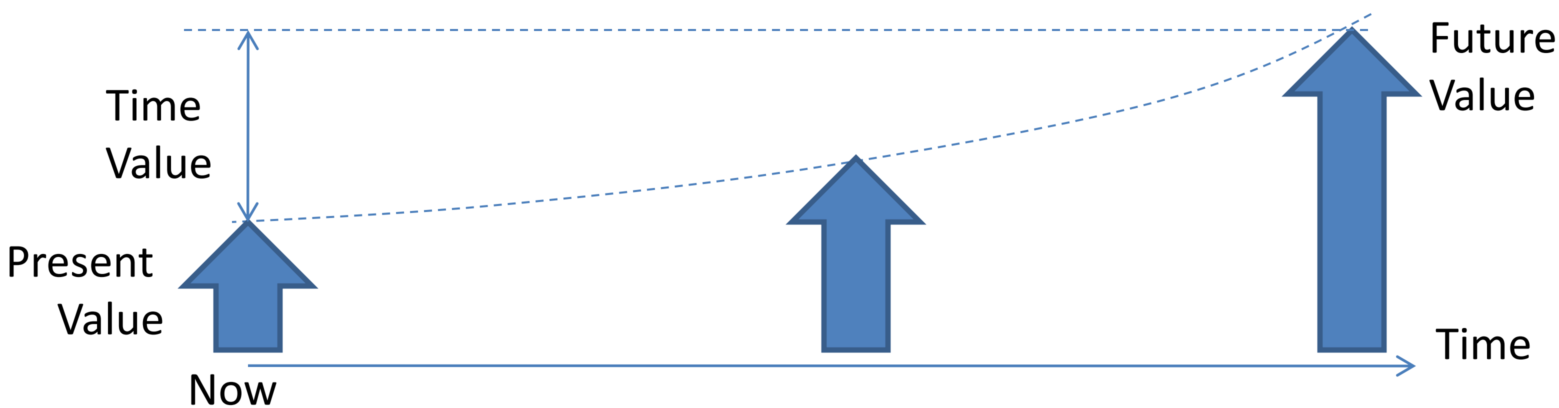
An activity's value is the sum of its expected future cash flows

- Positive cash flows (inflows) => benefits received (income or revenues)
- Negative cash flows (outflows) => costs incurred (expenses)



Time Value

- Money received or spent today is worth more than the same amount of money received or spent in the future
- Project's expected cash flows are adjusted according to when they occur before they can be compared
- Time Value = Future Value – Present Value

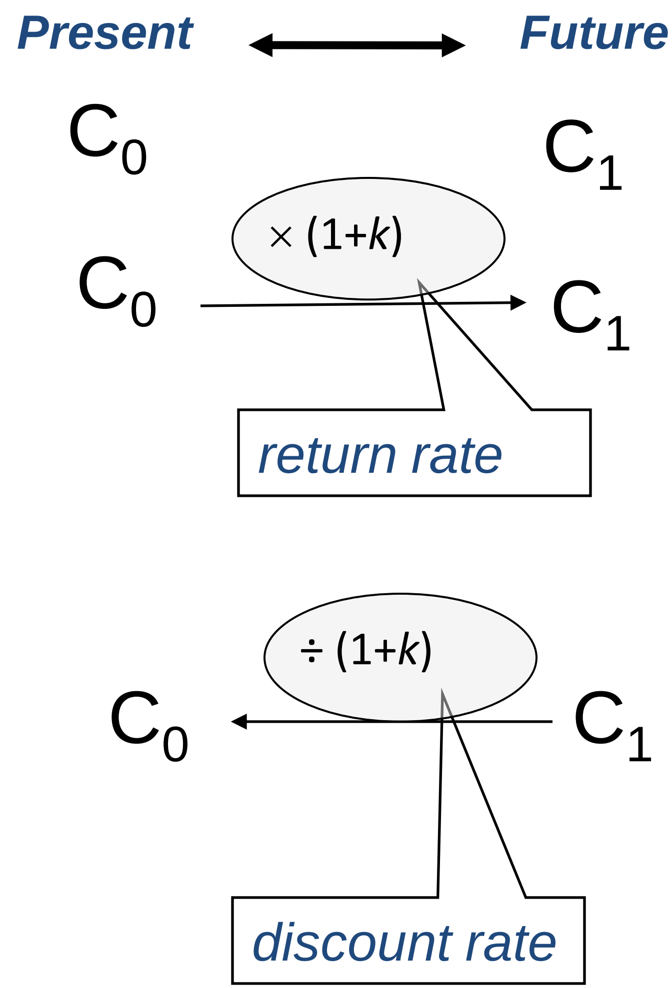


Present Value (PV)

- To sum cash flows that occur at different times. calculate what they are worth at *present*
- Present Value: the value of a future cash flow as though it were received today

Calculating Present Value

- Moving *forward* from present to future, an investment is expected to grow at a **return rate** ***k***
- Now turn it around: moving *backwards* from future to present, an investment shrinks with that same rate of return
- When moving back in time, the rate of backward adjustment is called the **discount rate**
  - is the process of backward adjustment that brings a future cash flow to the present is called *discounting*



Calculating Present Value

- Discount rates are expressed in per-period percentage terms (e.g. annual, monthly) and are compounded just like interest or return rates
- Let C be a cash flow occurring at a future time of T periods from the present
- Let k be a compound per period rate
    - *Expressed, e.g., as 0.1 or 10%*

- PV of C discounted at a discount rate k by T periods:

$$PV[C] = C/(1 + k)^T$$

Net Present Value (NPV)

NPV is the sum of the PV of a project's *expected* cash flows

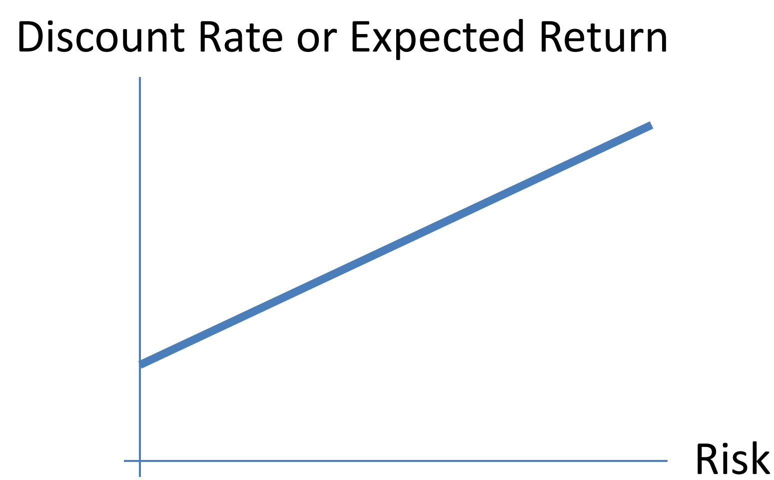
$$NPV = \sum_{i \geq 0} PV[C_i]$$

When time value is important, NPV replaces NV

Determining Discount Rate

- A project's discount rate depends on
  - country-specific economic & market conditions
  - organization's, sector's, and project's risk characteristics
  - uncertainty of its individual cash flows
  - organization's, sector's, and project's expected (or required) returns
  - project's and organization's capital structure

- Discount rate captures project's
  - riskiness
  - expected period return



Risk?

- Can be measured in different ways
  - Captures exposure to uncertainty
  - Correlates with variability of benefits and costs
- Has two components
  - Systematic/Market: applies to all projects within a given context
  - Unique/Private: project-specific
  - If owner of risk can diversify, only systematic/market risk matters
  - If owner of risk cannot diversify, total risk matters

NPV Rule

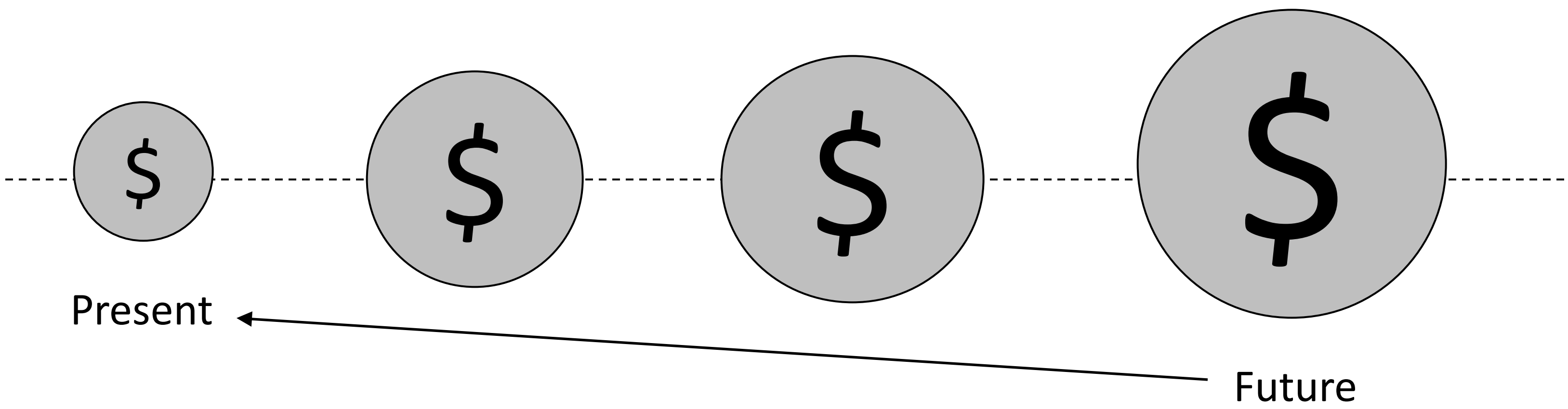
- NPV answers the question: is an activity likely to add value to the organization?

- NPV Rule
  - NPV > 0: activity likely to add value => **Accept**
  - NPV < 0: activity likely to destroy value => **Reject**

- NPV[A] > NPV[B] => A adds more value than B

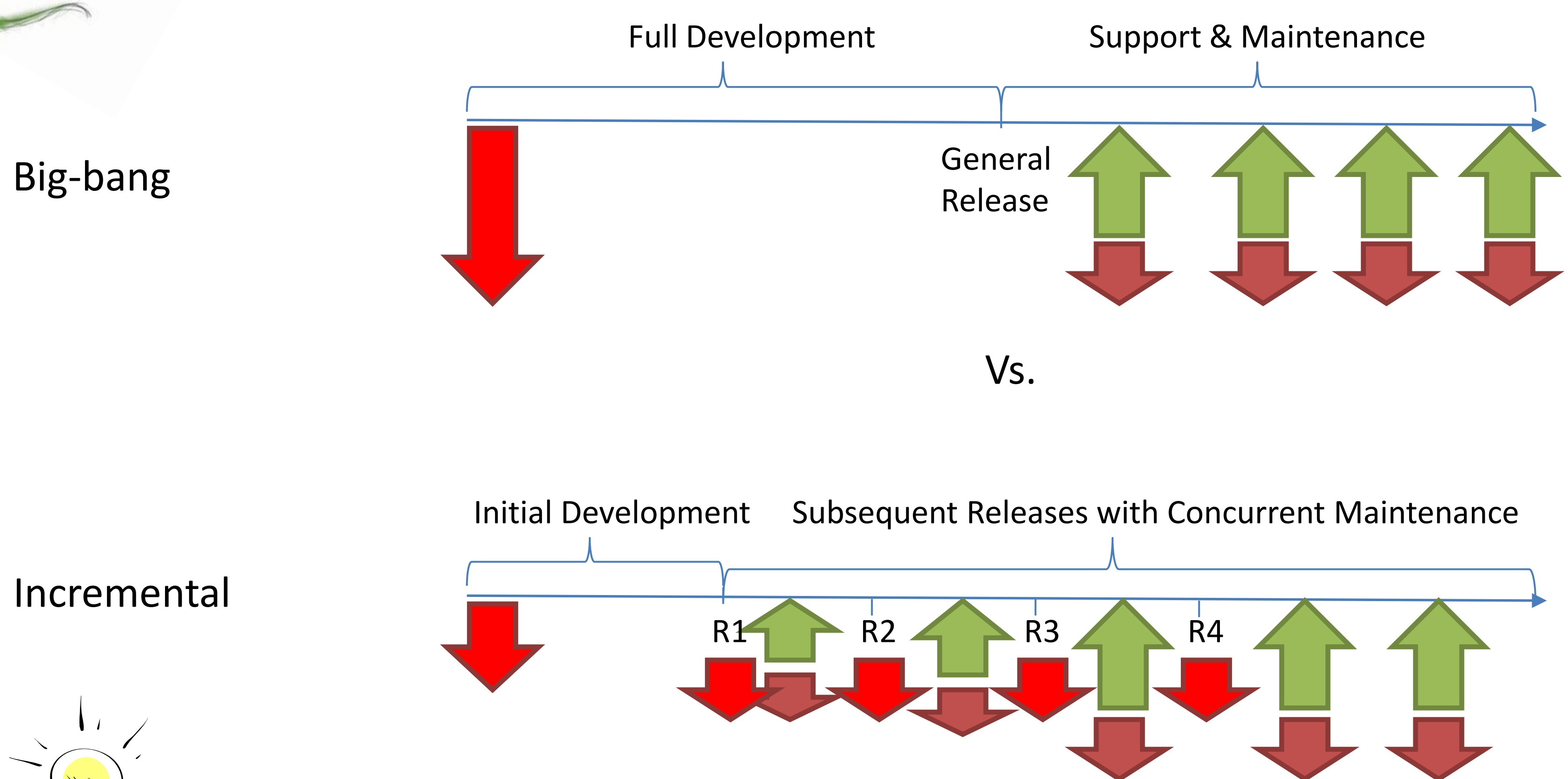
Impact of Time Value

Earn early: expedite benefits



Spend late: defer costs

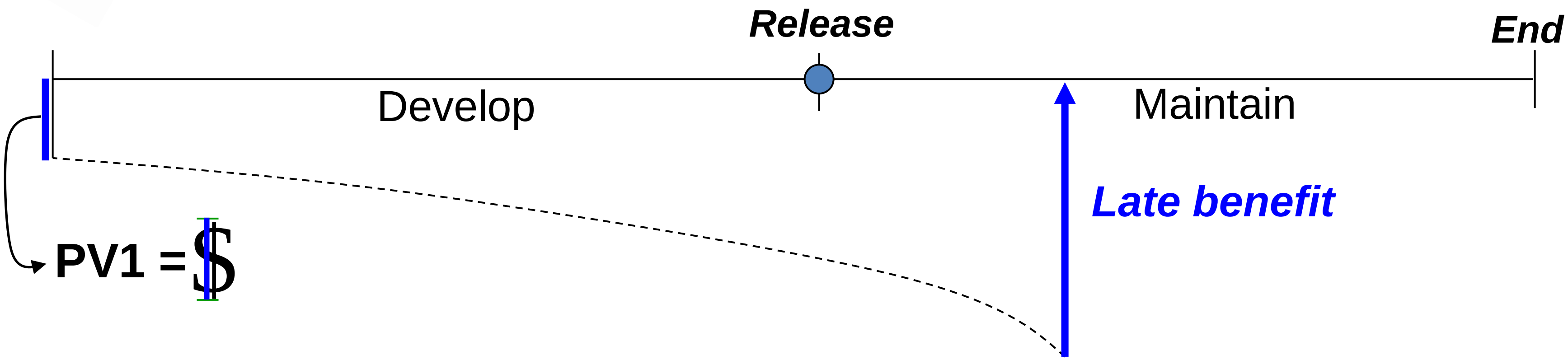
Time Value in Software Development



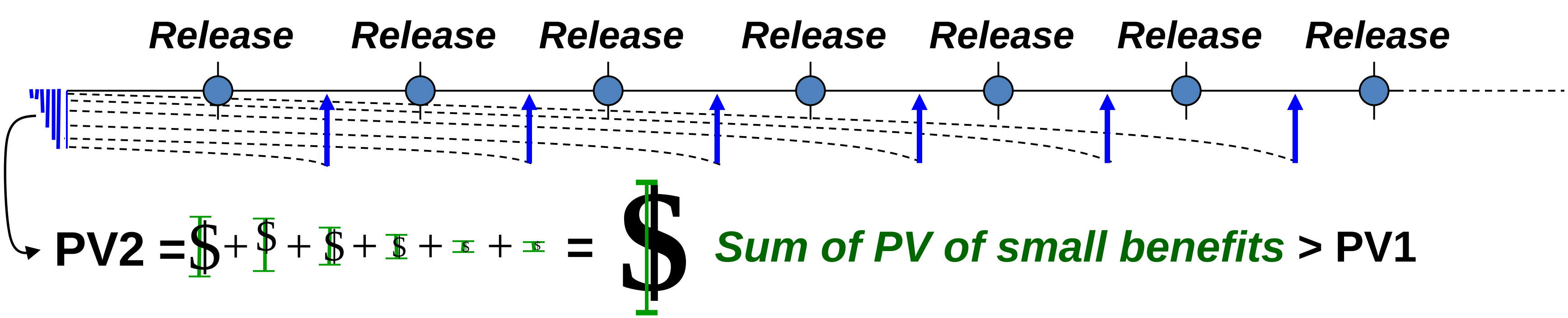
An incremental project creates more value than an equivalent big-bang project (with same total cost and benefit in absolute terms)!

Why is Incremental Development Valuable?

Big-bang: Late benefits, all at once



Incremental : Early benefits, in small chunks

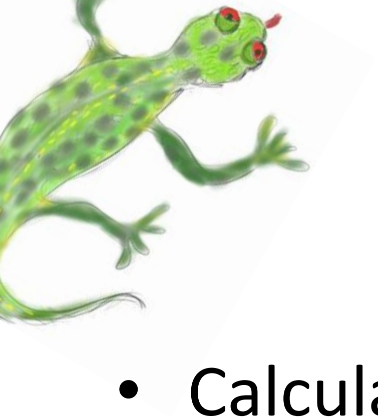


Why is Incremental Development Valuable?

- Reverse for costs if costs are committed incrementally (spread throughout the project) rather than being committed upfront

  => sum of PV of incrementally committed costs is smaller than total committed at project start

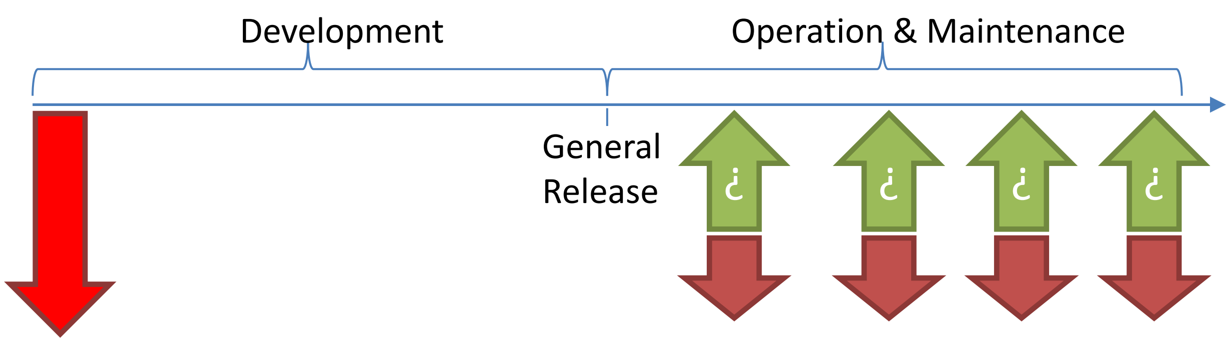
TRIALWEB: VALUE OF STRATEGY A



Key Objectives

- Calculate NPV in the context of a linear software project
- Identify the underlying data requirements
- Demonstrate Internal Rate of Return

Strategy A: Linear Project



Givens

- Development schedule
- Development cost
- Years Trialweb will be in operation
- Yearly maintenance & operation costs
- MedSoft’s assessment of the risk category of the project
- MedSoft’s required returns for new initiatives in different risk categories
- Marketing department’s assessment of revenues: 3 scenarios

Data: Schedule, Costs, Risk

- Development schedule: 2 years
- Development cost: team of 8 at $125K/person-year
- Years Trialweb will be in operation after release: 6
- Yearly maintenance & support costs: team of 4 at $100K/person-year

- MedSoft's assessment of the project's risk category

Risk Category	Required Return
External-High: *Never tried before or Critical*	30%
External-Medium: *Business as usual*	20% ⇐
External-Low: *Repeat or Guaranteed income*	10%
Internal-Low: *Routine IT- or automation initiative*	10%
Internal-High: *Introduce new process*	20%

Discount Rate = Required Return = 20% (0.2) per year

Data: Benefits

- Market: 30 potential customers for whom automated data collection and patient tracking is worth between $200-$500K/year.
- Yearly subscription price set at $100K for optimal affordability

Scenario	# of Customers	Yearly Revenues	Likelihood
Worst	2	$200K	1/4
Nominal	10	$1000K	1/2
Best	20	$2000K	1/4

- Expected revenues: $1050K

Strategy A Value

Year	0	1	2	3	4	5	6	7	**Total**	
Dev. Cost	-2000									
Maint. Cost			-400	-400	-400	-400	-400	-400		
Revenues			1050	1050	1050	1050	1050	1050		
Net	-2000	0	650	650	650	650	650	650	**1900**	NV
PV of Net	-2000	0	451	376	313	261	218	181	**-199**	NPV

$650/(1+0.2)^4$

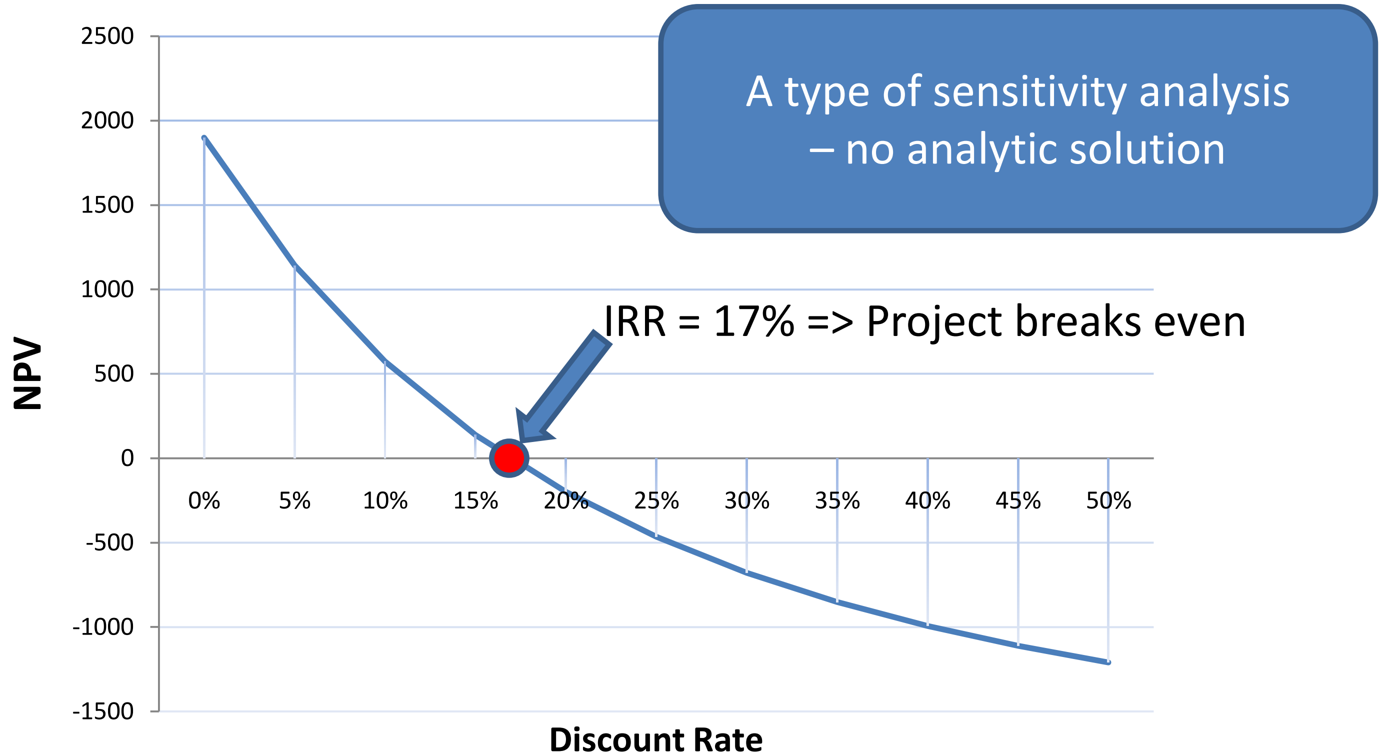
$650/(1+0.2)^7$

NV > 0, ROI = NV/(Dev. Cost) = 1900/2000 = 95% => Looks profitable

But, NPV < 0 => Doesn't add value (compared to alternative projects that can yield better returns for similar risk)

Internal Rate of Return (IRR)

- Plot NPV as a function of discount rate
- Determine the discount rate where NPV becomes 0 => gives IRR



- If IRR < Required Return then project does not meet expectations
- A project with larger IRR breaks even easier

Strategy A Summary

- NV is positive, but NPV is negative
- IRR is below required return for projects in similar risk category

- A no-go!

FLEXIBILITY AND VALUE

Flexibility and Uncertainty

Consider two airline tickets (same route, class, dates, …)	Consider two scenarios -- which ticket would you buy?
– Ticket A is non-refundable, non-changeable and costs \$300 (inflexible)	– Scenario 1 (Certain): You can’t think of a reason that will prevent you from traveling on the ticket’s date
– Ticket B is refundable at an admin. fee of \$50 and costs \$600 (flexible, has refund option)	– Scenario 2 (Uncertain): You have lots of work, there is a 60% chance that your boss will ask you to stay behind

Ticket B is more valuable under Scenario 2, but not Scenario 1, because…

Airline Ticket Decision

<u>Scenario 1 (Certain)</u>

Expected final cost:

- Ticket A: $300
- Ticket B: $600

Choose A (inflexible)

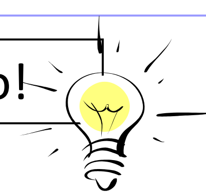
<u>Scenario 2 (Uncertain)</u>

Expected final cost:

- Ticket A: $300
- Ticket B: (0.4)*$600 + (0.6)*($50) = $270

Choose B (flexible)

Flexible ticket has value only under uncertain scenario!

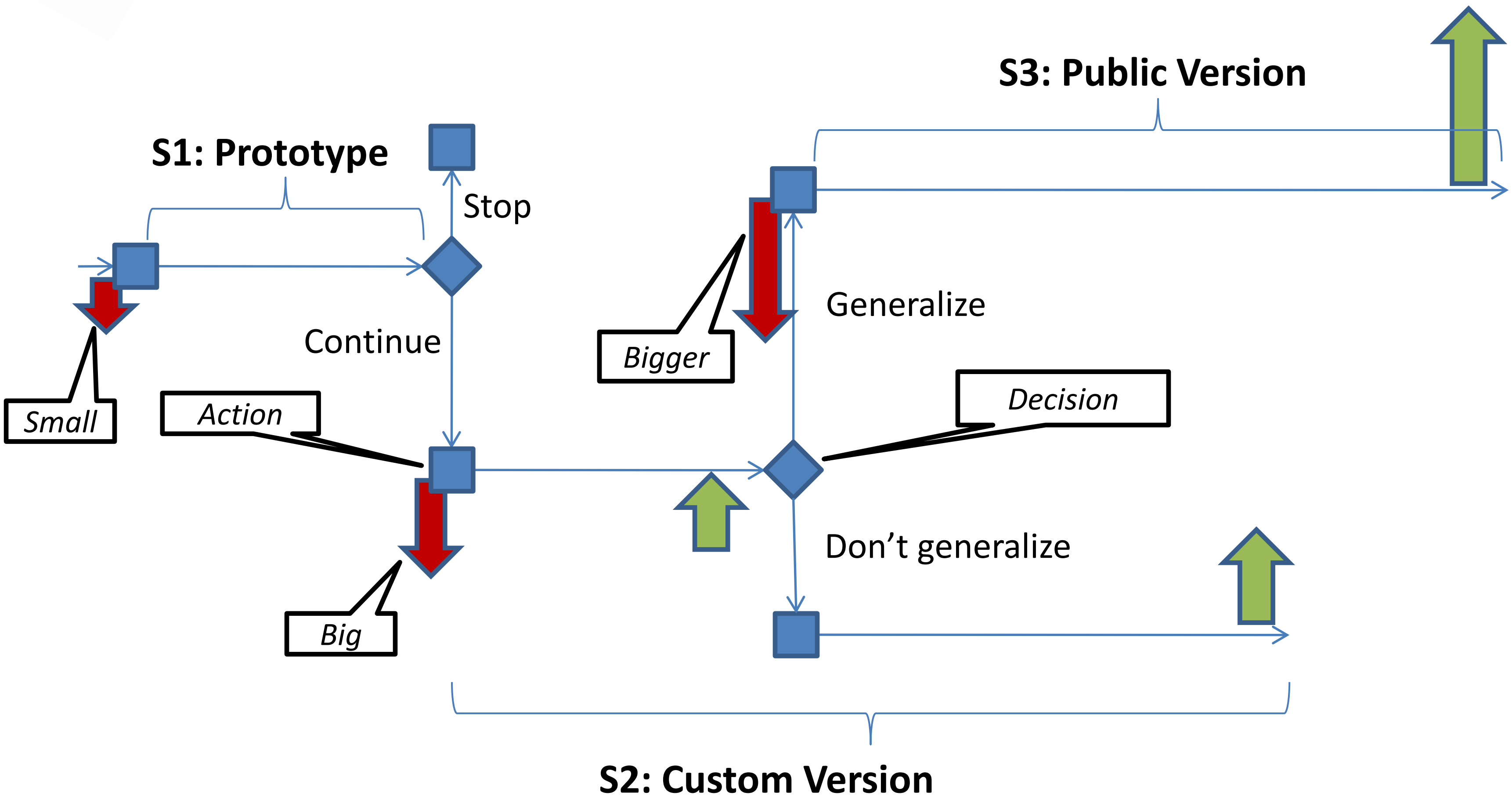


Flexible Projects

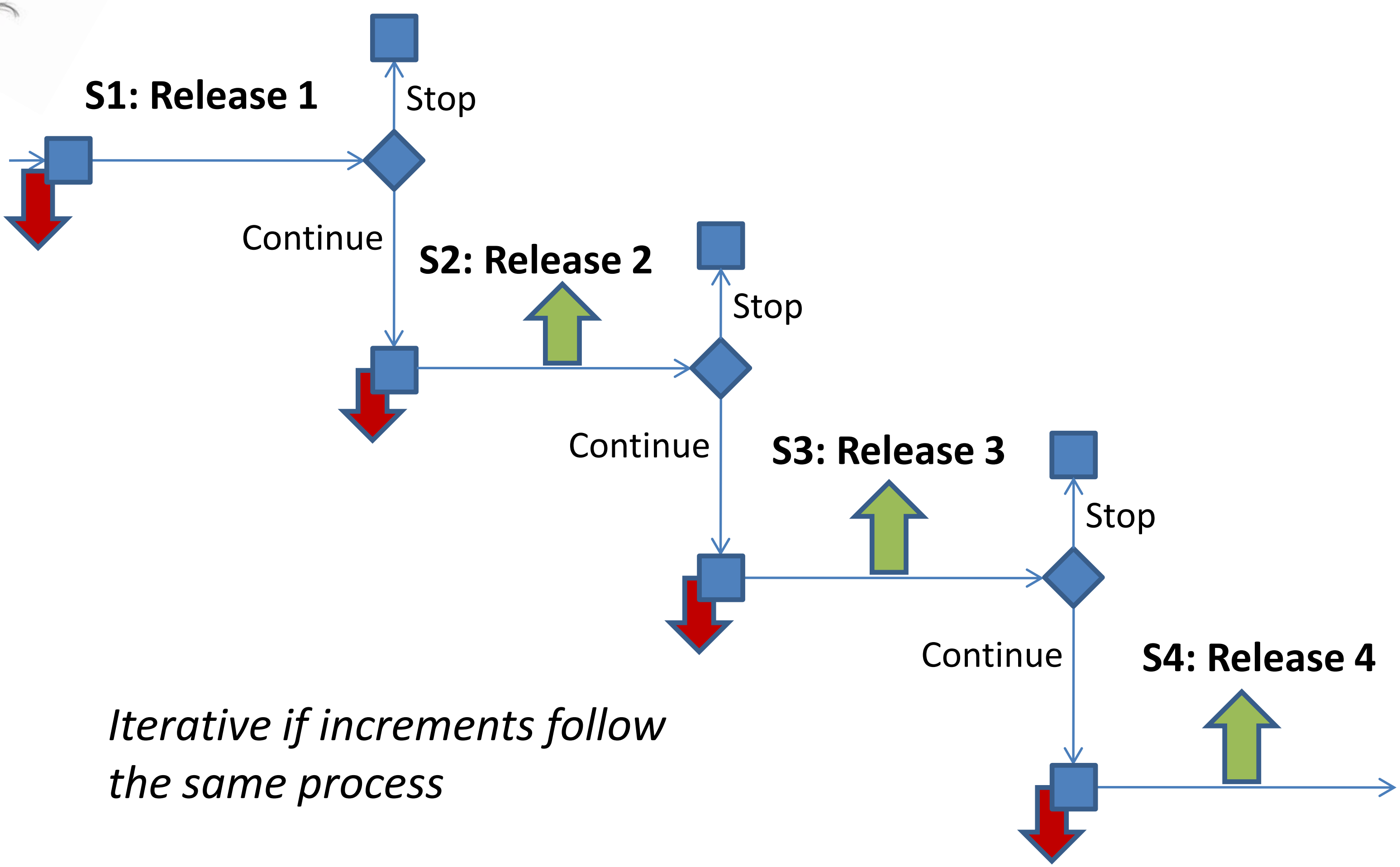
- A flexible project with intermediate or delayed investment decisions is just like a flexible airline ticket
  - Has extra value under uncertainty
  - Doesn’t have extra value if there is no uncertainty

- Flexibility can be achieved by
  - Delaying investment decisions
  - Staging: structuring the project as a sequence of stages
    - Each stage partially resolves project uncertainty
    - Each stage requires an associated investment decision represented by a choice among different courses of action to take

A Typical Staged Project



An Incremental Project is a Staged Project



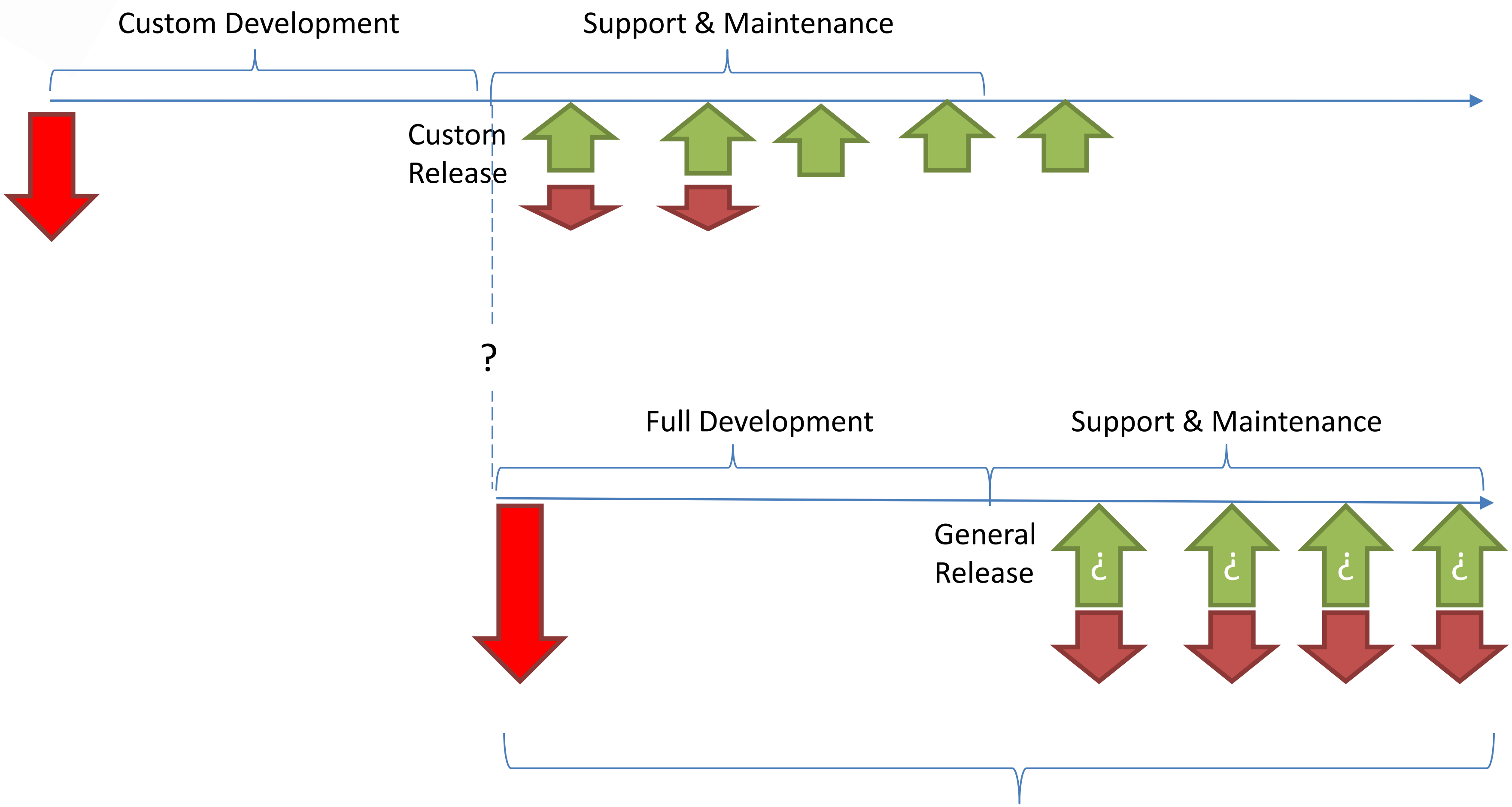
Iterative if increments follow the same process

TRIALWEB: VALUE OF STRATEGY B

Key Objectives

- Show how to structure an uncertain software project for increased flexibility
- Calculate NPV for a staged software project
- Illustrate why flexibility is valuable under uncertainty
- Provide a modern interpretation of flexibility

Strategy B: Lead Customer First



Structurally same as Strategy A, but is optional and has reduced risk

Additional Givens

- Custom development schedule
- Custom development cost
- Yearly maintenance & operations costs for lead customer
- MedSoft’s assessment of the risk category of the full development stage (subproject) after development and initial operation of custom version

Data: Schedule, Costs, Risk

- Custom development schedule: 1 year
- Full development decision: Immediately after custom version release
- Custom development cost: team of 8 at $125K/person-year
- Full development cost: team of 12 at $125K/person-year
- Full development schedule: 1 year
- Yearly maintenance & support costs for lead customer: 1 person at $100K/person-year for 2 years; no maintenance thereafter if full version is not developed
- Full development stage's risk category following development of custom version

Risk Category	Required Return
External-High: *Never tried before or Critical*	30%
External-Medium: *Business as usual*	20%
External-Low: *Repeat or Guaranteed income*	10%
Internal-Low: *Routine IT- or automation initiative*	10%
Internal-High: *Introduce new process*	20%

Data: Benefits

- 50% subscription discount for lead customer
- Prospects for full version are same as Strategy A but will be narrowed down to one of the 3 scenarios as being dominant outcome following development of the custom version

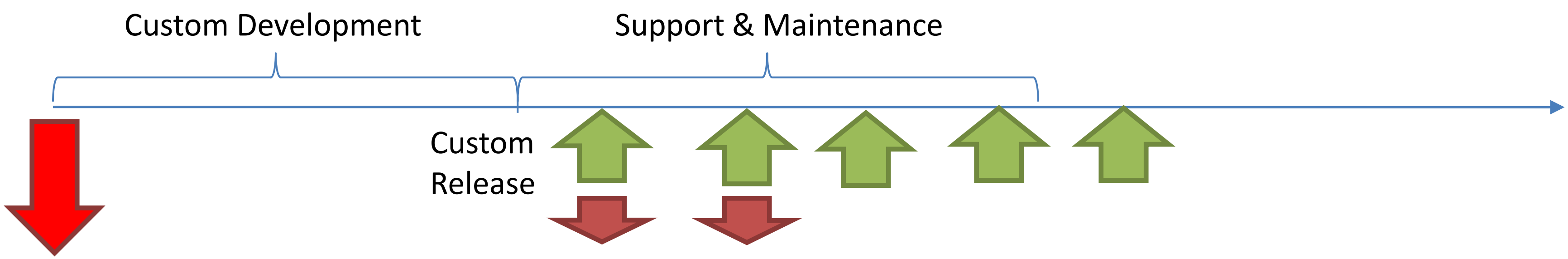
Scenario	# of Customers	Yearly Revenues	Likelihood
Worst	1 additional	$200K	1/4
Nominal	9 additional	$1000K	1/2
Best	19 additional	$2000K	1/4

Valuation of Staged Project

- Separate project into disjoint **static** (**unconditional**) and **dynamic** (**optional**) parts
- Static part => Value as a linear subproject
- Dynamic part => Value as a separate subproject using dynamic programming starting from the furthest decision

Strategy B - Static Part

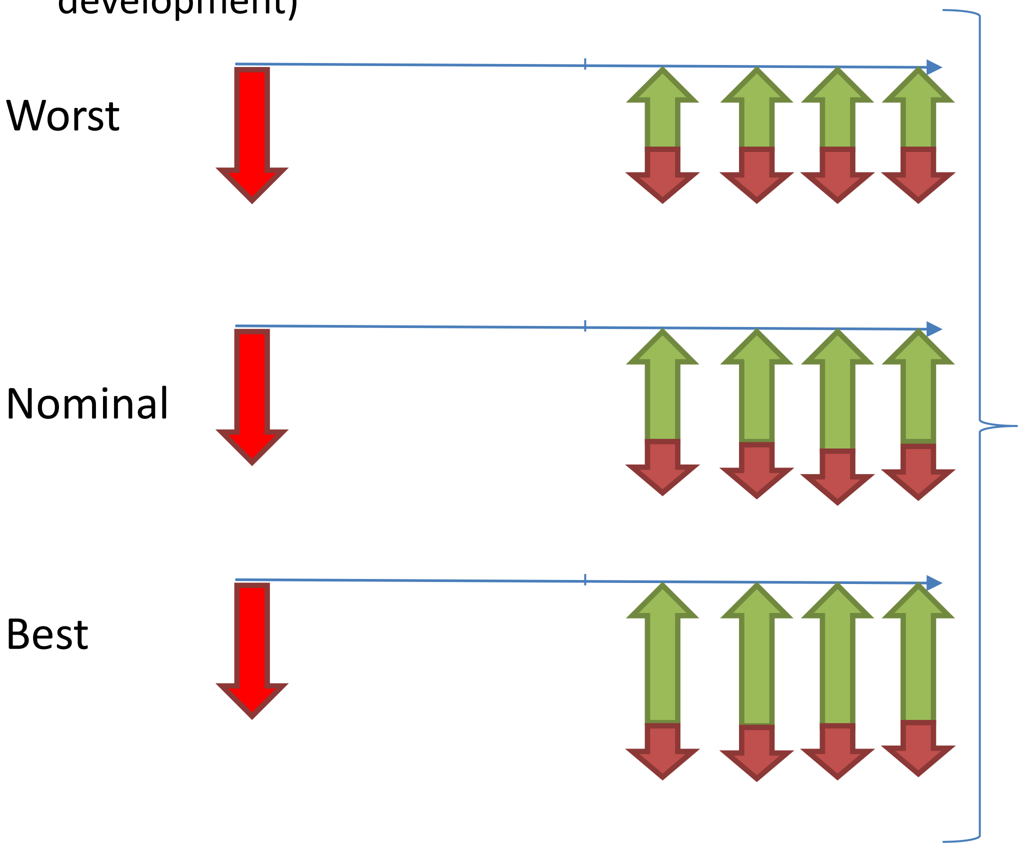
- No decision, more risky



Discount Rate	Year	0	1	2	3	4	5	6	7	**Total**	
	Custom Development Cost	-1000									
	Revenues Lead Customer		50	50	50	50	50	50	50		
	Maintenance Cost Custom Version		-100	-100	---- No custom maintenance ----						
	Net	-1000	-50	-50	50	50	50	50	50		
20%	PV of Net	-1000	-42	-35	29	24	20	17	14	**-973**	NPV(S)

Strategy B -Dynamic Part

- Starts with full development decision; treat it as a subproject
  - Optional
  - Less risky (like a repeat project, market uncertainty resolved by the end of custom development)



- Value each scenario separately using reduced discount rate
- Only those with positive NPV result in a full development decision

Dynamic Part NPV

Disc. Rate	Year	0	1	2	3	4	5	6	7	Total
	Worst Case									
	Full Development Cost		-1500							
	Maintenance Cost Full Version			-400	-400	-400	-400	-400	-400	
	Revenues Additional Customers			100	100	100	100	100	100	
	Net		-1500	-300	-300	-300	-300	-300	-300	
10%	PV of Net @ Year 1		-1500	-273	-248	-225	-205	-186	-169	**-2807**
	Decision									**STOP**
	PV of Net @ Year 1 after decision									**0**
	Nominal Case									
	Full Development Cost		-1500							
	Maintenance Cost Full Version			-400	-400	-400	-400	-400	-400	
	Revenues Additional Customers			900	900	900	900	900	900	
	Net		-1500	500	500	500	500	500	500	
10%	PV of Net @ Year 1		-1500	455	413	376	342	310	282	**678**
	Decision									**FULL DEV**
	PV of Net @ Year 1 after decision									**678**
	Best Case									
	Full Development Cost		-1500							
	Maintenance Cost Full Version			-400	-400	-400	-400	-400	-400	
	Revenues Additional Customers			1900	1900	1900	1900	1900	1900	
	Net		-1500	1500	1500	1500	1500	1500	1500	
10%	PV of Net @ Year 1		-1500	1364	1240	1127	1025	931	847	**5033**
	Decision									**FULL DEV**
	PV of Net @ Year 1 after decision									**5033**

Aggregating Scenaorios

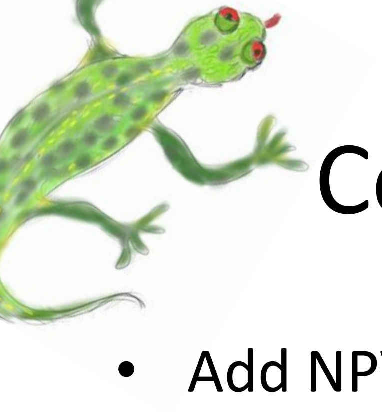
- Aggregate NPVs for 3 scenarios of the dynamic part by calculating their expected value

Expected NPV @ decision (Year 1) = .25*0 + 0.5*678 + 0.25*5033

= 1597

- Discount expected NPV @ decision to the start of whole project

Expected NPV @ Year 0 = 1597/(1 + 0.10) = 1452 NPV(D)



Combining Subproject Results

- Add NPV of static and dynamic parts

  NPV of Strategy B = NPV(S) + NPV (D)
  = -973 + 1452
  = 479

- *Recall*: NPV of Strategy A = -199

Why is Strategy B More Valuable?

Because of the STOP decision preventing losses from being incurred in the worst-case scenario

Worst Case								
Full Development Cost	-1500							
Maintenance Cost Full Version		-400	-400	-400	-400	-400	-400	
Revenues Additional Customers		100	100	100	100	100	100	
Net	-1500	-300	-300	-300	-300	-300	-300	
PV of Net @ Year 1	-1500	-273	-248	-225	-205	-186	-169	**-2807**
Decision								**STOP**
PV of Net @ Year 1 after decision								**0**

vs.

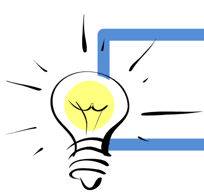
Worst Case								
Full Development Cost	-1500							
Maintenance Cost Full Version		-400	-400	-400	-400	-400	-400	
Revenues Additional Customers		100	100	100	100	100	100	
Net	-1500	-300	-300	-300	-300	-300	-300	
PV of Net @ Year 1	-1500	-273	-248	-225	-205	-186	-169	**-2807**
Decision								**FULL DEV**
PV of Net @ Year 1 after decision								**-2807**

Otherwise NPV of Strategy B would have been -159, almost as bad as Strategy A

Staged Projects Have Embedded Options

- The conditional full development subproject in Strategy B is referred to as a (**real**) **option**
- Options embedded in a risky project increase the project's NPV
- The more uncertain the outcome of a project, the more valuable the options contingent on that outcome

-- *just like a financial option on a stock*

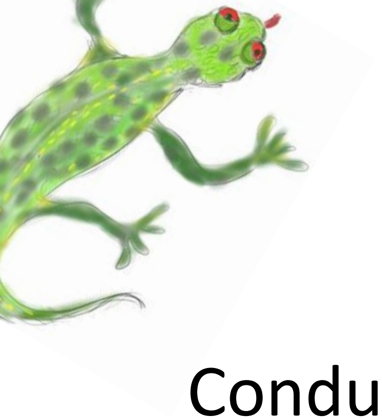


Flexibility = Options

Trialweb Key Insight

Medsoft is better off structuring Trialweb as a staged project if it can secure a lead customer to resolve project uncertainty

SENSITIVITY ANALYSIS

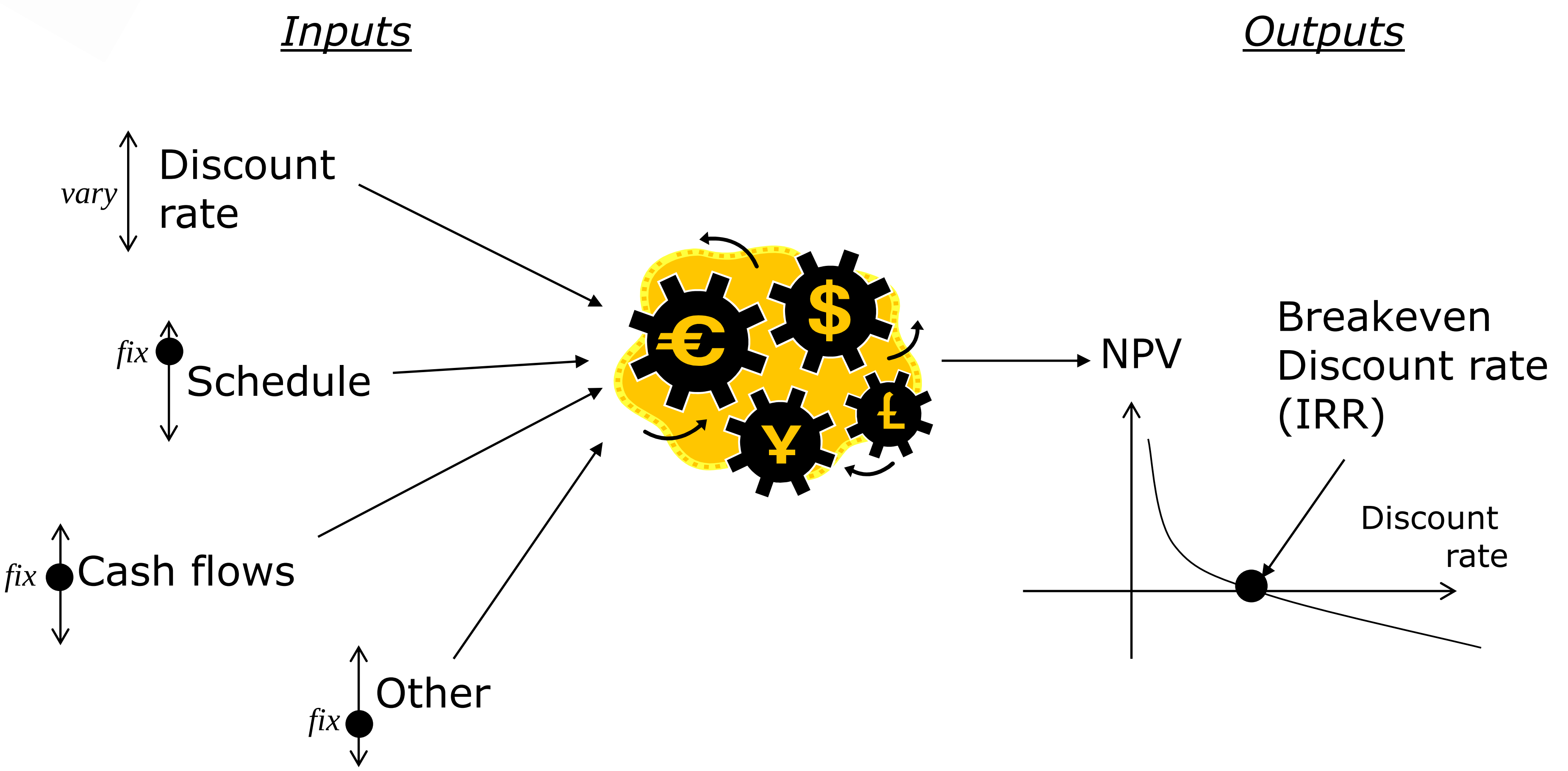


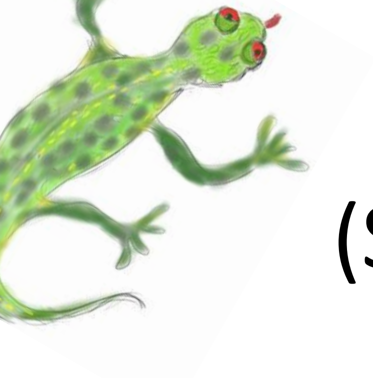
From Numbers to Behavior

Conduct sensitivity analysis to understand

- How sensitive value is to variations in inputs
- Breakeven thresholds
  - At what discount rate does the project break even?
  - In how many years will the project break even?
  - What is the minimum unit price that makes the project break even in X years?
  - What percentage of market share should be captured to break even in X years?

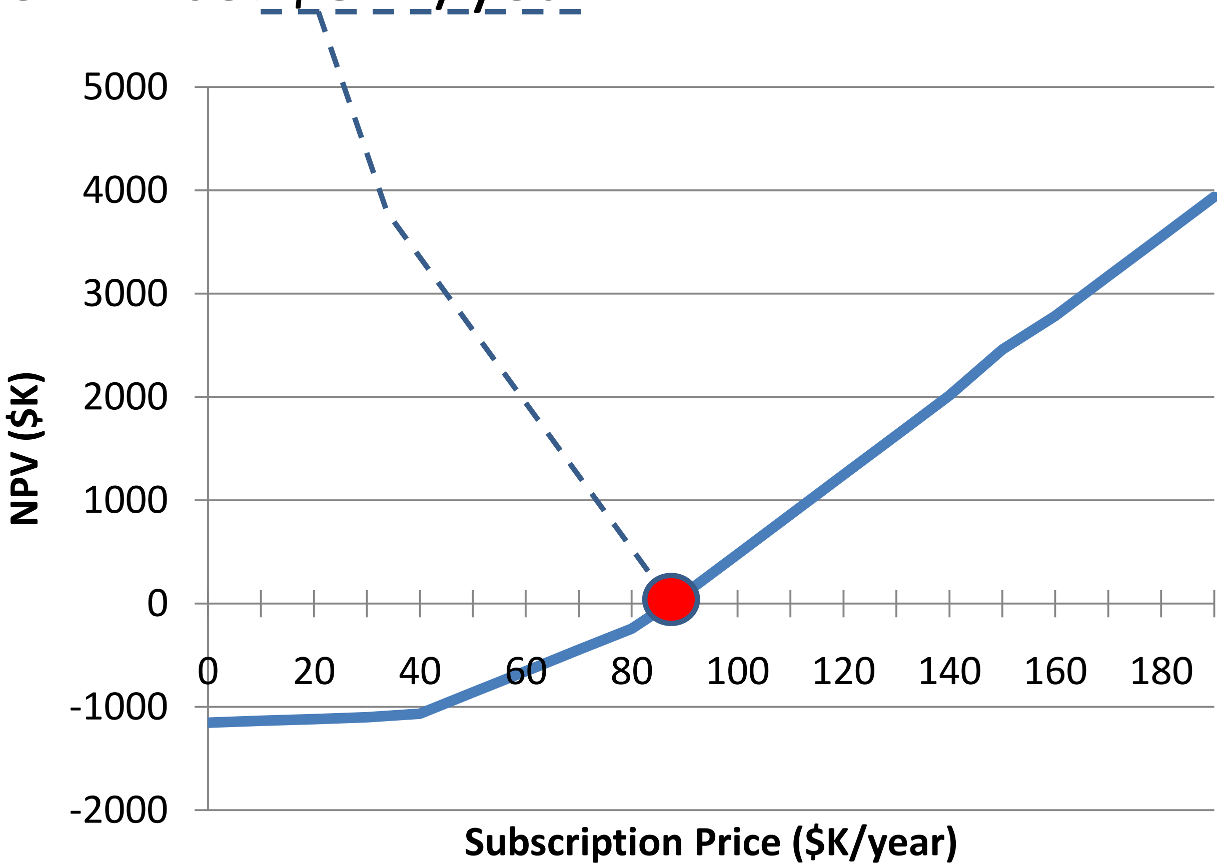
Sensitivity Analysis: IRR





Trialweb Sensitivity Analysis (Scenario B – Subscription Price)

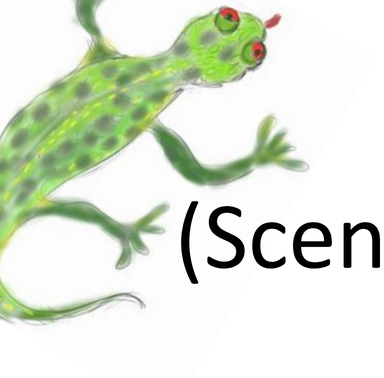
Breakeven Price: $87K/year



IRR = Breakeven Discount Rate

- Pros of IRR:
  - Leverages break-even analysis to avoid choosing a discount rate
  - Allows comparison with required or average return of projects with similar risk

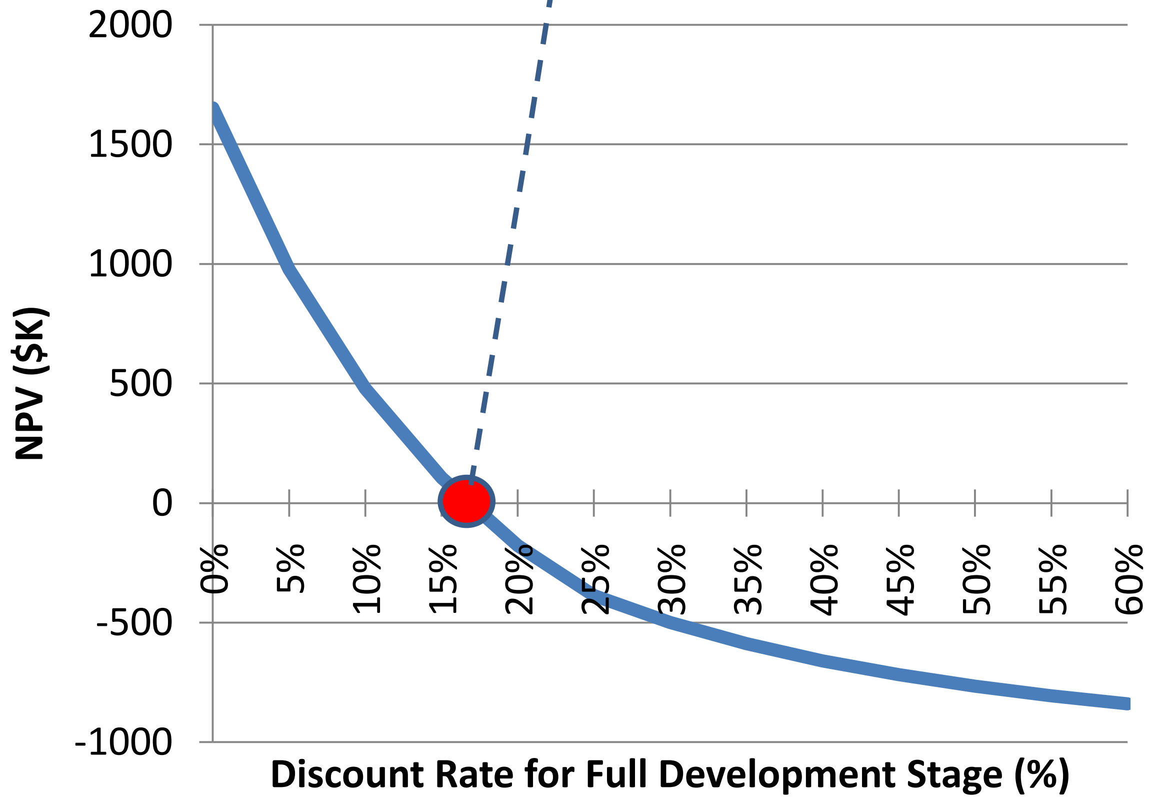
- Cons of IRR:
  - Not always unique (in projects having atypical or chaotic cash flows)
  - Not suitable for comparing projects that require drastically different upfront investment costs
    - $1K project with 100% IRR vs. $10M project with 10% IRR: which is better?



Trialweb Sensitivity Analysis (Scenario B – Discount Rate of 2nd Stage)

IRR for Full Development: 16.5%

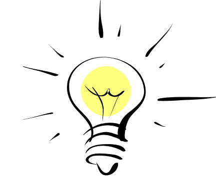
Above required return of 10% for low-risk projects



PART I KEY MESSAGES

Focus on Behaviour

- Conduct sensitivity analysis
- Calculate breakeven values



Is Time Value Important?

- Are costs and benefits uncertain?
- Does the timing of costs and benefits matter?

If so…

- – Determine when resources will be committed
- – Estimate when benefits will be realized (*for external projects*) or when outcomes become usable or operational (*for internal projects*)
- – Identify what discount rate applies to projects (subprojects, stages) of different type and with different risk characteristics
- – Use NPV

To Maximize Value

- Delay costs, accelerate benefits
- Deliver benefits incrementally
- Structure risky projects to increase their flexibility

ANNEX: DISCOUNT RATE ESTIMATES FOR HEALTH CARE INFORMATICS (2010)

Diversified Firm

- US
  - 8% based on average industry Cost of Capital*
  - **Above 8%** depending on diversification ability

- Europe
  - Industry Market Risk (Beta)*: .64
  - Market Risk Premium: 5%
  - Risk-free Rate (Germany): 2.7%
  - Cost of Equity: 2.7% + .64(5%)= 5.9%
  - **Around 6%** depending on actual capital structure, borrowing rate and diversification ability

Undiversified Firm

- US (Typical)
  - Avg. Tax Rate*: 12%
  - Industry Total Risk (Total Beta)*: 4.14
  - Target Capital Structure: 23% debt and 77% equity
  - Firm Total Risk (Total Beta): 4.4(1 + (1 – 12%)(23%/77%)) = 5.3
  - Risk-free Rate: 3.3%
  - Market Risk Premium: 5%
  - Cost of Equity = 3.3% + 5.3(5%) = 30%
  - **Below 30%** depending on actual capital structure and borrowing rate

*2009 Data

Sources

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