Lecture 2

Business decision making under <u>risk</u> and <u>uncertainty</u>

Often the above <u>terms</u> are used interchangeably, but a distinction is sometimes drawn:

Risk - past experience can be a guide and help probabilities to be attached to possible outcomes (note that <u>objective</u> probabilities apply in certain situations eg tossing a coin; but such situations don’t normally apply in business situations)

Uncertainty - little in the way of past experience on which to base probabilities

In some circumstances the above distinction may be unimportant and subjective judgements may be used in establishing a probability distribution (based on past experience where applicable)

But a great short reference on why this distinction can be very important is “Amaranth and the limits of mathematical modelling", by John Kay (2006) in the Financial Times

Discrete probability distributions and Expected Values (or Expected Payoff)

Simple example - tossing a coin once

Result (R)	Probability (p)	R x p
Heads (Win £1)	.5	.5
Tails (Lose £1)	.5	(.5)
EV (Expected value)	=	£0

Utility

(and a slight digression) based on the insight of the Swiss mathematician Bernoulli

the subjective assessment of the value of an amount of money is not necessarily equal to the absolute value of that money

In particular the

Law of diminishing marginal utility means that, in the last example, even though

EV in money	= 0
EV (utility)	< 0

so an apparently “even” bet is not rational

State of world	Probability	A	B
		£	£
1	1/3	90	0
2	1/3	100	100
3	1/3	110	200
Expected Value	=	100	100

Even though EVs are equal, most people would not be indifferent -

Risk seeker would tend towards B

Risk averter would tend towards A

But choice will also depend on judgment of **Utility**

CVP Analysis and Discrete Probability Distributions

Example XYZ

3 mutually exclusive products are being considered for future production:

Budgeted figures (per annum):

Product	X	Y	Z
Contribution per unit	£32	£90	£38
Fixed costs (avoidable)	£190,000	£220,000	£150,000

Example XYZ (continued)

Probability distribution of sales levels

X		Y		Z	
Sales (Units)	Prob.	Sales (Units)	Prob.	Sales (Units)	Prob.
6000 7000 8000	.4 .3 .3	0 3000 5000	.2 .5 .3	2000 4000 7000 10000	.1 .6 .2 .1

Note that this kind of question typically assumes a limited number of outcomes, it is a subjective, discrete, probability distribution

In reality there may be many possible outcomes, so that these figures might be thought of as the mid-points of likely ranges

But also note that the typical analysis treats these discrete outcomes as the only possible ones - which is an implicit simplifying assumption

Example XYZ (continued)

Question 1

Calculate the expected value (EV) of the profit for each separate product and advise on the best course of action.

(Note that the last part of this question ideally requires more information than is given by the EV calculation).

Question 2:

(Involving the value of perfect information.)

For product Y only, suppose that market research costing £30,000 could show with certainty which level of sales demand would be achieved.

Assuming that all the costs of Y are avoidable if the venture is not undertaken, would it be worthwhile to undertake this work?

Question 1

Quick Way to calculate EV for Product X

EV of Sales Volume:	6000 x .4 =	2400
	7000 x .3 =	2100
	8000 x .3 =	<u>2400</u>
	=	6900 units

			£
EV of Contribution	=	6900 x 32 =	220,800
		Less F.C.	<u>190,000</u>
		EV of Profit	30,800

May be a quick way to calculate the overall EV but gives no information on individual outcomes.

Example XYZ, Question 1 showing more detail

	X	Y	Z
	£000	£000	£000
32 x 6,000 = 192,000 x .4 =	76.8	etc	etc
32 x 7,000 = 224,000 x .3 =	67.2		
32 x 8,000 = 256,000 x .3 =	76.8		
EV of contribution =	220.8		
Fixed cost	190.0		
Expected Value of Profit	**30.8**	**50**	**40**
Worst result	**2 (p .4)**	**(220) (p .2)**	**(74) (p .1)**
Best result	**66 (p .3)**	**230 (p .3)**	**230 (p .1)**

In principle all outcomes and their associated probabilities could be calculated – though this may be unrealistic if there are many.

Advise on best course of action:

Based on EVs alone, Y is the best

but of course it is very risky, and decision makers are often particularly concerned about potential losses

Typically it may not be appropriate to state that a particular outcome is best – the choice would depend on the attitude to risk and the “utility function” of management, but recommendations could be made.

Qn 2 Product Y with Research (ie with Perfect Information)

Sales units	Cont'n £000	Fixed Cost £000	Profit* x Prob £000	£000
0 3000 5000	0 270 450	0** 220 220	0 x .2 = 50 x .5 = 230 x .3 =	0 25 69 94
			Cost of Research = **EV of Profit =**	30 **64**

* Excluding Research Cost

**Not incurred if F.C. > Predicted Contribution

	Product Y with Research	**Product Y without Research**
Worst Possible Profit	(£30,000) p = .2	(£220,000) p = .2
Best Possible Profit	£200,000 p = .3	£230,000 p = .3

Although the research raises the expected value of profit for Y from £50,000 to £64,000, the choice of whether to do the research at all, or whether to choose X, or Y (with or without research) or Z still depends on management's judgement - based on their attitude to risk and their assessment of utility, not on expected money values alone.

In other words there are now 4 choices, each with their EV and range of individual outcomes