

# International Climate Agreements: How Economists Think

## Economic efficiency – perfect competition

A key issue in economics is how resources actually are used, as opposed to how they should be used to obtain economic efficiency. According to a fundamental result in economics, a perfectly working economy, henceforth referred to as ‘perfect competition’, provides efficient use of all resources. Whereas other institutional arrangements may also lead to efficiency, our starting point below is perfect competition, partly because this market structure is at the core of how economists think and partly because these alternative arrangements are of limited relevance in respect of our main focus, i.e., international climate agreements.



**Senior Research Fellow**

**Rolf Golombek**

The Ragnar Frisch Centre for Economic  
Research, Norway

E-mail: [rolf.golombek@frisch.uio.no](mailto:rolf.golombek@frisch.uio.no)

CAS Fellow 2005/2006

Perfect competition is based on a number of assumptions. Some of them are i) there are markets for all goods, ii) all agents take all prices for granted (which can be rationalized since it is assumed that there are many agents, all being small), and iii) all agents are rational. In economics, there is more than one definition (or

understanding) of rationality. Typically, the minimum requirement for an agent to be termed rational is that he has a clear purpose to his actions and behaves consistently. Under the assumption of perfect competition, rationality is operationalized as a) consumers maximize their well being, represented by their preferences, which depend solely on their own consumption of goods, and b) producers maximize profits.

Under perfect competition, the social optimal level of production is reached for all goods. Moreover, production of each good is cost efficient, that is, it is not possible to provide the same level of production at a lower total cost. Prices play an important role. In particular, they reflect the preferences of consumers as well as the technologies of producers. Under these prices, agents make choices that lead to an economic efficient outcome.

## Deviations from perfect competition

The concept of perfect competition is a theoretical construction that is frequently useful as a benchmark. In a strict sense, the assumptions of perfect competition are hardly satisfied for a whole economy, but might be satisfied for a number of goods/markets. For example, some producers might be aware that if they cut back on their production, the market price will rise. In the corner case of only one producer (a monopolist) supplying a good, production will be (much) lower than under perfect competition, and thus the market price is highest under a monopoly. Yet, the government may provide incentives to the monopolist to make the monopolist

supply the socially optimal level of production. This can be done through a subsidy on production, thereby making it more profitable to produce goods. If the government has complete information, the subsidy that will make the monopolist produce exactly the quantity that would have been supplied under perfect competition (without any subsidy) can be calculated.

Under perfect competition, actions taken by one agent affect all other agents through market prices alone. However, in the real world, actions taken by one agent might have a direct impact on other agents, and not through prices alone. For example, a firm emitting harmful gasses into the air has direct negative impact on the consumers living in its neighbourhood. Because the firm is assumed to care only about its profits, it overlooks the harmful effects it causes. The problem is that there is no market for clean air (the price of clean air is actually zero, but should have been positive). Thus, the firm is not charged for causing harmful effects on people. The standard suggestion in economics to solve this problem is to introduce a market for clean air by imposing a tax on all agents emitting the harmful gas. Through the tax, the firm gets an incentive to take into account that people suffer from the emissions, and thus the firm will reduce its emissions.

### **Domestic emissions**

Suppose there are two producers in a country (termed producers 1 and 2) that emit a harmful gas,  $\text{CO}_2$ , into the air. Each producer can reduce its emissions in a number of ways; i) install equipment that captures the  $\text{CO}_2$ , which is then stored safely, ii) reduce the level of production, iii) change the production process (less emission-intensive technology), and iv) change the type of product (less emissions per unit of product). Each producer finds the combination of actions that, for each level of reduced emissions, minimizes his costs.

Suppose that for producer 1, the cost of reducing emissions by one unit is always 2. For producer 2, the cost of reducing the first unit of emission is supposed to be 1, the cost of reducing the second unit of emission is supposed to be 2, and cost of reducing the third unit of emission is supposed to be 3. Assume further that the government in the country has decided that emissions should be reduced by, say, 3 units (The reduction may reflect that the country has signed an international agreement that imposes this emission reduction). How much should each firm reduce its emissions in order to obtain a total emission reduction of 3 units at *the lowest possible cost* for the country? The first unit should be reduced by firm 2 (cost is 1). For the two remaining units, either emissions should be reduced solely in firm 1 (cost is always 2), or one unit should be reduced in firm 1 (cost is 2) and one unit should be reduced in firm 2 (cost is 2). Hence, the optimal solution is characterized by equal costs for the two firms of reducing the last unit of emission.

How can this solution be implemented in a market? As explained above, by the government imposing a tax on emissions, each firm is given an incentive to reduce its emissions. A key result in environmental economics is that the optimal solution for the country can be achieved by imposing this tax on both (all) firms (The tax that achieves the optimal solution can be calculated if the government has all the relevant information).

Alternatively, the optimal solution can be achieved through tradable credits, that is, i) each unit of emission a firm wants to emit requires a credit, and ii) credits can be bought and sold in a market. Assume that initial emissions in each firm are 10 units. The government can then distribute  $(2 \times 10 - 3) = 17$  credits among the firms in order to reach the goal of reducing emissions by 3 units. Assume the credit market works perfectly. The price of credits will then be equal to the optimal emission tax, and hence the optimal reduction of emissions between the firms will be achieved.

### International climate agreement

Above, we examined the case of reductions in emissions from firms in the same country. In the real world, there are emissions of CO<sub>2</sub> in all countries. If, hypothetically, there were a legal body with jurisdiction over all firms in the world, that body could impose a tax on CO<sub>2</sub> emissions from all firms or impose a tradable credit system for all firms. That would solve the global pollution problem.

However, there is no legal body with jurisdiction over all firms in the world. Yet, if all countries sign an international climate agreement, the problem will still be solved. The agreement could commit each country either to impose a common tax on CO<sub>2</sub> emissions or to participate in an international system of tradable credits. However, countries are independent units and free to choose whether or not to sign agreements. If a country signs an agreement, it will bear some costs as emissions are reduced. Moreover, total emissions of CO<sub>2</sub> will be reduced since it is the sum of CO<sub>2</sub> emissions, not the distribution of emissions between countries, which matters for the climate costs of a country. In other words, all countries will benefit from lower emissions. Hence, by participating in an international climate agreement, a country bears the full costs but receives only part of the benefits, whereas if the country does not sign, it has no costs but still receives benefits (as long as other countries participate in the agreement). Hence, based on pure self-interest, each country prefers not to sign the agreement (although collective rationality implies that all countries should participate). This is probably the main reason why only 36 countries have accepted emission reductions under the Kyoto Protocol.

There is no easy way to solve this problem, that is, to make countries subscribe to climate agreements. The key to resolving the problem is to find a mechanism that allows each country to benefit from participating in the climate agreement. At present, there are several proposals under discussion. Of particular interest are technology agreements: Through research and development (R&D) on climate-friendly technologies, the cost of reducing emissions will be reduced, making countries less reluctant to reduce their emissions (See Golombek and Hoel, 2006).

### References

Golombek, R. and M. Hoel. "Climate agreements: Emission quotas versus technology policies". *Working paper 21/2006* from Department of Economics, University of Oslo, 2006.