

# Risk and Uncertainty

30% ↑ 10%  
70% ↓ 10%

**Risk:** there are a number of possible outcomes and the probability of each outcome is known.

**Uncertainty:** there are a number of possible outcomes but the probability of each outcome is not known

## Expected values (EVs)

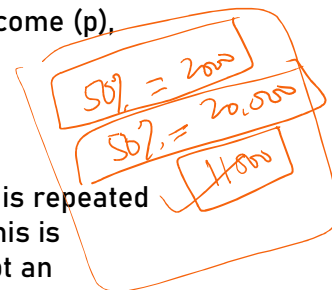
An expected value is a weighted average of all possible outcomes. It calculates the average return that will be made if a decision is repeated again and again. In other words, it is obtained by multiplying the value of each possible outcome (x), by the probability of that outcome (p), and summing the results.

The formula for the expected value is  $EV = \sum px$

Since the expected value shows the long run average outcome of a decision which is repeated time and time again, it is a useful decision rule for a risk neutral decision maker. This is because a risk neutral investor neither seeks risk or avoids it; he is happy to accept an average outcome.

Expected values are used to support a risk-neutral attitude. A risk-neutral decision maker will ignore any variability in the range of possible outcomes and be concerned only with the expected value of outcomes.

Expected values are more valuable as a guide to decision making where they refer to outcomes which will occur many times over. Examples would include the probability that so many customers per day will buy a can of baked beans, the probability that a customer services assistant will receive so many phone calls per hour, and so on.

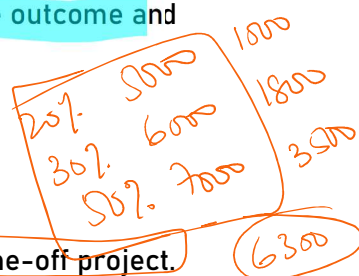


## Advantages:

- Takes uncertainty into account by considering the probability of each possible outcome and using this information to calculate an expected value.
- The information is reduced to a single number resulting in easier decisions.
- Calculations are relatively simple.

## Disadvantages:

- The probabilities used are usually very subjective.
- The EV is merely a weighted average and therefore has little meaning for a one-off project.
- The EV gives no indication of the dispersion of possible outcomes about the EV, i.e. the risk.
- The EV may not correspond to any of the actual possible outcomes.



## Payoff tables

A profit table (payoff table) can be a useful way to represent and analyse a scenario where there is a range of possible outcomes and a variety of possible responses. A payoff table simply illustrates all possible profits/losses

### **Maximax, maximin and minimax regret**

When probabilities are not available, there are still tools available for incorporating uncertainty into decision making.

#### **Maximax**

The maximax rule involves selecting the alternative that maximises the maximum payoff achievable.

This approach would be suitable for an optimist, or 'riskseeking' investor, who seeks to achieve the best results if the best happens.

#### **Maximin**

The maximin rule involves selecting the alternative that maximises the minimum payoff achievable.

The investor would look at the worst possible outcome at each supply level, then selects the highest one of these. The decision maker therefore chooses the outcome which is guaranteed to minimise his losses. In the process, he loses out on the opportunity of making big profits.

This approach would be appropriate for a risk averse pessimist who seeks to achieve the best results if the worst happens.

#### **The Minimax Regret rule**

The minimax regret strategy is the one that minimises the maximum regret. It is useful for a risk averse decision maker. Essentially, this is the technique for a 'sore loser' who does not wish to make the wrong decision. 'Regret' in this context is defined as the opportunity loss through having made the wrong decision.

**Example:** Suppose the budgeted demand for product X will be 11,500 units if the price is \$10, 8,500 units if the price is \$12 and 5,000 units if the price is \$14. Variable costs are estimated at either \$4, \$5, or \$6 per unit. A decision needs to be made on the price to be charged.

**Q1.** Envico Ltd, another subsidiary of the KCB Group, is well established and provides seminars on various aspects of current and recently announced changes in employment legislation. Envico Ltd has decided to enter into a one-year renewable contract with Mieras Business Associates, which owns large premises that are suitable for holding educational seminars in each of eight cities. Envico Ltd has had similar dealings with Mieras Business Associates during recent years.

Mieras Business Associates has offered a choice of four different contracts, each of which relates to seminar rooms of differing sizes. These are known as room types A, B, C and D, which are capable of accommodating 100, 200, 300 and 400 delegates respectively.

Envico Ltd will charge an all-inclusive fee of £80 per delegate at every seminar throughout the year. The cost incurred by Envico Ltd varies according to room type, as shown in the following table:

Room type	No of attendees	Cost per seminar (£)
A	100	6,000
B	200	10,800
C	300	14,400
D	400	16,000

Envico must decide in advance of the forthcoming year which size of conference room to contract for. It is not possible to contract for a different size conference room in different cities, i.e. only one size of room can be the subject of the contract with Mieras Business Associates.

Envico Ltd has decided to hold one seminar in every week of the year in each city. Sometimes a regional government representative will attend and speak at such seminars.

On other occasions a national government representative will attend and speak at such seminars. The rest of the time the speakers at seminars are representatives from within Envico Ltd.

Envico has estimated the following frequency regarding seminars to be held during the forthcoming year:

Category of speaker:	%
Envico representative	20
Regional government representative	50
National government representative	30

Market research has indicated that where a national government representative is in attendance, Envico Ltd can be reasonably assured of selling 400 seminar places and where a regional government representative is in attendance 200 seminar places can be sold. Envico Ltd expects to sell only 100 seminar places when there is no attendance by a government representative.

**Required:**

**(i) Advise Envico Ltd on the size of seminar room that should be contracted from Mieras Business Associates, using the criterion of expected value. Your answer should show the expected annual contribution from each decision option. (ii) Determine whether your decision in (b)(i) would change if you were to use the Maximin and Minimax regret decision criteria. Your answer should be supported by relevant workings.**

**Q2.** Healthfoods Ltd (HFL) is a well-established company which markets fruit and vegetables under their 'Good Health' brand name at each of its 6 outlets in the country of Ateland. During recent years HFL has marketed organically grown fruit and vegetables. The directors are now planning to market organic mushrooms which have a unique eating quality and will be the most nutritious mushrooms available on the market.

The finance director has collated the following information regarding the proposed introduction and sale of organic mushrooms within Ateland:

(1) HFL will purchase the organic mushrooms from Orgmush Ltd (OML) and sell them at each of its 6 outlets within Ateland. Sales volumes of organic mushrooms are expected to be at the same level at each outlet.

(2) OML, which is the only grower of this particular type of organic mushroom within Ateland, has offered HFL a choice of four different contracts in respect of the forthcoming year. OML has the capacity to produce 360,000 kilograms of organic mushrooms for each of the 6 outlets.

The cost incurred by HFL in respect of organic mushrooms will vary according to contract size, as shown in the following table:

<b>Contract</b>	<b>Number of kilograms</b>	<b>Cost per kilogram (£)</b>
A	160,000	4.45
B	240,000	3.70
C	280,000	3.55
D	360,000	3.35

Note: The same contract type must be chosen in respect of each outlet.

(3) HFL will charge £5.50 per kilogram for all sales of organic mushrooms.

(4) Any unsold produce will be sold to the Animal Farm Group for £0.25 per kilogram.

(5) HFL must decide in advance of the forthcoming year which size of contract to enter.

(6) HFL uses acclaimed dieticians, international athletes or international film stars to promote its products via television advertisements and has estimated the following probability distribution of advertisements to be held during the forthcoming year:

<b>Category of advertisement:</b>	<b>%</b>
Acclaimed dietician	20
International athlete	40
International film star	40

Market research has indicated that where an acclaimed dietician appears in an advertisement, HFL can be reasonably assured of selling 160,000 kilograms of mushrooms per outlet and where an international athlete appears in an advertisement then 234,000 kilograms of mushrooms per outlet will be sold. HFL expects to sell 360,000 kilograms of mushrooms per outlet when an international film star appears in an advertisement.

**Required:**

**(a) Using expected values, advise HFL regarding which contract should be entered into with OML.**

Your answer should show the expected annual contribution from each contract. (12 marks)

**(b) Determine whether your decision in (a) would change if you were to use each of the Maximin and Minimax regret decision criteria. (6 marks)**

**Q3.** Shifters Haulage (SH) is considering changing some of the vans it uses to transport crates for customers. The new vans come in three sizes; small, medium and large. SH is unsure about which type to buy. The capacity is 100 crates for the small van, 150 for the medium van and 200 for the large van.

Demand for crates varies and can be either 120 or 190 crates per period, with the probability of the higher demand figure being 0.6.

The sale price per crate is \$10 and the variable cost \$4 per crate for all van sizes subject to the fact that if the capacity of the van is greater than the demand for crates in a period then the variable cost will be lower by 10% to allow for the fact that the vans will be partly empty when transporting crates. SH is concerned that if the demand for crates exceeds the capacity of the vans then customers will have to be turned away. SH estimates that in this case goodwill of \$100 would be charged against profits per period to allow for lost future sales regardless of the number of customers that are turned away.

Depreciation charged would be \$200 per period for the small, \$300 for the medium and \$400 for the large van.

SH has in the past been very aggressive in its decision-making, pressing ahead with rapid growth strategies. However, its managers have recently grown more cautious as the business has become more competitive.

**Required:**

- (a) Explain the principles behind the maximax, maximin and expected value criteria that are sometimes used to make decisions in uncertain situations. (4 marks)
- (b) Prepare a profits table showing the SIX possible profit figures per period. (9 marks)
- (c) Using your profit table from (b) above discuss which type of van SH should buy taking into consideration the possible risk attitudes of the managers. (6 marks)

**Q4.** Cement Co is a company specialising in the manufacture of cement, a product used in the building industry. The company has found that when weather conditions are good, the demand for cement increases since more building work is able to take place. Last year, the weather was so good, and the demand for cement was so great, that Cement Co was unable to meet demand. Cement Co is now trying to work out the level of cement production for the coming year in order to maximise profits. The company doesn't want to miss out on the opportunity to earn large profits by running out of cement again. However, it doesn't want to be left with large quantities of the product unsold at the end of the year, since it deteriorates quickly and then has to be disposed of. The company has received the following estimates about the probable weather conditions and corresponding demand levels for the coming year:

Weather	Probability	Demand
Good	25%	350,000 bags
Average	45%	280,000 bags
Poor	30%	200,000 bags

Each bag of cement sells for \$9 and costs \$4 to make. If cement is unsold at the end of the year, it has to be disposed of at a cost of \$0.50 per bag. Cement Co has decided to produce at one of the three levels of production to match forecast demand. It now has to decide which level of cement production to select.

**Required:**

- (a) Construct a pay off table to show all the possible profit outcomes. (8 marks)
- (b) Decide the level of cement production the company should choose, based on the following decision rules:
  - (i) Maximin (ii) Maximax (2 marks)
  - (iii) Expected value (4 marks)

**Q5.**

The following scenario relates to questions 16–20.

Mylo runs a cafeteria situated on the ground floor of a large corporate office block. Each of the five floors of the building are occupied and there are in total 1,240 employees.

Mylo sells lunches and snacks in the cafeteria. The lunch menu is freshly prepared each morning and Mylo has to decide how many meals to make each day. As the office block is located in the city centre, there are several other places situated around the building where staff can buy their lunch, so the level of demand for lunches in the cafeteria is uncertain.

Mylo has analysed daily sales over the previous six months and established four possible demand levels and their associated probabilities. He has produced the following payoff table to show the daily profits which could be earned from the lunch sales in the cafeteria:

Demand level	Probability	Supply level			
		450	620	775	960
		\$	\$	\$	\$
450	0.15	1,170	980	810	740
620	0.30	1,170	1,612	1,395	1,290
775	0.40	1,170	1,612	2,015	1,785
960	0.15	1,170	1,612	2,015	2,496

**16 If Mylo adopts a maximin approach to decision-making, which daily supply level will he choose?**

- A 450 lunches
- B 620 lunches
- C 775 lunches
- D 960 lunches

**17 If Mylo adopts a minimax regret approach to decision-making, which daily supply level will he choose?**

- A 450 lunches
- B 620 lunches
- C 775 lunches
- D 960 lunches

**18 Which of the following statements is/are true if Mylo chooses to use expected values to assist in his decision-making regarding the number of lunches to be provided?**

- (1) Mylo would be considered to be taking a defensive and conservative approach to his decision
  - (2) Expected values will ignore any variability which could occur across the range of possible outcomes
  - (3) Expected values will not take into account the likelihood of the different outcomes occurring
  - (4) Expected values can be applied by Mylo as he is evaluating a decision which occurs many times over
- A 1, 2 and 3
  - B 2 and 4
  - C 1 and 3 only
  - D 4 only

- 19 The human resources department has offered to undertake some research to help Mylo to predict the number of employees who will require lunch in the cafeteria each day. This information will allow Mylo to prepare an accurate number of lunches each day.

**What is the maximum amount which Mylo would be willing to pay for this information (to the nearest whole \$)?**

- A \$191
- B \$359
- C \$478
- D \$175

- 20 Mylo is now considering investing in a speciality coffee machine. He has estimated the following daily results for the new machine:

	\$
Sales (650 units)	1,300
Variable costs	(845)
	<hr/>
Contribution	455
Incremental fixed costs	(70)
	<hr/>
Profit	385

**Which of the following statements are true regarding the sensitivity of this investment?**

- (1) The investment is more sensitive to a change in sales volume than sales price
- (2) If variable costs increase by 44% the investment will make a loss
- (3) The investment's sensitivity to incremental fixed costs is 550%
- (4) The margin of safety is 84.6%

- A 1, 2 and 3
- B 2 and 4
- C 1, 3 and 4
- D 3 and 4 only

SEPT 2016

## Q6

Gam Co sells electronic equipment and is about to launch a new product onto the market. It needs to prepare its budget for the coming year and is trying to decide whether to launch the product at a price of \$30 or \$35 per unit. The following information has been obtained from market research:

Price per unit \$30		Price per unit \$35	
Probability	Sales volume	Probability	Sales volume
0.4	120,000	0.3	108,000
0.5	110,000	0.3	100,000
0.1	140,000	0.4	94,000

### Notes

- 1 Variable production costs would be \$12 per unit for production volumes up to and including 100,000 units each year. However, if production exceeds 100,000 units each year, the variable production cost per unit would fall to \$11 for all units produced.
- 2 Advertising costs would be \$900,000 per annum at a selling price of \$30 and \$970,000 per annum at a price of \$35.
- 3 Fixed production costs would be \$450,000 per annum.

### Required:

- (a) Calculate each of the six possible profit outcomes which could arise for Gam Co in the coming year. (8 marks)
  - (b) Calculate the expected value of profit for each of the two price options and recommend, on this basis, which option Gam Co would choose. (3 marks)
  - (c) Briefly explain the maximin decision rule and identify which price should be chosen by management if they use this rule to decide which price should be charged. (3 marks)
  - (d) Discuss the factors which may give rise to uncertainty when setting budgets. (6 marks)
- (20 marks)**

JUNE 2014

Q7. A ticket agent has an arrangement with a concert hall that holds concerts on 60 nights a year whereby he receives discounts as follows per concert:

<i>For purchase of</i>	<i>He receives a discount of</i>
200 tickets	20%
300 tickets	25%
400 tickets	30%
500 tickets or more	40%

Purchases must be in full hundreds. The average price per ticket is \$30.

He must decide in advance each year the number of tickets he will purchase. If he has any tickets unsold by the afternoon of the concert he must return it to the box office. If the box office sells any of these he receives 60% of their price.

His sales records over a few years show that for a concert with extremely popular artistes he can be confident of selling 500 tickets, for one with lesser known artistes 350 tickets, and for one with relatively unknown artistes 200 tickets.

His records show that 10% of the tickets he returns are sold by the box office. (Note: these are in addition to any sales made by the ticket agent).

His administration costs incurred in selling tickets are the same per concert irrespective of the popularity of the artistes.

	%
With popular artistes	45
With lesser known artistes	30
With unknown artistes	25

**Required:**

- Decide on the basis of maximax , maximin and minimax regret which ticket lot should be selected
- Decide on the basis of expected value which ticket lot should be selected

**HINT: cost of ticket = ticket price – discount**

**Q8.**

	PROBABILITY	Project A	Project B	Project C
GOOD WEATHER (\$)	25%	500,000	600,000	200,000
AVERAGE WEATHER	40%	300,000	500,000	120,000
BAD WEATHER	35%	(200,000)	(250,000)	50,000

**Calculate value of perfect information**