



MAS1403

Quantitative Methods for Business Management

Semester 1, 2017–2018

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Additional lecturers: Dr. Dave Walshaw and Dr. Ged Cowburn

Lecture 6

PROBABILISTIC DECISION-MAKING

Announcements

- **CBA2** is now live in **practice mode**
- Next week will be assessed mode
- **Deadline: 23:59 Friday 17th November**

6.1 Expected Monetary Value

Tree diagrams can be used to see the effect of making particular decisions in the face of uncertainty. This is achieved by weighting the probability of different outcomes by their value.

Often this value is **financial**.

The **Expected Monetary Value (EMV)** of a single event is the probability of that event multiplied by the monetary value of that outcome.

Example 1

For example, if you win £5 if you pulled an ace from a pack of cards, the EMV would be

$$EMV(Ace) = \frac{1}{13} \times 5 = 0.38.$$

In other words, if you repeated this bet a large number of times, overall you would come out, on average, 38 pence better off per bet.

6.1 Expected Monetary Value

Consider another bet. When rolling a die,

- if it's a six you have to *pay* £5
- if it's any other number you *receive* £2.50

Would you take on this bet?

6.1 Expected Monetary Value

Probability

Financial outcome

$$P(6) = 1/6$$

−£5

$$P(\text{Not a 6}) = 5/6$$

£2.50

Therefore

$$EMV(\text{Six}) = \frac{1}{6} \times -5.00 = -0.833$$

$$EMV(\text{Not a Six}) = \frac{5}{6} \times 2.50 = 2.0833$$

and hence the expected monetary value of the bet is

$$EMV(\text{Bet}) = -0.833 + 2.083 = 1.25.$$

6.1 Expected Monetary Value

Therefore, in the long run, this would be a bet to take on as it has a positive expected monetary value.

In general, the expected monetary value of a project or bet is given by the formula

$$EMV = \sum P(\text{Event}) \times \text{Monetary value of Event}$$

where the sum is over all possible events.

The *EMV* of a project can be used as a decision criterion for choosing between different projects and has applications in a large number of situations.

Example 2

Synaptec is a small technology company with a new product that they wish to launch on to the market.

It could go for a direct approach, launching onto the whole of the domestic market through traditional distribution channels, or it could launch only on the internet.

A third option exists where the product is licensed to a larger company through the payment of a licence fee irrespective of the success of the product.

How should the company launch the product?

Example 2

The company has done some initial market research which suggests that demand for the product can be classed into three categories:

High Medium Low

We think that these categories will occur with probabilities 0.2, 0.35 and 0.45 respectively and her thoughts on the likely profits (in £K) to be earned in each plan are

	High	Medium	Low
Direct	100	55	-25
Internet	46	25	15
Licence	20	20	20

Example 2

The EMV of each plan can be calculated as follows:

$$EMV(\text{Direct}) = 0.2 \times 100 + 0.35 \times 55 + 0.45 \times (-25) = \text{£}28\text{K}$$

$$EMV(\text{Internet}) = 0.2 \times 46 + 0.35 \times 25 + 0.45 \times 15 = \text{£}24.7\text{K}$$

$$EMV(\text{Licence}) = 0.2 \times 20 + 0.35 \times 20 + 0.45 \times 20 = \text{£}20\text{K}.$$

On the basis of expected monetary value, the best choice is the **direct approach**.

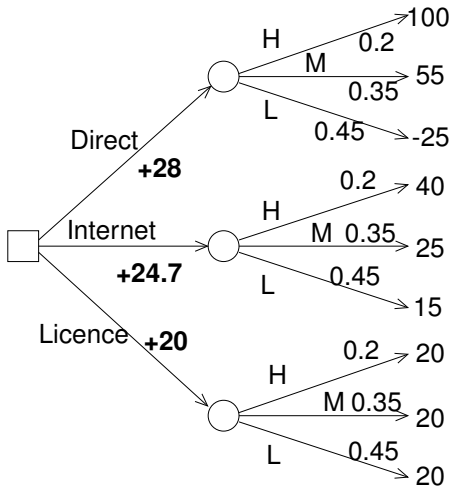
6.2 Decision trees

When we include a decision in a tree diagram (see Chapter 5) we use a rectangular node, called a **decision node** to represent the decision.

The diagram is then called a **decision tree**.

Example 3

The decision tree for the last example would look like this:



Example 3

Key points:

- There are no probabilities at a decision node but we evaluate the expected monetary values of the options.
- In a decision tree the first node (on the left) is always a decision node.
- There may also be other decision nodes.
- If there is another decision node then we evaluate the options there and choose the best one (based on EMV), and the expected monetary value of this option becomes the expected monetary value of the branch leading to the decision node.
- We work “backwards” through the tree (from right to left), evaluating EMVs and making decisions at each decision node.

Example 4

Charlotte Watson, the manager of a small sales company, has the opportunity to buy a fixed quantity of a new type of Android tablet which she can then offer for sale to clients.

The decision to buy the product and offer it for sale would involve a fixed cost of £200,000. The number of tablets that would be sold is uncertain, but Charlotte judges that:

- Sales will be “poor” with probability 0.2; this will result in an income of £100,000.
- Sales will be “moderate” with probability 0.5; this will result in an income of £220,000.
- Sales will be “good” with probability 0.3; this will result in an income of £350,000.

Example 4

For an additional fixed cost of £30,000, market research can be conducted to aid the decision-making process.

The outcome of the market research can be either positive or negative, with probabilities 0.58 and 0.42 respectively. Knowing the outcome of the market research changes the probabilities for the main sales project as follows:

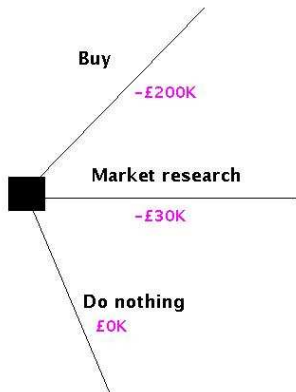
Market research	Main sales probabilities		
	Poor	Moderate	Good
Positive	0.15	0.45	0.4
Negative	0.6	0.35	0.05

Example 4

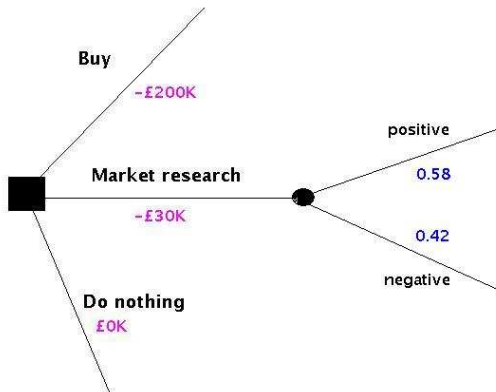
Charlotte will make decisions based on expected monetary value.

- (a) Draw a decision tree for this problem.
- (b) Use expected monetary value to determine the optimal course of action for Charlotte.

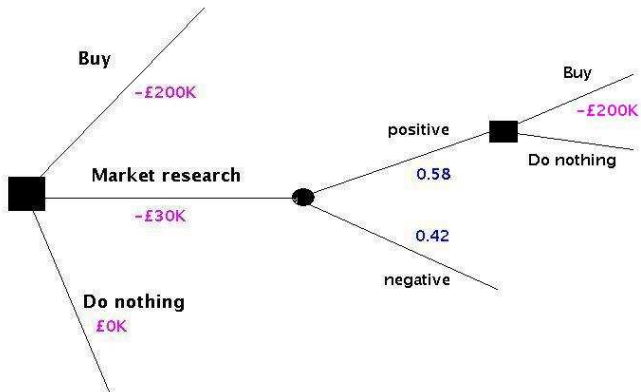
Example 4



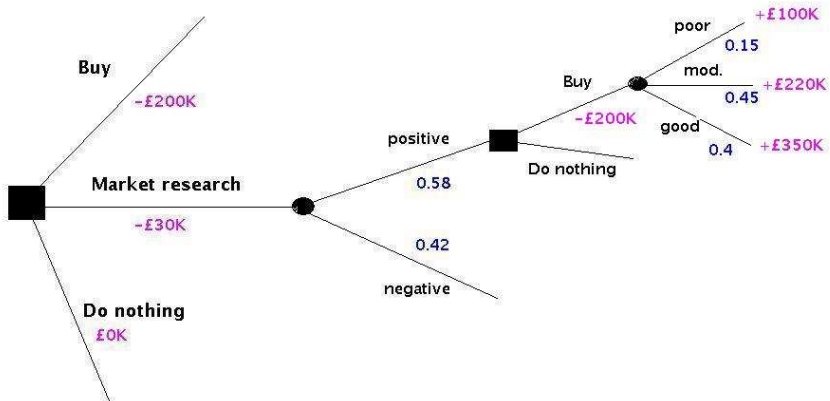
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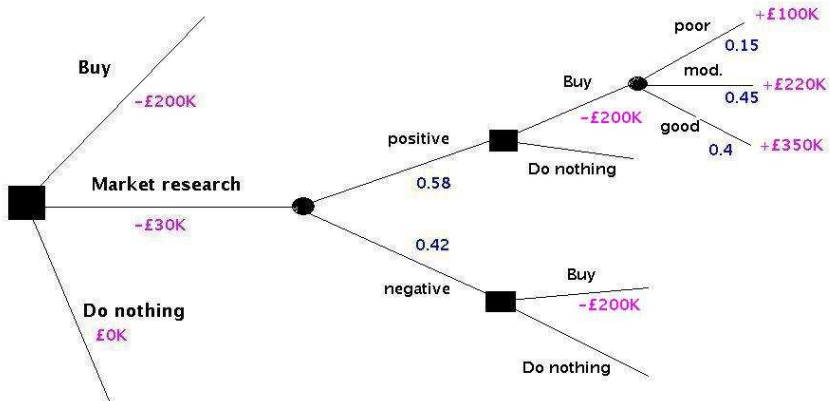
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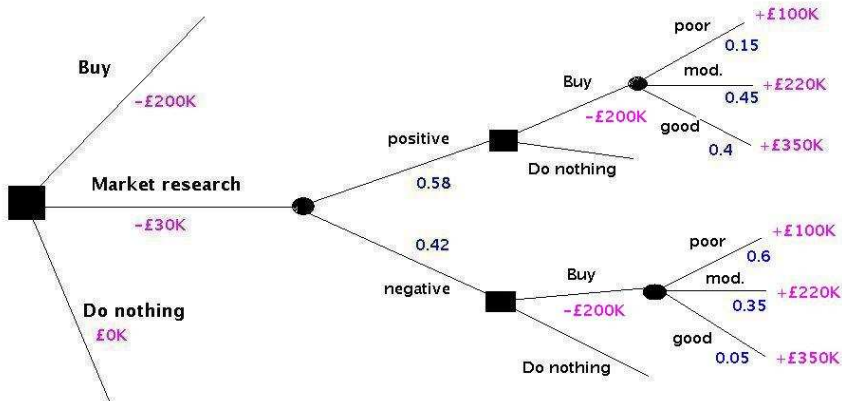
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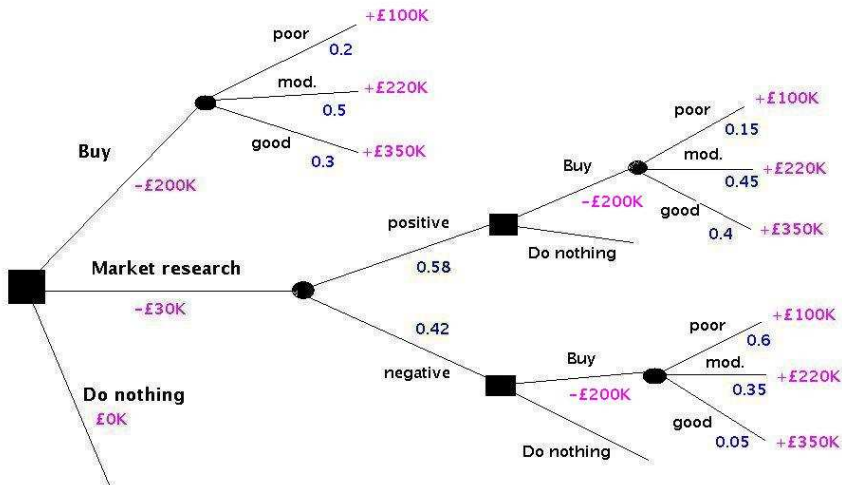
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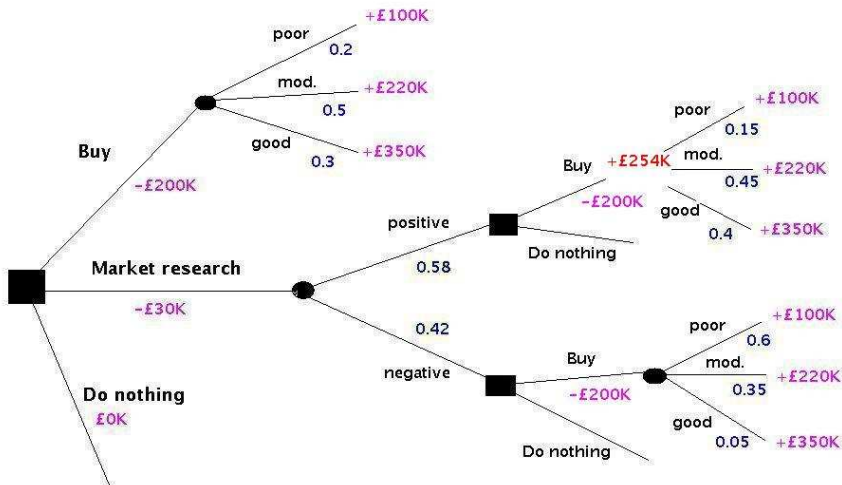
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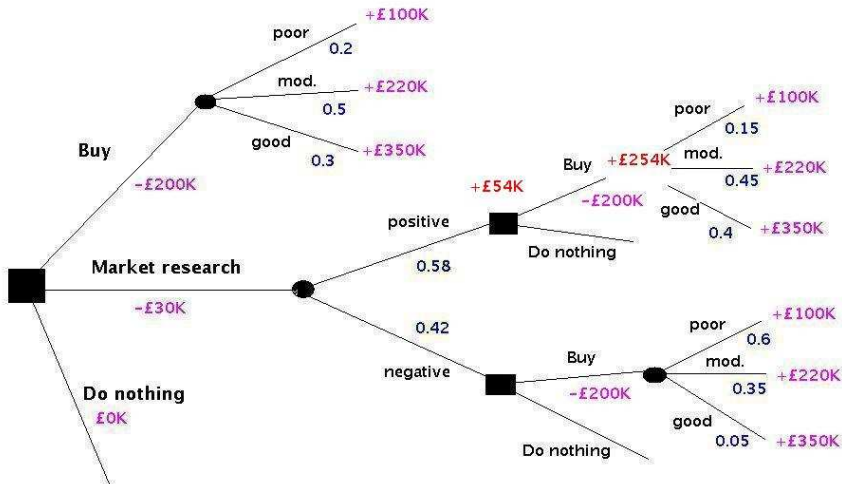
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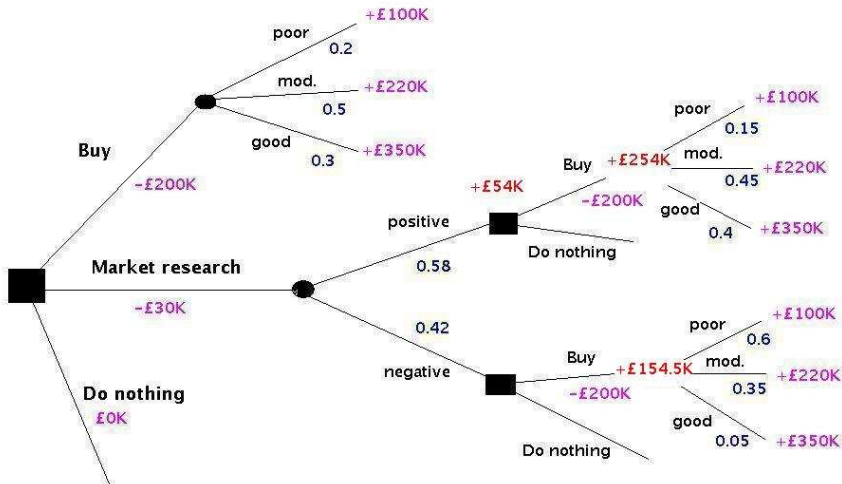
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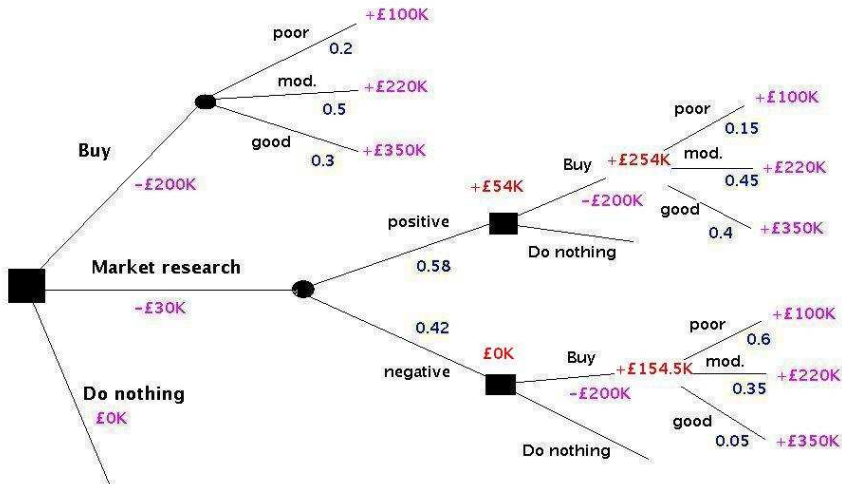
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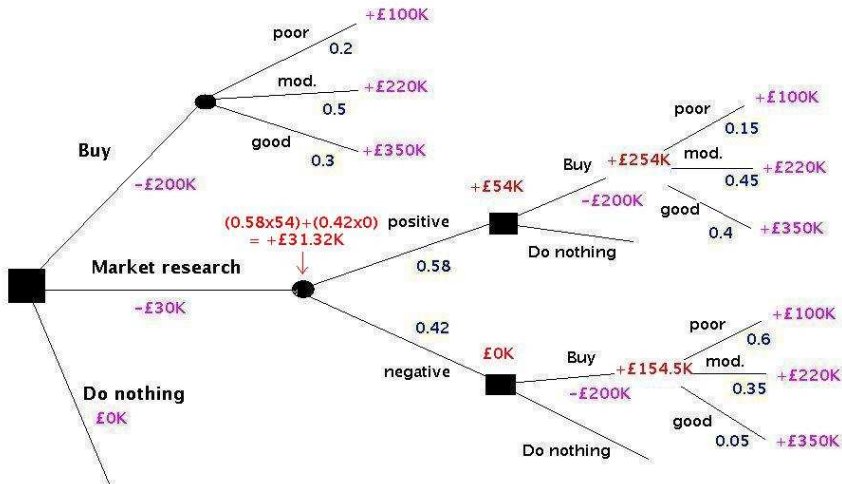
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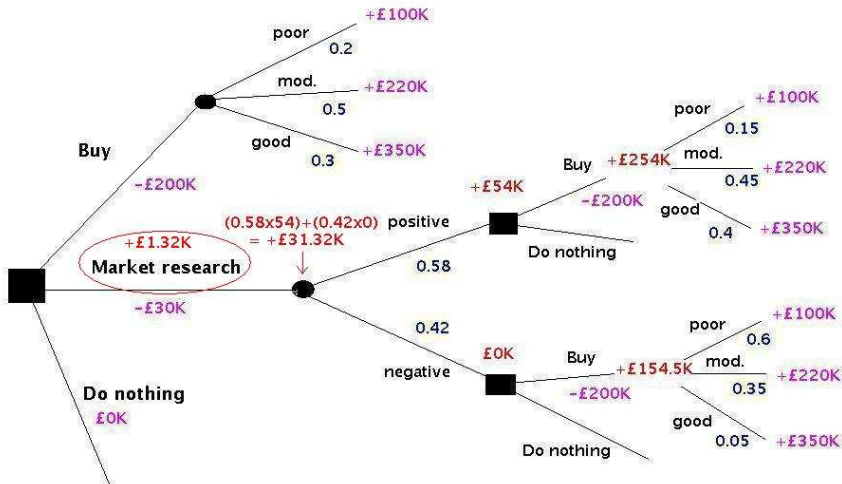
Example 4



Example 4



Example 4



Example 4

