

1) Ethiopia is currently considering putting in place a disease free zone where animals can be held and observed for six weeks. Animals held for this length of time in the zone are eligible to be exported to Saudi Arabia. If an animal does not go through this process, it is not allowed to be exported internationally and is sold domestically. The value of an animal in Saudi Arabia is twice what it is worth in Ethiopian markets – that is a bull that sells for \$150 USD in Ethiopia is worth \$300 if exported to Saudi Arabia. It will cost us 20 million USD in  $t=0$  to build the disease free zone. During year zero, animals will be marketed domestically so domestic revenue and costs will apply. In years  $t=1$ ,  $t=2$ , and  $t=3$  it will cost us 5 million per year to provide veterinary goods and services to establish the disease free zone and 10 million per year to buy feed for animals held in the zone and animals will be marketed in Saudi Arabia. Production for the domestic market currently has 2 million per year spent on veterinary goods and the implicit cost of feeds consumed by domestically marketed animals is estimated to be 5 million per year. Revenue per year of selling animals domestically is 15 million. The same animals sold in Saudi Arabia are worth 30 million. The discount rate is 10%.

What is the net present value of producing for the domestic market?

	Benefits	Costs
T=0	15	20+5
T=1	$15/1.1$	$7/1.1$
T=2	$15/1.1^2$	$7/1.1^2$
T=3	$15/1.1^3$	$7/1.1^3$
NPV	52.30	24.41

$$\begin{aligned}
 8 &= 8 \\
 8/1.1 &= 7.27 \\
 8/1.1^2 &= 6.61 \\
 8/1.1^3 &= 6.01 \\
 &27.89
 \end{aligned}$$

What is the net present value of building the disease free zone and selling in Saudi Arabia?

	Benefits	Costs
T=0	15	$20 + 2 + 5 = 27$
T=1	$30/1.1$	$5 + 10 = 15/1.1$
T=2	$30/1.1^2$	$15/1.1^2$
T=3	$30/1.1^3$	$15/1.1^3$
NPV	89.61	64.30

$$\begin{aligned}
 -12 &= -12 \\
 15/1.1 &= 13.64 \\
 15/1.1^2 &= 12.40 \\
 15/1.1^3 &= 11.27 \\
 &25.31
 \end{aligned}$$

Which is preferable in NPV terms?

25.31

Keep domestic, since domestic NPV = 27.89 which is higher than disease free zone NPV = 25.31

Discuss how this demonstrates the difference between "before and after" and "with and without" in benefit cost analysis.

At the time of deciding to establish the disease free zone we are in the "before" period as we approach the decision point. If we establish the zone at  $t=0$  we enter into the "after" phase. However for the "after" options, we find we are better off in NPV terms without the disease free zone compared to the NPV with the disease free zone.

2) Studies have shown that placing trained nutrition monitors in local clinics leads to lower child malnutrition rates in your country. Studies also show that improved school feeding programs leads to lower child malnutrition in your country. Two proposals are on your desk, each designed to reduce the child malnutrition rate in your country by 1% per year. You only have enough operating funds to do one, and you can't combine them – it is pick one or the other.

Placement of nutrition monitors: This is a three year program (start up recruitment and hiring is year zero, year one the monitors are in place working, year two the monitors are in place working, then the project phase ends) to hire and place in local clinics the nutrition monitors. It will cost 2.3 million in the current start up year to hire and place these monitors, and will cost 1 million per year for each of two years of program implementation to pay the salaries of these local nutrition monitors.

School feeding: This is also a three-year program (start up and organization in year zero, then feeding in the following two years  $t=1$  and  $t=2$ , then the project phase ends) to provide food to children in primary schools.  $T=0$  costs 1.6 million, and the operating costs per year are 1.4 million for the following two years.

- a. Which program achieves the targeted reduction of the child malnutrition rate at the lowest present value cost if the discount rate is 10%?

NM

$t=0$	2.3
$t=1$	1/1.1
$t=2$	1/1.1 <sup>2</sup>
4.036	

SF

$t=0$	1.6
$t=1$	1.4/1.1
$t=2$	1.4/1.1 <sup>2</sup>
4.030	
Lower cost	

- b. Which program achieves the targeted reduction of the child malnutrition rate at the lowest present value cost if the discount rate is 5%?

NM

$t=0$	2.3
$t=1$	1/1.05
$t=2$	1/1.05 <sup>2</sup>
4.159	
Lower cost	

SF

$t=0$	1.6
$t=1$	1.4/1.05
$t=2$	1.4/1.05 <sup>2</sup>
4.203	

- c. Contrast your answer to (a) and (b) by describing how future expenses are impacted by a relatively lower discount rate, and the pattern of cost flows for the two policies.

NM has more cost in  $t=0$  and less in years 1 and 2 compared to SF. At the higher discount rate, less weight is put on the higher SF costs in future years. At the lower discount rate more weight is put on the higher values of SF for years 1 and 2.

3) Highland agriculture in Nepal is facing problems due to soil erosion. You are considering two different programs that will address the soil erosion problem over a four year time horizon ( $t=0$ ,  $t=1$ ,  $t=2$ ,  $t=3$ ). The present value of benefits due to reduced soil erosion resulting from **either program** is estimated to be 5 million dollars. The discount rate is given as 10%.

*Program One: Agroforestry.* This tree planting project will cost 3 million dollars in the current year ( $t=0$ ). The trees will provide a benefit in addition to combating soil erosion in the form of marketable seeds. This benefit is estimated to be 0.5 million dollars in the first year after they are planted ( $t=1$ ), 1 million dollars in the second year after they are planted ( $t=2$ ), and 0.5 million dollars in the third year after they are planted ( $t=3$ ). After this time the trees will no longer produce seeds, thus this benefit will come to an end.

*Program Two: Bund construction.* Bunds are an anti soil erosion measure that involves building dirt and stone rows across steeply sloped land to reduce soil erosion. Bund construction will take two years, the current year ( $t=0$ ) and next year (year 1). It will cost 1 million dollars each year to construct these bunds.

a. Which program is superior in NPV terms?

AF

	B	C
$t=0$	5	3
$t=1$	0.5/1.1	
$t=2$	1.0/1.1 <sup>2</sup>	
$t=3$	0.5/1.1 <sup>3</sup>	
	3.657	

BC

	B	C
$t=0$	5	1
$t=1$		1/1.1
$t=2$		
$t=3$		
		3.591

AF is superior to BC in terms of NPV

b. Does your answer change if the benefits of the marketable seeds is lower than predicted in the original scenario, and is instead 0.25 million when  $t=1$ , 0.5 million when  $t=2$ , and 0.25 million when  $t=3$ ?

	B	C
$t=0$	5	3
$t=1$	0.25/1.1	
$t=2$	0.5/1.1 <sup>2</sup>	
$t=3$	0.25/1.1 <sup>3</sup>	

2.828

Yes, the answer will change and now BC has the higher NPV.

4) Questions about cost benefit methods

a) What is the difference between a real and a nominal value?

Real values have been deflated to account for inflation and are directly comparable in base <sup>year</sup> dollar terms.

Nominal values are the values that are expressed in terms of the currency value of their time. These have not been deflated to account for inflation.

b) Why are taxes and interest payments not counted as costs in cost benefit analysis?

They are claims on an existing flow which neither add to or detract from the real resource flows.

c) Why is job creation not a benefit in cost benefit analysis?

It does not create any real new resource flow, it creates costs in the wages needed to pay for the jobs what the workers do, the value of their marginal product, is a real resource flow created when they work.

d) Why do we discount?

Impatience - rather have it sooner rather than later  
Inflation - meaning of money changes over time due to inflation

Opportunity cost - money put in an interest bearing account will be worth more in the future.

e) Contrast net present value and internal rate of return as ways to present cost benefit

findings.

$$NPV = PVB - PVC = \sum_{t=0}^T \frac{B_t}{(1+r)^t} - \sum_{t=0}^T \frac{C_t}{(1+r)^t}$$

$$IRR \text{ is the "r" that makes } PVB = PVC, \sum_{t=0}^T \frac{B_t}{(1+r)^t} = \sum_{t=0}^T \frac{C_t}{(1+r)^t}$$