CHAPTER 1
INTRODUCTION

On the agenda of environmental problems, the enhanced greenhouse effect has nowadays acquired a prominent place. Although there is still much uncertainty about its extent and its consequences, there is an important rationale for addressing the possible problem of climate change now: whatever the specific consequences may be, they are to a large extent determined by the actions we take (or do not take) today. Emissions from greenhouse gases will determine the atmospheric concentrations of these gases for centuries to come. Because of the increase in anthropogenic CO$_2$ emissions, starting with the industrial revolution and the rise in the use of fossil fuels which it has caused, the concentration of CO$_2$ in the atmosphere has risen by 25 percent since 1750. If we want to limit the increase of CO$_2$ concentrations, action must be taken now.

Within the broad area of research on climate change, one specific strand of economic research has focused on the problem of how to reduce emissions from greenhouse gases, especially the emission of carbon dioxide, which is the main greenhouse gas. Taking as a starting point the assumption that a CO$_2$ emission reduction target has been set, the objective of these studies is to determine the optimal way of reducing these emissions.

From the start, it has been pointed out by environmental economists that economic instruments are suitable for implementing a policy of reducing emissions of greenhouse gases. With economic instruments, emissions will be reduced in an efficient manner, according to the theory. This has been argued and illustrated in a large number of studies which deal with economic instruments like taxes or charges and tradeable emission permits (see e.g. Barrett 1992, UNCTAD 1992, OECD 1992a and 1992b, Smith 1992). In this study, the instrument of tradeable carbon emission permits (TCP’s) is studied in more detail. The central issue is: the design of a feasible system of TCP’s and the study of the consequences of implementing such a system.

Up till now, the focus of research in this area has been predominantly on the efficiency of reducing CO$_2$ emissions by means of tradeable emission permits or taxes.
Less attention has been paid to the design of such a system, which is the subject of chapter 2. In this chapter the outlines are sketched of a feasible system of tradeable emission permits for the European Union. The proposed system is in essence a system of (carbon in) fuel rationing with tradeability of quota between citizens. Points under consideration are a.o. the characteristics of the fuel permit, the distribution of the permits (either the government sells them or gives them away for free), the market allocation of the permits, the time path by which the number of permits available is reduced, monitoring and enforcement of the system and the consequences which a system of tradeable emission permits might have for business location choice. Moreover it is studied whether a system of TCP’s can operate on a national base in one member state of the European Union or if it should be implemented at the European level. Last, the requirements of a EU-wide system are sketched.

A study of the implications of reducing CO\textsubscript{2} emissions by means of TCP’s (or any other instrument) can not be complete without studying the economic consequences of such a system. To predict some of the consequences of introducing an instrument like TCP’s in an industry a micro-economic approach is necessary in which the influence on one or more facets of economic behaviour is studied in detail. For example, attention has been given to the potential misuse of market power in the permit market (see Tietenberg 1985 and Hahn 1984). On the other hand hardly any attention has been paid up till now to the possible effects of tradeable emission permits on entry into industries. This is especially interesting because it has been practice to grandfather permits to existing sources while new sources, potential entrants, have to buy them. Many people, and even economists have the intuition that in particular such a system of grandfathering will erect barriers to potential entrants, whereas a system of auctioning permits to all firms, established ones and entrants, would not have such an impact, or at least a much weaker negative effect on entry. In chapter 3 and 4 it is analyzed how far this idea is true. The question is addressed whether, how and to what extent a system of tradeable permits might create barriers to entry in the product market. Several forms of entry barriers which might be caused or increased by tradeable permits are identified and analyzed. Subsequently, it is studied whether these forms of entry barriers are likely to occur in the system of TCP’s which is outlined in chapter 2. An effort is made to determine to what extent entry will be affected when
entry barriers are raised due to the TCP system.

The above questions are important, not only from a static point of view, but also if a dynamic view is taken. If a TCP-system for reducing \( \text{CO}_2 \) emissions raises entry barriers, it will affect the whole economy, affecting long-term industry dynamics. This in turn might reduce the efforts on research and development and reduce economic activity and efficiency in the longer run in the whole economy. The approach taken here is to study the micro-economic consequences of a system of tradeable carbon permits with respect to entry barriers, both with grandfathering and with auctioning of \( \text{CO}_2 \) emission permits. The results will be compared with the results achieved under two other instruments, taxes and standards. The possible occurrence of entry barriers is analyzed both theoretically and empirically.

A salient feature of the greenhouse problem is that it occurs worldwide, irrespective of the place where \( \text{CO}_2 \) and the other greenhouse gases are emitted. While this facilitates the design of a TCP system considerably (see chapter 2), it does pose the additional problem of coordination of policies. It is important to examine whether and how countries cooperate in reducing emissions and what the role of the instruments of taxes and tradeable permits can be in an international setting. This is the subject of chapter 5 and 6.

The approach taken is more general than in the earlier chapters. The model used ‘pictures’ the whole economy but in a very simplified way. The economy is assumed to consist of one representative consumer who can consume two goods, one of which causes pollution when it is consumed (the pollution represents \( \text{CO}_2 \) emissions). In addition, the consumer chooses how much of his time he will spent working (and earning an income) and how much leisure he takes. The consumer does not take this pollution into account when he makes his consumption decision, therefore the government has to use instruments like taxation (or TCP’s) to limit emissions. In the first sections of chapter 5, the optimal levels of \( \text{CO}_2 \) emission reduction are not taken as given; instead they are a result of the analysis. In addition to reducing pollution, the government also has to raise an exogenously given amount of revenue. The government maximises a (social) welfare function which includes damage from pollution under constraint of its revenue requirement. Its instruments (the variables in
the model) are the taxes it can levy on the two goods, labour is not taxed. The taxes must serve two purposes: reducing pollution and raising revenue. This reflects the complicating factor that fossil fuels, the main source of CO₂ emissions, are already taxed in most countries. In this model it can be determined how an emission reduction policy should be combined with these existing taxes, as has originally been done by Sandmo (1975).

Our approach differs from earlier literature on the subject by extending the model to an international context. The extended model includes two countries which are assumed to be equal in all respects except in the damage suffered from pollution and the amount of revenue which has to be raised. The object of the analysis is to answer the following questions:

- How will the tax structure in both countries change when they cooperate in reducing emissions and use taxes as instruments of coordinated emission reduction?
- What is the consequence of such cooperation for the welfare level (or worded differently for the economy) and the level of pollution in both countries?
- Can coordination be improved (made more efficient) and total emission reduction raised by allowing for Joint Implementation, that is by allowing one country to pay another country which in return increases its emission reduction by increasing its tax on the polluting good? In our model sidepayments have to be raised by taxation on the two goods, which further complicates the analysis.
- How are the tax structures and the pollution levels affected by this form of Joint Implementation?

In addition to the formal analysis a less general functional form is used in simulations to get more specific answers to the questions posed above.

Instead of a damage function from which the optimal level of pollution is derived an exogenously determined emission ceiling can be used. This better reflects the current practice of CO₂ emission reduction policy. In chapter 6 the model is modified to include such emission ceilings instead of damage functions. It is studied how different government budgets and different initial emission quota influence the tax structures in both countries when they cooperate.

It might be an interesting exercise to determine the optimal tax structures when
countries coordinate in reducing pollution, it is also important to determine which institutional arrangements and instruments can be used to achieve the optimal conditions. It is studied whether international agreements have to specify in detail the level of taxes which each country should levy or whether it suffices to agree on emission limits and sidepayments and leave it to the countries themselves to set taxes. Moreover it is analyzed which role TCP’s can have in international agreements to limit CO₂ emissions. Conventional wisdom is that trade in emission quota between countries will lead to a cost-efficient and welfare maximising solution. It will be studied whether this is also the case in our model in which governments have to reduce emissions and raise revenues at the same time.

A last question which is addressed is the role of grandfathering. Selling the permits will raise revenue for the government while grandfathering means that taxes have to be used to meet the government’s budget constraint. The question arises whether grandfathering and auctioning have the same welfare effects or whether they differ in their consequences.

In the outline sketched above, two themes are recurrent. First, the choice between grandfathering and auctioning the permits. This is a central element in the design of a system of tradeable emission permits. Experience with tradeable emissions shows that up till now it has been practice to grandfather the permits to existing sources whereas new sources have to buy the permits they need. A main reason for this policy is that grandfathering permits reduces resistance from (industrial) polluters considerably as compared with auctioning the permits or imposing emission charges. The outlays of polluters on permits can be large compared with their abatement costs when they have to buy permits to cover their remaining emissions. While this does not mean that the use of the permits is without costs (the firms forego the opportunity to sell the permits, therefore they bear the opportunity costs), receiving the permits for free is equivalent to receiving a lump-sum capital transfer. However, while grandfathering is attractive from the point of view of the existing sources, it might be a drawback to entrants. This possible negative influence of grandfathering is considered in the third chapter on entry barriers. Furthermore, in chapter six the role of grandfathering is analyzed in a model in which governments have to reduce pollution and raise revenue at the same time. The
welfare implications of grandfathering are compared with those of auctioning of the permits (chapter four).

The second recurrent theme is the comparison of the instrument of tradeable emission permits with other instruments: a charge on CO$_2$ emission (the so-called carbon tax) and command-and-control type of regulation like emission standards. This comparison is made (a) in order to highlight the peculiarities of tradeable emission permits vis-a-vis other policy measures and (b) because carbon taxes have received much attention in the current debate on CO$_2$ emission reduction, both from policy makers and scientists. The different consequences for entry barriers between on the one hand TCP’s and on the other hand taxes and standards are studied in chapters 3 and 4. In chapter 6 the role of taxes and TCP’s are compared in international agreements on CO$_2$ emission reduction policies.