Motu Economic and Public Policy Research
Level 1, 97 Cuba Street
PO Box 24390, Wellington 6142
New Zealand
Ph 64-4-939 4250
Fax 64-4-939 4251
www.motu.org.nz

Environmental Trading Systems – Notes for instructors

Trading systems use price to encourage polluters to reduce their environmental impact. Regulators fix the total amount of pollution to a level that will achieve an environmental target and introduce a price on pollution. Polluters use their own information to decide how much they wish to reduce pollution. This can lead to environmental benefits at a lower cost.

Further information on nutrient trading can be found on the Motu website. See http://www.motu.org.nz/research/detail/nutrient_trading for research and further discussion of nutrient trading.

ACTIVITY IDEA: A trading game and short films.

Motu has developed a game where participants take part in a simplified nutrient trading system. The game was developed to give participants 'hands on' experience of trading. Participants manage either a dairy farm or a sheep/beef farm. Each farmer decides how much to produce each year. When they increase production they increase their pollution from nutrients. During the game, regulations to control nutrients will be introduced. Students will have to respond by altering their production.

Motu has also created two short films to illustrate some of the issues around declining water quality in Lake Rotorua. The films feature a dairy farmer and three Maori landowners/caretakers. All have knowledge of a prototype nutrient trading system we have designed for the Lake Rotorua catchment, but were free to present their own views of the proposed system and its implications. We have produced a brief slide show to introduce these ideas.

We suggest using these materials across two sessions:

Session 1

- Introductory slide show. 2 minutes.
- Trading game. Approximately 45 minutes to 1 hour, including and depending upon discussion time. The extension (a demonstration of the impact of allocation) will take additional time, and could be carried over to session 2.

Session 2

- Short films. 5 minutes and 11 minutes respectively.
- Further discussion and/or allocation extension.

The short films are available on DVD from Motu (contact info@motu.org.nz) or can be downloaded from our website at http://www.motu.org.nz/research/detail/rotorua_films.

Note: a trading game for emissions trading is also available. It is identical to the version described here, except that it refers to greenhouse gases in place of nutrients.

Trading Game Instructions

Set up

Organise students into groups of two or three. Pair each group with another group for trading.

Hand out a worksheet to each group. Each pair of groups should be made up of one dairy farm and one sheep/beef farm. Tell the students not to show their sheets to the other group.

Explain to students that this is a simplified version of reality where their farms are the only sources of nutrients in the economy. The aim of the game is to choose production levels to maximise profit given the regulation imposed.

Draw the following table on the board to allow comparison, or use the powerpoint provided. The table will be filled in as the game progresses.

	Total profit	Sheep/ beef nutrients	Dairy nutrients	Total nutrients
No regulation				
Nutrient limits				
Nutrient trading				

The Game

In each year of the game, participants choose a profit maximising production level according to the regulations in place. The students have a profit schedule at the top of their work sheets.

Example profit schedule:

Meat produced	0	1	2	3	4	5	6	7
Profit from meat production	-$12	$-1	$8	$14	$19	$24	$28	$26
Nutrient loss	0	4	6	8	10	12	14	16

Explain that the profit schedule shows the profit and nutrient units associated with each production level. Work through an example of how profit and nutrient levels change with changes in production. This may be easier visualised up on the whiteboard or on an OHP.

Scenario 1: Production decisions under no regulation

In the first year, the farmers' nutrients are not regulated. Ask the students to choose a production level to maximise profit (~5 minutes). They should all select the following:

Farm type	Production	Profit	Nutrients
Sheep & beef	8 units	$27	7 units
Dairy	8 units	$27	11 units
Total	--	$54	18 units

Fill in the "no regulation" row at the front of the class as part of the discussion.

Scenario 2: Production decisions under emission limits

The Government has introduced regulations to reduce the amount of nutrients entering waterways. Each farmer may emit no more than 6 units of nutrient each year.

Given this regulation, ask the students to choose a new production level to maximise profit (~5 minutes). They should all select the following:

Farm type	Production	Profit	Nutrients
Sheep/beef	7 units	$26	6 units
Dairy	3 units	$14	6 units
Total	--	$40	12 units

Discuss students' production and profit under this regulation. They should notice that both have fallen, and also that the Government has achieved its goal of reducing nutrients in waterways. Encourage students to compare with the previous round.

Fill in the "Nutrient limits" row at the front of the class as part of the discussion.

Scenario 3: Production decision under a nutrient trading system

The Government has decided that, instead of limiting nutrients with regulation, they will introduce a nutrient trading system. Participants must now surrender one allowance for each unit of nutrients. Farms will be allocated sufficient allowances to be able to produce as much as they could under the previous scenario (i.e. 6 allowances) to maintain the same environmental outcome.

Groups should negotiate with their assigned partners to see if they can increase their profit by buying or selling allowances. They should look at the change in profit from production before and after the trade to ensure that the trade will increase their total profits.

Students might need some encouragement to start trading, so suggest that someone makes the first offer. They won't be able to work out their optimal strategy without talking to the other team (for example, they won't know whether they want to buy or sell).

Allow ten minutes for trading, and give a warning two minutes before time is up. Only trades agreed upon by the end of this time will be counted.

Discuss this trading round with the class, emphasising the successful trades. Some questions to ask the students could be:

- Who managed to undertake a trade?
- Who was the buyer/seller?
- How many allowances did they trade?
- How much did they increase their profit by? Or who made more than $X profit?

This discussion provides guidance to those groups who did not manage to successfully trade. Do not fill in the final row of the table on the board yet!

Scenario 3a: Trading with another 'farm'

We recommend running a second round of trading with different trading partners. Changing trading partners allows those who understand to spread the knowledge and ensures that groups don't just agree to repeat the numbers from the last scenario. One way to efficiently swap groups is to ask all the dairy farm groups to stand up and move clockwise around the room to the next sheep/beef farm group.

Stress that the game is beginning fresh. Their play in the previous round has no impact on this round. It should be run identically to the previous round.

Discuss the outcomes, including questions such as:

- Who managed to undertake a trade?
- Who made more profit than the last round?

The optimal trade occurs when sheep/beef farmers sell 2 allowances to dairy farmers. Discuss this with the class. The exact profit split will depend on the negotiation skills of the participants but it should look something like this (in this example the 2 allowances were sold for $3 each):

Farm type	Production	Profit	Nutrients
Sheep/beef	5 units	$29	4 units
Dairy	5 units	$17	8 units
Total	--	$46	12 units

Discussion

Refer to the table on the board (see below for the correct figures) and compare environmental and economic outcomes for the different regulatory states. Students should be able to see the following:

- Regulators determine environmental targets (the cap), i.e. trading itself does not affect environmental outcomes.
- Trading can reduce the costs of meeting a target

	Total profit	Sheep/ beef nutrients	Dairy nutrients	Total nutrients
No regulation	$54	7 units	11 units	18 units
Nutrient limits	$40	6 units	6 units	12 units
Nutrient trading	$46	4 units	8 units	12 units

Extension – Allocation

Suppose that instead of providing each farm with 6 allowances, the government had decided that dairy farmers needed to be compensated most. In this scenario, sheep/beef farmers are allocated 3 allowances and dairy farmers are allocated 9 allowances.

With new (clean) handouts, or as a whole class discussion, look at the outcome of this allocation for individual profits and total profits. Note that the total nutrient loss will be the same: 12 units.

With these nutrient limits applied, farmers maximise profits as follows:

Farm type	Production	Profit	Nutrients
Sheep/beef	4 units	$14	3 units
Dairy	6 units	$25	9 units
Total	--	$39	12 units

An optimal trade in this scenario occurs when the dairy farmer sells one allowance to the sheep/beef farmer at a cost of $3, with the following outcome:

Farm type	Production	Profit	Nutrients
Sheep/beef	5 units	$20	4 units
Dairy	5 units	$26	8 units
Total	--	$46	12 units

Compared to the original scenario, the dairy farmer receives a greater proportion of the total profit (first allocation: $17; second allocation $26). The amount of total profit ($46) and the optimal level of production (five units on each farm) is the same.

Students should be able to see that:

- The initial allocation does not affect overall profits or optimal production patterns, however it does affect the distribution of wealth within the economy.

Further Questions

- What are some of the problems of shifting this type of system into the real world?
- How might farms reduce nutrient loss other than by reducing production?
- How does allowance trading affect firms' inclination to invest in more environmentally friendly technology relative to non-trading regulation?
- Could limiting nutrients allow a business to continue as usual, or perhaps become more profitable? Could tradable allowances?
- Who enforces the system and how?