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 about emissions trading in New Zealand can be found at the government climate change website. See http://www.climatechange.govt.nz/emissions-trading-scheme/about/ for basic emissions trading information.

A more in depth discussion of the issues can be found on Motu's climate change page. See http://www.motu.org.nz/research/group/climate_change for research on a wide variety of climate change related issues.

Agricultural emissions comprise a significant proportion of New Zealand's total emissions profile. For more information and teaching materials on issues relating to agricultural emissions, see our Agricultural Emissions Dialog blog http://agriculturalemissions.blogspot.co.nz/.

### ACTIVITY IDEA: trading game

Motu has developed a game where participants take part in a simplified emissions trading system. The game was developed to give participants 'hands on' experience of trading. Participants manage either an aluminium smelter or an electricity retailer. Each firm decides how much to produce each year. When they increase production they increase their greenhouse gas emissions. During the game, regulations to control emissions will be introduced. Students will have to respond by altering their production.

Note: a trading game for nutrient trading is also available. It is similar to the version described here, except that it refers to sheep/beef and dairy farms in place of electricity retailers and aluminium smelters, and nutrients in place of green house gases. The nutrient trading version is designed to accompany our nutrient trading short films. See http://www.motu.org.nz/research/detail/rotorua_films for more information.

## 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 aluminium smelter and one electricity retailer. 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 firms are the only sources of emissions in the economy. The aim of the game is to choose production levels of their firm 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 | Electricity retailer emissions | Aluminium smelter emissions | Total emissions |
|---|---|---|---|---|
| No regulation | | | | |
| Emissions limits | | | | |
| Emissions 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:

| Coal-fired electricity supplied | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|---|
| Profit from all electricity supplied | -$10 | $0 | $9 | $12 | $20 | $22 | $24 | $23 |
| Emissions | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |

Explain that the profit schedule shows the profit and greenhouse gas emissions associated with each production level. Work through an example of how profit and emission 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 firms' emissions are not regulated. Ask the students to choose a production level to maximise profit (~5 minutes). They should all select the following:

| Firm type | Production | Profit | Emissions |
|---|---|---|---|
| Electricity retailer | 8 units | $27 | 7 units |
| Aluminium smelter | 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 levels of emissions. Each firm may emit no more than 6 units of greenhouse gases 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 | Emissions |
|---|---|---|---|
| Electricity retailer | 7 units | $26 | 6 units |
| Aluminium smelter | 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 total emissions. Encourage students to compare with the previous round.

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

***Scenario 3: Production decision under an emissions trading system***

The Government has decided that, instead of limiting emissions with regulation, they will introduce an emissions trading system. Participants must now surrender one allowance for each unit of emissions. Firms 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 'firm'***

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 aluminium smelter groups to stand up and move clockwise around the room to the next electricity retailer 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 electricity retailers sell 2 allowances to aluminium smelters. 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):

| Firm type | Production | Profit | Emissions loss |
|---|---|---|---|
| Electricity retailer | 5 units | $29 | 4 units |
| Aluminium smelter | 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 | Electricity retailer emissions | Aluminium smelter emissions | Total emissions |
|---|---|---|---|---|
| No regulation | $54 | 7 units | 11 units | 18 units |
| Emissions limits | $40 | 6 units | 6 units | 12 units |
| Emissions trading | $46 | 4 units | 8 units | 12 units |

## Extension – Allocation

Suppose that instead of providing each firm with 6 allowances, the government had decided that aluminium smelters needed to be compensated most. In this scenario, electricity retailers are allocated 3 allowances and aluminium smelters 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 emissions will be the same: 12 units.

With these emissions limits applied, firms maximise profits as follows:

| Firm type | Production | Profit | Emissions loss |
|---|---|---|---|
| Electricity retailer | 4 units | $19 | 3 units |
| Aluminium smelter | 6 units | $25 | 9 units |
| Total | -- | $39 | 12 units |

An optimal trade in this scenario occurs when the aluminium smelter sells one allowance to the electricity retailer at a cost of $3, with the following outcome:

| Firm type | Production | Profit | Emissions loss |
|---|---|---|---|
| Electricity retailer | 5 units | $20 | 4 units |
| Aluminium smelter | 5 units | $26 | 8 units |
| Total | -- | $46 | 12 units |

Compared to the original scenario, the aluminium smelter 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 for each firm) 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 firms reduce emissions 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 emissions allow a business to continue as usual, or perhaps become more profitable? Could tradable allowances?
- Who enforces the system and how?