EDF ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

Motu economic & policy research

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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.

You can find more information about climate change and emissions trading on the following links:

Emissions trading in practice: a handbook on design and implementation

https://motu.nz/our-work/environment-and-resources/emission-mitigation/

https://icapcarbonaction.com/

https://carbonpricingdashboard.worldbank.org/resources

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 a cement producer or an electricity generator. 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.

Trading Game Instructions

Set up

Organize 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 cement producer and one electricity generator. 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 maximize 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 generator emissions	Cement producer emissions	Total emissions
No regulation				
Emissions limits				
Emissions trading				

The Game

In each round of the game, participants choose a profit maximizing 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 generated	0	1	2	3	4	5	6	7
Profit from all electricity generated	-$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 visualized up on the whiteboard.

Scenario 1: Production decisions under no regulation

In the first round, the firms' emissions are not regulated. Ask the students to choose a production level to maximize profit (~2 minutes). They should all select the following:

Firm type	Production	Profit	Emissions
Electricity generator	8 units	$17	7 units
Cement producer	8 units	$37	11 units
Total	--	$54	18 units

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

Next, the Government introduces 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 maximize profit (~3 minutes). They should all select the following:

Firm type	Production	Profit	Emissions
Electricity generator	7 units	$16	6 units
Cement producer	3 units	$24	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 or use the slides.

Scenario 2: 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, emphasizing 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 2a: 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 cement producer groups to stand up and move clockwise around the room to the next electricity generator 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 generators sell 2 allowances to cement producers. 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):

Firm type	Production	Profit	Emissions loss
Electricity generator	5 units	$16	4 units
Cement producer	5 units	$30	8 units
Total	--	$46	12 units

Scenario 3: Accepting a more ambitious environmental limit in exchange for the flexibility of trading

In this scenario, the goal is to see if you can be more ambitious and obtain greater environmental benefits by using an ETS. It is assumed that the government has implemented an emissions limit regulation of 6 units, as in the second section of round 1. The companies try to propose to the government a more flexible system, an ETS, in which there is a win-win for the government and the private sector. The objective of the players is to find an allocation of units for each company with the greatest environmental gain (smallest total allocation) but where neither company is worse off than under the initial regulation. Their profits remain at least as high as in the case of a limit of 6 emission units each.

Allow 15 minutes for negotiation, with the optimal allocation and emissions being the following:

Firm type	Production	Profit	Emissions
Electricity generator	3 units	$16*	2 units
Cement producer	5 units	$24*	8 units
Total	--	$40	10 units

* the actual distribution of profits between the companies depends on negotiations.

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
- Trading can allow greater environmental gains than emission limits without increasing cost

	Total profit	Electricity generator emissions	Cement producer 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
Win-Win Production	$40	2 units	8 units	10 units

Extension – Allocation

Suppose that instead of providing each firm with 6 allowances, the government had decided that cement producers needed to be compensated most. In this scenario, electricity generators are allocated 3 allowances and cement producers 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 maximize profits as follows:

Firm type	Production	Profit	Emissions
Electricity generator	4 units	$9	3 units
Cement producer	6 units	$35	9 units
Total	--	$44	12 units

An optimal trade in this scenario occurs when the cement producer sells one allowance to the electricity generator, with the following outcome:

Firm type	Production	Profit	Emissions
Electricity generator	5 units	$13	4 units
Cement producer	5 units	$33	8 units
Total	--	$46	12 units

Compared to the original trading scenario, the electricity generator receives a greater proportion of the total profit (first allocation: $9; second allocation $13). 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.

In case of questions from the players it is important to note that this allocation illustration is for 'grandparenting'. Output-based allocation is another common approach. It has slightly different implications.

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?