Discounting Effectiveness

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What are we talking about?

A class of decision problems characterized by:

- multiyear profile
- importance of timeliness
- changing effectiveness

Examples might include:

- adding R&D capacity
- developing an in-house capability
- building strategic partnerships

But we’re going to talk about some boats…

Once upon a threat…

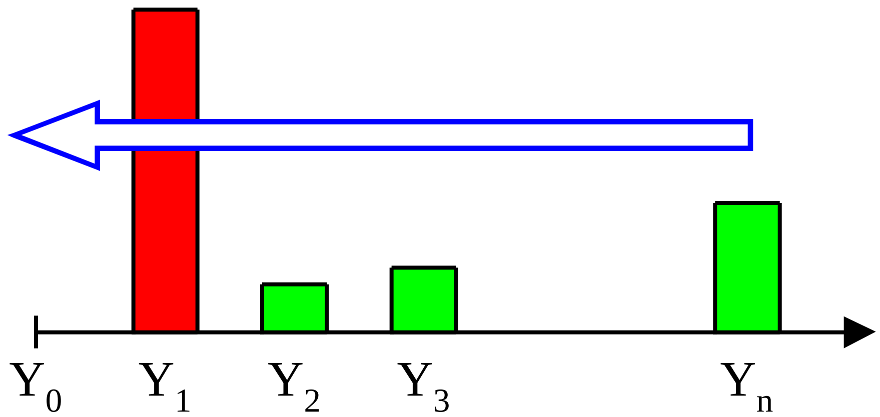
A small island nation faces two maritime threats:

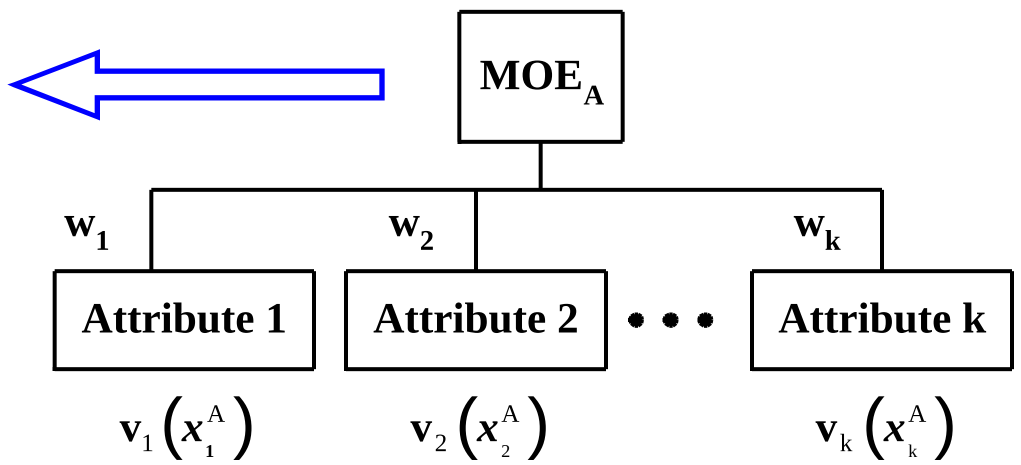
- sea-based smuggling of luxury goods
  - *reducing tax revenue*
- fishery predation by foreign fishing fleets
  - *jeopardizing food supply*

To counter these threats, the government has decided to procure and operate a fleet of Offshore Patrol Vessels (OPV). Two types of vessel are available, A and B.

Cost-effectiveness

Common approach to C-E Analysis





Comparing alternatives

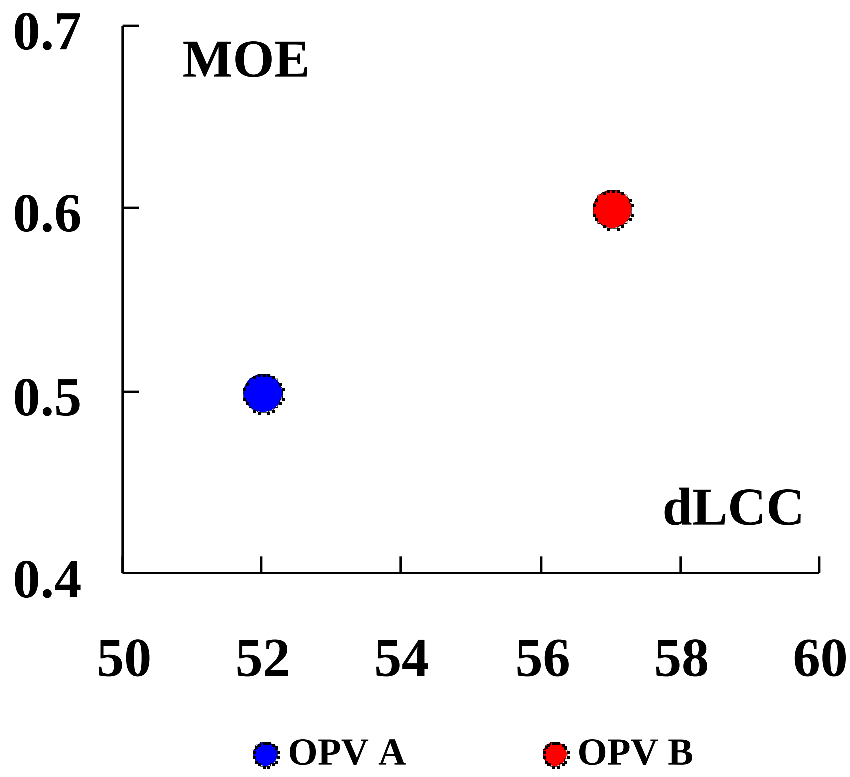
Suppose we apply these models and determine:

$MOE_A = 0.5$

$MOE_B = 0.6$

$Cost_A = \$52\ M$

$Cost_B = \$57\ M$



Two important issues

Issue 1 We are comparing a discounted LCC with a non-discounted MOE

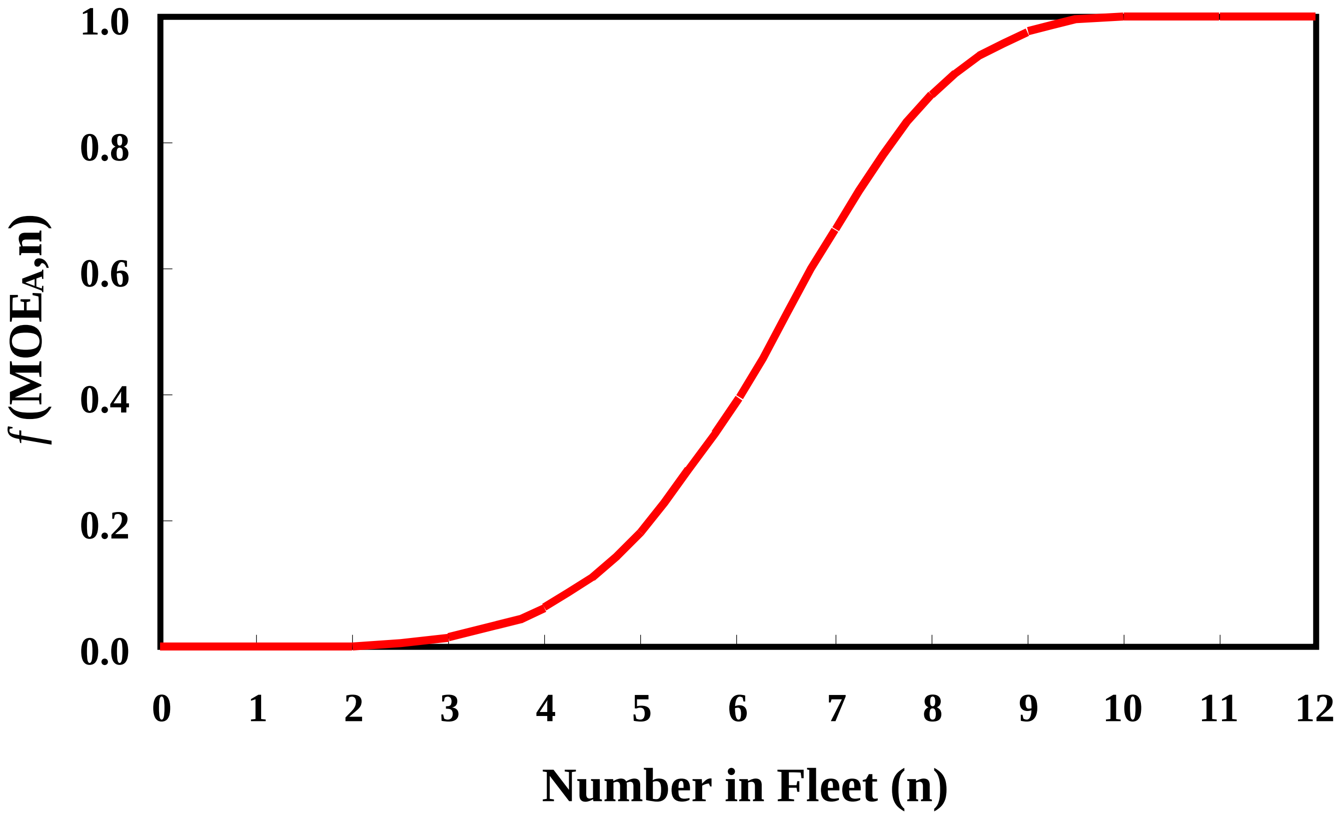
Not a problem if timing is not a concern

Issue 2 MOE is representative for a single vessel in a “head-to-head” comparison

Not a problem if the MOE of k-many vessels is k times the MOE of one.

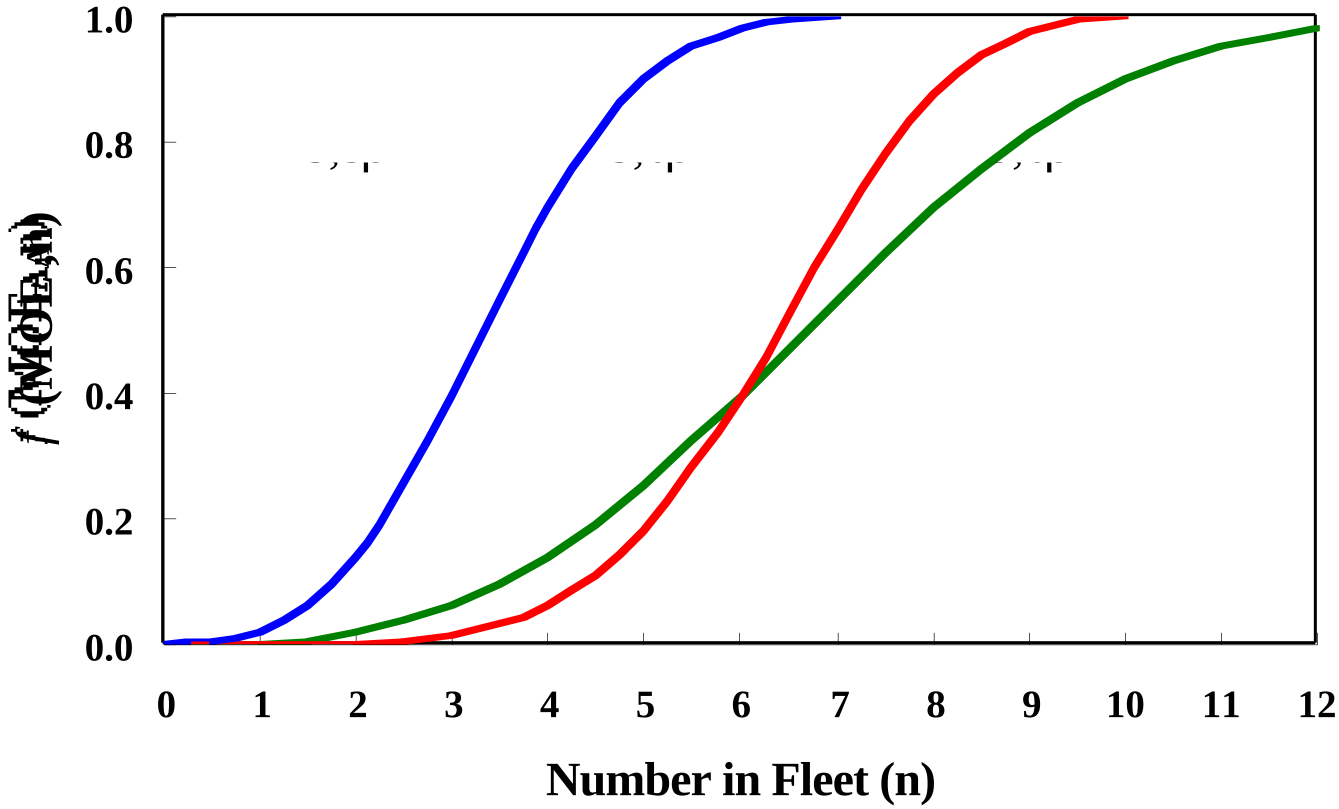
Effectiveness over time…

Think about building up a level of effectiveness over time (proxied by number of vessels operating).



A fleet effectiveness function

Consider a (pure) fleet MOE function of the form:



Back to our two OPVs

Suppose that $MOE_A = 0.5$ and $MOE_B = 0.6$. Further suppose that:

- A is available for procurement next year at a rate of 2 vessels per year.
- B will not available to procure for two years, but can be procured at a rate of 3 vessels per year.

For simplicity, we assume that personnel and maintenance constraints will limit the final fleet to 10 vessels of a single type.

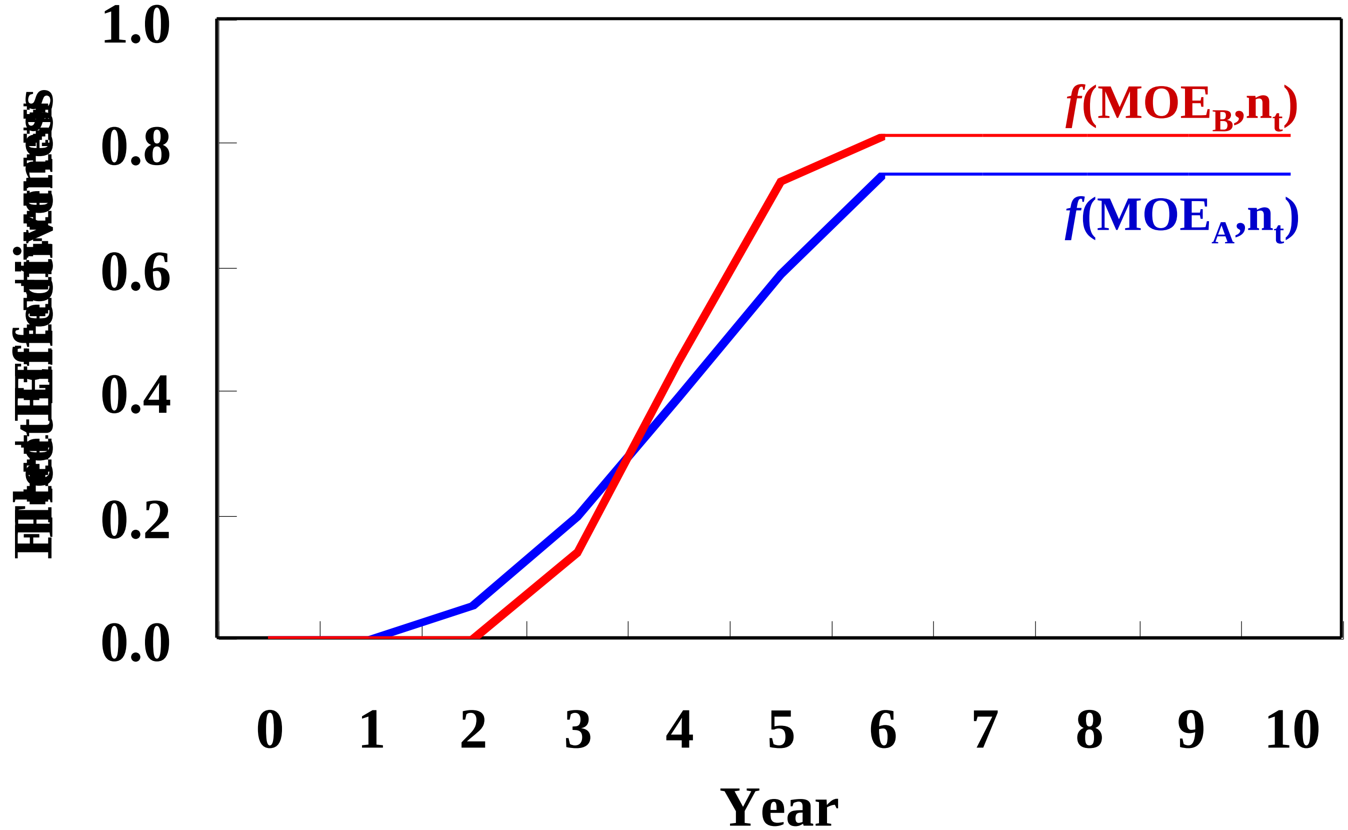
Fleet effectiveness over time

Production of fleet effectiveness over time under the assumption that $\alpha = 2$ and $\beta = 6$.

	Type A OPVs			Type B OPVs		
Year	**Procure**	**Operate**	***f*(.)**	**Procure**	**Operate**	***f*(.)**
0	0	0	0	0	0	0
1	2	0	0	0	0	0
2	2	2	0.054	3	0	0
3	2	4	0.199	3	3	0.139
4	2	6	0.393	3	6	0.451
5	2	8	0.589	1	9	0.741
6	0	10	0.751	0	10	0.811
7	0	10	0.751	0	10	0.811
8	0	10	0.751	0	10	0.811
9	0	10	0.751	0	10	0.811
10	0	10	0.751	0	10	0.811

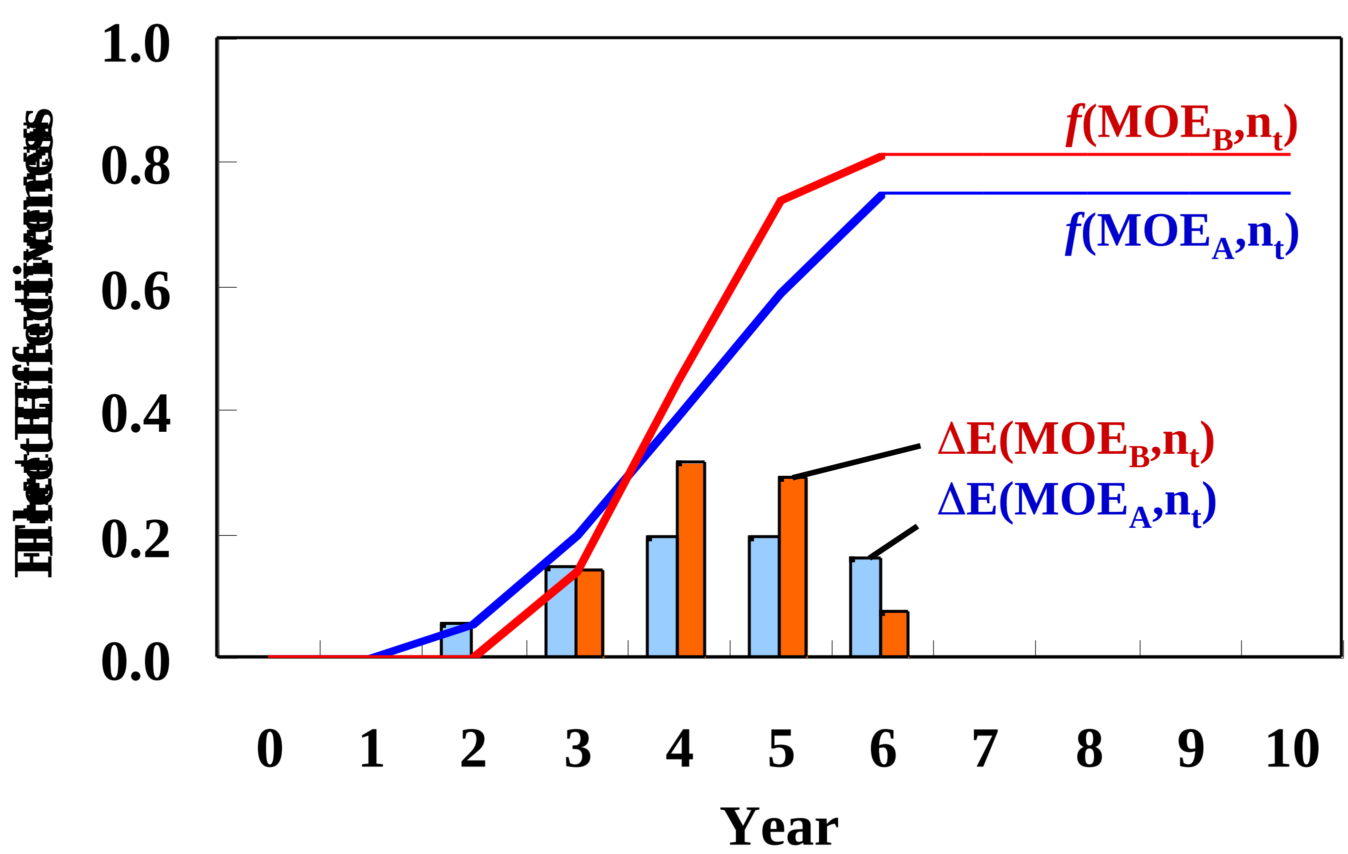
Fleet effectiveness over time

Graphic depiction of fleet effectiveness over time



Marginal effectiveness over time

Marginal increases of fleet effectiveness over time



Effectiveness decreases over time

r_t represents a ***measure of effectiveness lost*** due to a one period delay in operation of a vessel.

Tradeoffs

Tradeoffs: "… an OPV operational in year t is worth γ_t as much as one operational in year t+1…"

Behavior: Given the existence of a threat, it's reasonable to assume the decision maker's preference is to have vessels operational sooner rather than later, so $\gamma_t \geq 1$ t.

Tradeoffs → discount rates

Discounting Formula

Tradeoff information

Discounting example

Stronger desire for rapid deployment:

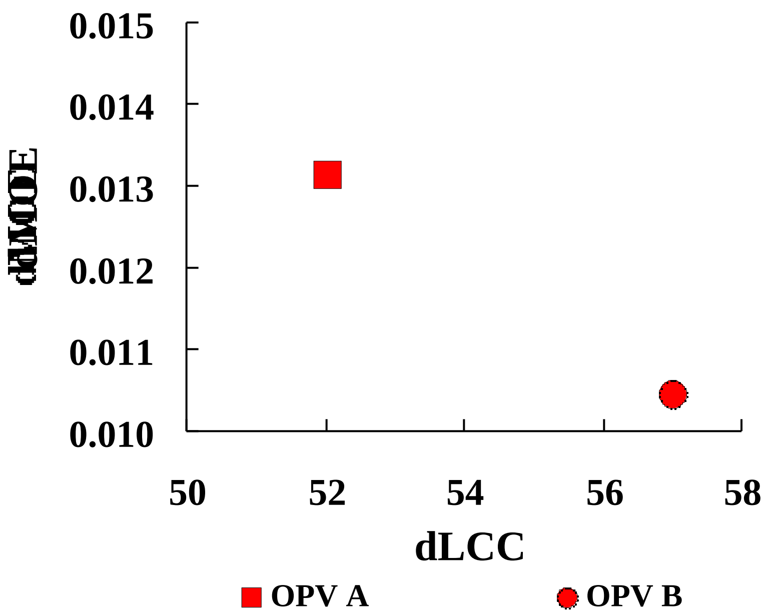
Year	$^{\Delta}E(A,n_t)$	$^{\Delta}E(B,n_t)$	γ_t	r_t	Discount Factor	OPV A $d^{\Delta}E(\cdot)$	OPV B $d^{\Delta}E(\cdot)$
0	0	0	4	3			
1	0	0	3	2	0.2500	0	0
2	0.0540	0	3	2	0.0833	0.0045	0
3	0.1452	0.1393	2	1	0.0278	0.0040	0.0039
4	0.1942	0.3119	2	1	0.0139	0.0027	0.0043
5	0.1954	0.2896	2	1	0.0069	0.0014	0.0020
6	0.1618	0.0704	1	0	0.0035	0.0006	0.0002
7	0	0	1	0	0.0035	0	0
8	0	0	1	0	0.0035	0	0
9	0	0	1	0	0.0035	0	0
10	0	0	1	0	0.0035	0	0
	0.7506	**0.8111**				**0.0132**	**0.0105**
	Undiscounted MOE					Discounted MOE	

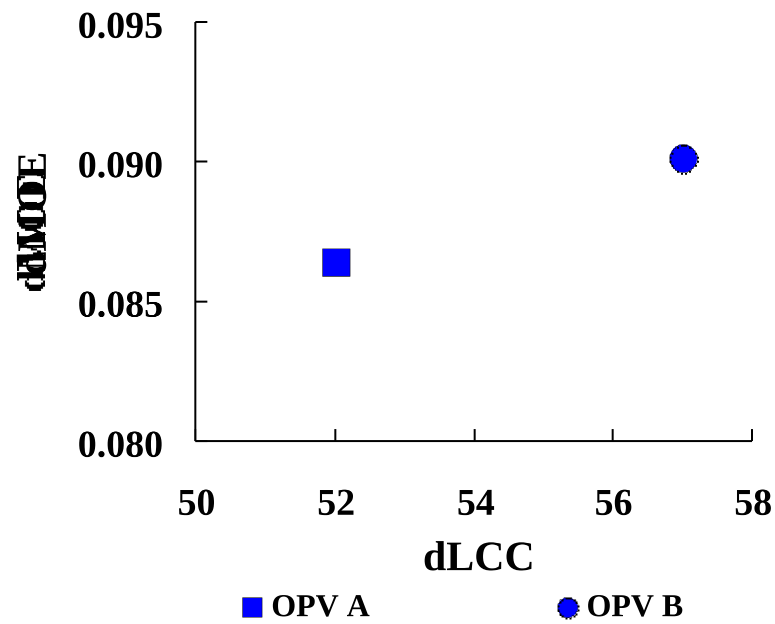
Discounting example

Lesser desire for rapid deployment:

Year	$^{\Delta}E(A,n_t)$	$^{\Delta}E(B,n_t)$	γ_t	r_t	Discount Factor	OPV A $d^{\Delta}E(\cdot)$	OPV B $d^{\Delta}E(\cdot)$
0	0	0	3	2			
1	0	0	2	1	0.3333	0	0
2	0.0540	0	1.5	0.5	0.1667	0.0090	0
3	0.1452	0.1393	1	0	0.1111	0.0161	0.0155
4	0.1942	0.3119	1	0	0.1111	0.0216	0.0347
5	0.1954	0.2896	1	0	0.1111	0.0217	0.0322
6	0.1618	0.0704	1	0	0.1111	0.0180	0.0078
7	0	0	1	0	0.1111	0	0
8	0	0	1	0	0.1111	0	0
9	0	0	1	0	0.1111	0	0
10	0	0	1	0	0.1111	0	0
	0.7506	**0.8111**				**0.0864**	**0.0901**
	Undiscounted MOE					Discounted MOE	

C-E consequences





Strong desire for rapid deployment

A dominates B

Lesser desire for rapid deployment

MB/MC required

Benefits

- Provides a framework to examine consequences of time preferences
- Can be used to examine consequences of:
  - Obsolescence (technology, threat, etc.)
  - Changes in mission/strategy
  - Developing capabilities over time
  - Anything affecting MOE at the margin

Caveats

- Infinite postponement and immediate consumption (Keeler and Cretin 1993)

  Rely on constant discount rates and perfect exchangeability of present and future money and benefits (Chapman and Elstein 1995)

  - Employ a time varying vice a constant discount rate (Harvey 1994)
  - Perfect exchangeability is not feasible in defense (threat and budgeting)

Caveats

- A discounting approach can induce a short-run focus and lead decision makers to always favor upgrading existing systems rather than investing in new ones. This can increase risks in the future.

  - In the OPV example, a fleet of 7 type C vessels with $MOE_C = 0.1$ available for immediate procurement is preferred to either fleet of 10 type A or 10 type B vessels due to their delay.

That's all, folks!