Optimal decision making in daily life

Is Castle Hill just a lump of rock in the middle of Townsville, or does it have more *value* than that?

How can we work our its economic value?

In our daily life, we usually need to make many decisions. For example, on a Sunday morning, you may need to decide "Shall I stay in bed for another 10 minutes or shall I get up and go running?" When you graduate from high school, you will need to think "Shall I go to university or take a gap year?" For some of these, you make decisions subconsciously, while for the others you carefully think about them and then make decisions. Nevertheless, for these decisions, you may wonder whether you make the best (optimal) decision.

Economics can help you here. Economics is about the allocation of scarce resources, and making good decisions. **Economists** call this optimal decision making.

It is said that economists think in terms of margin. What does this mean? To make an optimal decision, economists ask: "What are the extra (marginal) costs and what are the extra (marginal) benefits associated with the decision?" If the extra benefits are bigger than the extra costs, you shall go ahead with the decision, namely the decision is good.

Did you know?

During World War II, Castle Hill was used as a communications and observation post.

Aim: To make decisions by "thinking in terms of margin", using two examples, one real and the other hypothetical.

1. Website security

Dr Sizhong Sun is managing a website for the Chinese Economics Society Australia (CESA, www.ces-aus.org). On 12 Oct 2016, he was alerted by the website host that the website was hacked! What happened? Sizhong took the website offline, changed passwords, and considered the logs of http visits (see the figure below). It turned out that a hacker has stolen the password of the administrator account. The hacker logged into the administrator account, and planted some malicious codes into the website.

IP Address	Date	Request	Status	Size	Country
185.125.4.214	13/10/2016 11:32:44 AM	GET /wp-admin/ HTTP/1.1	200	19085	Poland
185.125.4.214	13/10/2016 11:32:44 AM	POST /wp-login.php HTTP/1.1	302	936	Poland
185.125.4.214	13/10/2016 11:32:46 AM	POST /wp-admin/theme-editor.php HTTP/1.1	302	478	Poland
185.125.4.214	13/10/2016 11:32:46 AM	GET /wp-admin/theme-editor.php?file=footer.php HTTP/1.1	200	8869	Poland
185.125.4.214	13/10/2016 11:32:47 AM	GET /wp-admin/theme-editor.php?file=footer.php&theme=twentyten&scrollto=0&...	200	25913	Poland
185.125.4.214	13/10/2016 11:32:48 AM	GET /?8Yx5AefYpBp07TEocRmv=jackydallas.com/css/ HTTP/1.1	200	27453	Poland
185.125.4.214	13/10/2016 11:32:49 AM	GET /?6FoNxbvo73BHOjhxokW3 HTTP/1.1	301	291	Poland
185.125.4.214	13/10/2016 11:32:50 AM	GET /?6FoNxbvo73BHOjhxokW3 HTTP/1.1	200	27465	Poland

Given that the website has been hacked and it is also likely that there will be attack in the future as well, it may sound reasonable to equip the website with an additional layer of security. So, Dr Sizhong Sun found the following website security service from Sucuri:

Now the decision that Sizhong needed to make was whether to purchase the website security service form Sucuri. Let's think in terms of margin and work out what decision Sizhong should make.

The extra cost of purchasing the website security service has a **Marginal Cost (MC)** = $299.99, as suggested by Sucuri. Then what is the extra benefit? The benefit of having the website security service is to reduce the likelihood of being hacked and subsequently financial lost is avoided.

Suppose <u>without</u> the website security service the probability of being hacked is:

$$p_1 = 0.8\%$$

and <u>with</u> the security service the probability of being hacked is:

$$p_2 = 0.3\%$$

Discussion Point:

Express these percentages as fractions. What is the difference in probability? Is this a lot?

How can we make it more meaningful?

Once the website is hacked, we estimate that it will incur a financial loss of:

$$L = \$80,000 \text{ dollars}$$

Therefore, the extra benefit (**Marginal Benefit, MB**) of purchasing the website security service is calculated by:

$$MB = (p_1 - p_2) \times L$$

= _____ * $_____   (substitute in the values and calculate)

= $ _____

Now compare the extra cost and extra benefit, it is then clear and easy to make the decision:

Marginal Cost (MC) = $_____   Marginal Benefit (MB) = $_____

Should Dr Sizhong Sun purchase the website security service?

2. Castle Hill maintenance

In the previous example, we see that the key rule for a good decision making is to think in terms of margin, namely to work out the extra cost and extra benefit that are due to the decision and then compare the extra cost with extra benefit. If the extra benefit is bigger than extra cost, then "Yes, it is a worthwhile decision", otherwise "No, it is not a worthwhile decision".

In working out the extra cost previously, Sizhong obtained the cost from the market (namely from the service provider Sucuri). However, there aren't always markets out there that you can look up. Sometimes your decision making is involved with estimating benefits and costs of items that do not have markets. Here we will investigate an example of this.

The Townsville City Council wants to find out if it is worth trying to maintain Castle Hill to prevent rockslides, (one happened in 2000). To decide whether the maintenance project is feasible or not, we need to work out what is the extra benefit associated with the project and what is the extra cost due to this project. Once we have extra cost and benefit data, we can again compare them to make an optimal decision.

Working out the extra cost is relatively easy, because we can put a price on a maintenance project, such as personnel. In contrast, working out the extra benefit associated with the project is more difficult as we cannot easily put a price on avoiding rock/landslide accidents. In this workshop, we will use the **contingent valuation method (CVM)** to work out the extra benefit associated with the project.

The CVM is a simple method that is widely used in cost–benefit analysis. It involves people being asked: "how much are you willing to pay (WTP) for …?"

In the CVM, a questioner suggests the first bid and respondent replies "Yes" or "No". If the response is "Yes", a higher bid is proposed, to which a respondent will reply "Yes" or "No". This process continues until a response of "No". The last "Yes" gives the maximum bid, i.e. the maximum willingness to pay (MWTP). Here's a flowchart that describes this process:
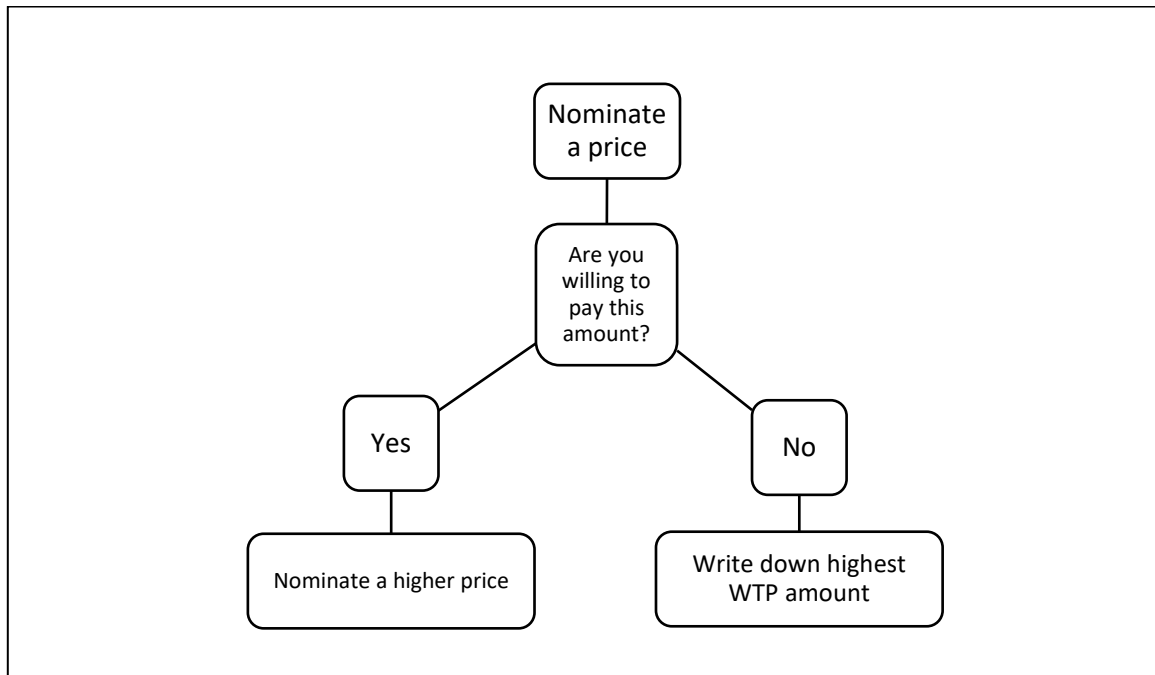
Let's look at an example of how much people were willing to pay for a Cowboys game ticket.

> **Discussion Point:**
>
> What is the lowest price someone was willing to pay for a Cowboys ticket? What is the highest price?
>
> What is the mean? What is the median? What is the mode?

Now let's use the CVM and an Excel spreadsheet on your computer to help us make decisions about the Castle Hill maintenance project.

Step 1:

In the Excel document, you are expected to conduct the CVM, namely to interview your fellow classmates to find out their maximum willingness to pay for avoiding the injury from the rock/landslide accidents in Castle Hill. You will start from a fist bid of $5, namely to ask the respondent, "Are you willing to pay $5 to avoid injury from rock/landslide while you are walking on Castle Hill?", and continue upward until the respondent says No, when you record the respondent's MWTP.

Step 2:

After the interview is completed, collect all the MWTP of the respondents in the Excel document (the sheet "2. MWTP"). Use the formula box at the top of the spreadsheet to type in a formula for calculating the Mean as follows:

1. Click in cell B:31 (next to the cell called "MEAN")

2. Type **=(**

3. Then select the cells that have the data (you will see the cell address appear in the formula box)

4. Then type **)**

5. Then press **Enter**

Do the same for Median (in Cell B:32) and Mode (in Cell B:33).

Discussion Point:

What do the statistics say about how much MEOW students are willing to pay for Castle Hill

maintenance? Can we use this data to decide for the whole of Townsville?

How should we do that? Should we use the mean, median or mode?

Step 3:

Now you need to find Townsville's population size, which is in the sheet "3. Population" of the Excel document. Multiply the median MWTP by the population size, you will find the dollar value of extra benefit that is associated with the Castile Hill maintenance project. This is the Marginal Benefit (MB)

You have estimated the extra (marginal) benefit that is due to the project. Now your next step is to work out what is the extra cost. Fortunately, this step is easy. All you need to do is to get quotes from the market. Two companies have provided quotes to carry out maintenance work on Castle Hill. Both companies have come up with the same costings (see the Table 1 below). The two companies both quote $249,700. This is the Marginal Cost (MC).

Marginal Cost (MC) = $_____   Marginal Benefit (MB) = $_____

Given this information, should Townsville City Council implement the project?

Suppose you would like to implement the project, as you get the same quotes from two companies, on behalf of the Council, you need to determine which of the firms that have provided a quote should be awarded the maintenance work.

Table 1: Quotes for the maintenance of Castle Hill.

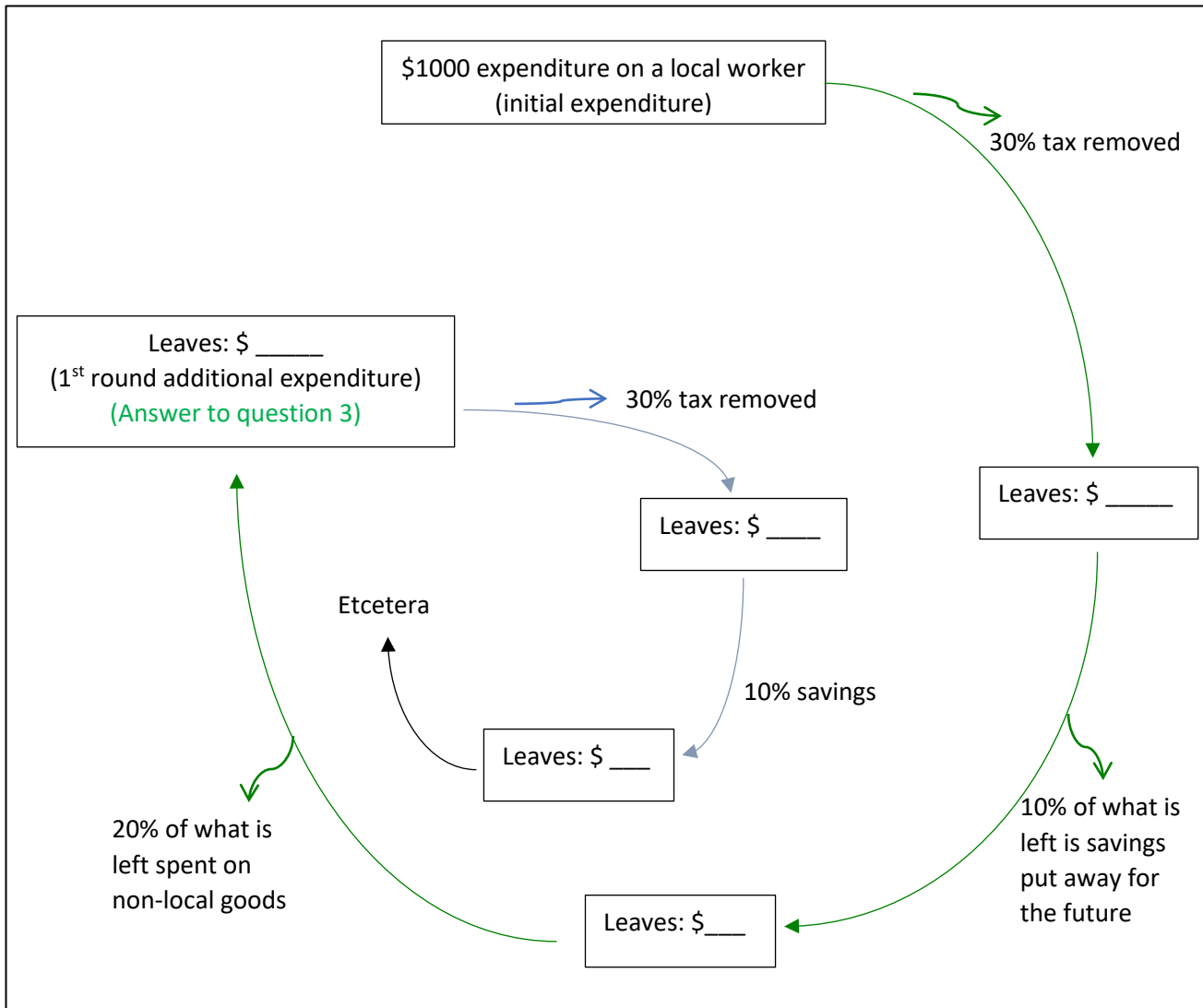| Townsville based firm (T)		Spent locally?
Labour cost:		
Wages construction workers	$35,000	Yes
Wages truck drivers	$25,000	Yes
Capital costs:		
Rocks/concrete	$120,000	Yes
Tools/machinery	$47,000	Yes
GST (10%)	$22,700	
Total cost	**$249,700**	
Brisbane based firm (B)		
Labour cost:		
Wages construction workers	$35,000	No
Wages truck drivers	$25,000	Yes
Capital costs:		
Rocks/concrete	$120,000	Yes
Tools/machinery	$47,000	No
GST (10%)	$22,700	
Total cost	**$249,700**	

The quotes are the same, so that is not easy. **But are they really the same?** In terms of costs they are, but what about economic impact in Townsville? The economic impact of the maintenance work is the amount of money that will be returned to the community when a company is paid to do the maintenance work. Let's calculate the economic impact of awarding the maintenance work to either of the firms and see whether that can inform us which firms should get the work.

3. Economic Impact

Step 1:

Refer to Table 1. What are the differences between the two companies?

The council wants to know how much of its $249,700 will be re-spent in the Townsville economy. This is called the **multiplier effect**. This is what happens to each dollar that a worker receives when the company pays them:

Diagram

$1000 expenditure on a local worker
(initial expenditure)

30% tax removed

Leaves: $ _____

Leaves: $ _____
(1st round additional expenditure)
(Answer to question 3)

30% tax removed

Leaves: $ _____

10% savings

10% of what is left is savings put away for the future

Etcetera

Leaves: $ ____

20% of what is left spent on non-local goods

Leaves: $ ____

Step 2:

Calculate the percentage of the initial expenditure that is left at the end of the first round of spending:

% of initial expenditure left = _____

We can use this percentage to express the relationship between every dollar paid locally and the amount left after each round:

For every $1 paid by the company	This much remains after 1 round of spending: 0.504 of $1 or 50.4 cents.
1 : 0.504	

Step 3:

Use Table 1 above to work out (with a calculator) how much money each company will spend locally in Townsville. Write down these amounts. Use the ratio to work out how much of the money Company T and Company B each pays locally is left after 1 round:

Table 2: How much each company will pay locally.

	Company T	Company B
Initial amount of money paid locally	$	$
This much remains after 1 round of spending (amount x ratio)	$	$

Step 4:

Go to the "4. Economic Return" worksheet in the spreadsheet. Look at Row 3 that is shaded pale green. How can we turn these numbers into the amount you calculated in Table 2? Write an Excel formula for each company:

Company T _____ Enter this formula into F4

Company B _____ Enter this formula into H4

Step 5:

Click and drag each formula down each column until you reach row 28.

How many rounds of spending occurred until only $0.01 was left?

Step 6:

Write an excel formula that totals the amount of money that is re-spent in the local community for each Company. This will be a sum formula:

Company T _____ Enter this formula into F30

Company B _____ Enter this formula into H30

Discussion Point:

Which company should be employed to do the work? Provide reasons for your decision.

How would you convince someone to shop locally?

Challenge

A generous friend is about to toss a coin, and offers you the following choice: a.) if the coin comes up heads they will give you $10, however if it comes up tails they will give you nothing, or b.) they will give you $5 whichever side comes up.

Which option would you choose? Is one choice more "valuable" than the other? Why/why not?

Puzzle

There are five number series given below. Can you work out what number comes next in each of the series? (There may be more than one answer.)

a)   8723, 3872, 2387, …
b)   99, 92, 86, 81, …
c)   1, 4, 9, 25, …
d)   1, 2, 6, 24, 120, …
e)   1, 10, 2, 9, 3, 8, 4, …

To gain **EXP** and level-up your mathematician, email your answers to the **Challenge** and **Puzzle** questions to Dr Greg at Gregory.Boyle@my.jcu.edu.au.

Q: Where does a fish keep its money?

A: In a river bank!