

University of Groningen

Strategic interactions in environmental economics

Heijnen, Pim

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version

Publisher's PDF, also known as Version of record

Publication date:

2007

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Heijnen, P. (2007). *Strategic interactions in environmental economics*. [Thesis fully internal (DIV), University of Groningen]. s.n.

Copyright

Other than for strictly personal use, it is not permitted to download or to forward/distribute the text or part of it without the consent of the author(s) and/or copyright holder(s), unless the work is under an open content license (like Creative Commons).

The publication may also be distributed here under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license. More information can be found on the University of Groningen website: <https://www.rug.nl/library/open-access/self-archiving-pure/taverne-amendment>.

Take-down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

Downloaded from the University of Groningen/UMCG research database (Pure): <http://www.rug.nl/research/portal>. For technical reasons the number of authors shown on this cover page is limited to 10 maximum.

Chapter 1

Introduction

Rapid economic growth in the postwar period in North-America and Western-Europe caused considerable and visible damage to the environment. By the early 1970's the first environmental regulations were implemented. These laws, aimed at improving the quality of water and air, and protecting endangered species, have been successful. Compared to 1970, North-Americans and Europeans live in a cleaner world. The success of these measures has been such that some authors claim, notably Lomborg (2001)'s controversial study, that humankind's impact on the environment has ceased to be a problem.

The environmental movement of the 1970's also raised more fundamental questions. For instance, if population continues to grow and resources are limited, is this a sustainable way of life? (Dasgupta and Heal, 1974; Hartwick, 1977; Asheim, Buchholz and Withagen, 2003). The main result from this literature is that a necessary condition for sustainable development is that natural resources must be sufficiently substitutable by labor and capital. The kind of models used in this literature assume the existence of a social planner: a benevolent force that tries to maximize social welfare. There are two drawbacks to this approach. First, it supposes that there are no possibly disturbing strategic effects (i.e. the social planner internalizes all externalities and can perfectly enforce regulation). Second, the natural resources can be substituted *ad infinitum* (i.e. with a minimal amount of energy production of goods can be kept constant by the introduction of new technology).

Our main concern is with strategic effects. As a clarifying example consider the Kyoto-protocol. During the 1980's it became apparent that mass CO₂-emissions were causing global warming. A first attempt to stop this trend was the signing of the Kyoto-protocol in 1997. The aim of the Kyoto-protocol is to reduce the emission of greenhouse gases. In contrast to the

local pollution that earlier regulation aimed at, strategic interaction between countries, that have signed the protocol, is a crucial factor. If, for instance, a number of countries would have ratified the contract, then the additional benefits for another non-ratifying country would be so small that not ratifying the contract could be optimal. In fact, as of 2006, while the members of the European Union have ratified the contract, the US seems unwilling to do so. Since the US is by far the largest producer of greenhouse gases, the efforts of the rest of the world are rendered almost useless. This brings us to a common theme in environmental economics: the tragedy of the commons (Hardin, 1968, is the seminal reference). All involved parties would benefit from a coordinated reduction of emissions, but individually each party also has an incentive to diminish the reduction afterward.

Strategic interaction between a government and firms is also of importance. For instance, the reduction of CO₂ as specified in the Kyoto-protocol, is basically to bring emission back to the 1990-level by 2010. Simple regulation like vehicle emission standards, on which the government relies, can have diminished effectiveness due to the behavior of, in this case, the car industry (see, e.g., Goldberg, 1998). This is true for many traditional government instruments such as taxation and quality standards. Similar considerations apply to private initiatives such as awareness campaigns by environmental groups.

This thesis aims to examine the role of strategic interactions between the various actors involved in environmental issues and its impact on economic policy. These strategic interactions arise at several levels three of which are discussed in this thesis: environmental groups versus firms, the government versus firms and governments versus governments.

Environmental groups versus firms: In light of examining how consumption habits can be changed, it is worthwhile to examine the role of private initiative to bring about these changes. I focus on environmental groups (EGs): a private initiative that can increase environmental awareness. The scope of the activities of EGs is broad and ranges from direct action to awareness campaigns and lobbying activities. A large part of these activities try to inform consumers about the state of the world or persuade the consumers. The educated or persuaded consumer may alter his habits by choosing to consume less or shift from dirty products to clean products. Can EGs alter habits? What is the effect of this campaigning on consumption? How do firms respond? Do they start producing cleaner products? And how efficient is this

campaigning? These kind of questions will be explored in Chapters 2 and 3.

The government versus firms: Taxation is another area where strategic interactions play an important role. In imperfect markets taxation can have adverse effects. In particular, it can create or aggravate product differentiation, which in turn creates a less competitive market. While the government may need to correct an externality by introducing a tax, it must also take into account these adverse effects. Decisions to change taxes are influenced by this consideration. In Chapter 4, I will examine how the effects of changes in car and fuel taxation are influenced by different market structures as well as the effects of introducing a tax fully depend on car use.

Government versus government: Taxation does not only influence the decisions of firms and consumers, but can also affect taxation in neighboring jurisdictions. A possible channel through which this could occur is a stream of pollutants, whose size depends on (the type of) taxation, to neighboring jurisdictions. In Chapter 5, I empirically investigate whether such spillovers exist in the context of waste disposal taxes in Dutch municipalities.

Both Chapter 4 and Chapter 5 explore the unintended strategic effects of taxation, but observe that the effects are not necessarily bad. In the case of the waste disposal taxes studied in Chapter 5, an initiative in one municipality could trigger the widespread use of a novel, environmentally-friendly tax.

Finally, in Chapter 6, a binary public good game will be studied. Many problems in environmental economics revolve around a public good. The question in these kind of games is often whether the public good in question is (efficiently) provided. I will examine how the probability that a public good is provided depends on the number of players.

All these problems involve strategic interactions. Game theory offers a consistent way to model such strategic interactions. Industrial organization (see Tirole, 1988, or Martin, 1993 for textbook expositions) was the first field in economics to use the formal tools of game theory to model strategic interaction between firms. According to Bagwell and Wolinsky (2002, p.1853):

It is mostly through industrial organization that game theory was brought on large scale into economics and achieved its current standing as a fundamental branch of economic theory.

This revolution has spread to almost all fields in economics, notably political economy (Grossman and Helpman, 2001) and environmental economics (Folmer, Hanley and Mißfeldt, 1998; Lyon and Maxwell, 2004). It has to be noted that the use of game theory in environmental economics does not constitute a complete breach with tradition. For instance, the seminal work of Mäler (1989) is still rooted in the traditional approach to environmental economics. Each chapter in this thesis employs game-theoretic tools to analyze topics in environmental economics (and Chapter 5 also contains an econometric analysis). I continue with an overview of the chapters.

1.1 Environmental groups: Chapters 2 and 3

First, the focus will be on the role of environmental groups in the formation of expectations and preferences about environmental damage. There is evidence that consumers care about the environment and that these preferences at least partly determine whether a good is bought. Two prime examples of this behavior are boycotts and environmental labeling. Friedman (1985, 1999) shows that boycotts are used and increasingly so. People start boycotts for various reasons but one of them is outrage about how goods are produced, i.e. due to environmental concerns. Friedman records 90 major boycotts in the United States during the 1970s five of which could be classified as environmental. Products are labeled to indicate that the product meets certain product quality standards. For instance, a labeled product can be more environmentally-friendly than a non-labeled product. Bjørner, Hansen and Russell (2004) try to estimate the value of such an environmental label, the Nordic Swan, to the Danish consumer. They find that labeled goods have a price that is 13 to 18 per cent higher. Kuhn (2005, Chapter 1) provides more evidence of consumers' willingness to pay for environmentally-friendly products.

Chapters 2 and 3 of this thesis are about a campaign launched by an EG like Greenpeace. EGs are most renowned for their direct actions against firms, but they also pursue campaigns aimed at raising awareness. Baron (2003) quotes environmentalists who are of the opinion that it is of the utmost importance to convince the public. These kind of campaigns can educate consumers and are a kind of advertising. Hence, the EG is involved in advertising which is basically of the same nature as regular advertising from a firm directed at consumers.

This type of advertising has, as far as I am aware, not been studied.

The literature focuses on lobbying where an EG addresses the government hoping to change regulation. There are different approaches. In one strand of the literature, EGs are better informed than politicians. If the aims of the EG and the politicians are not diametrically opposed, then the EG can signal information in various ways. Grossman and Helpman (2001) offer a broad overview of this literature. In the rent-seeking literature (Tullock, 1980; Nitzan, 1994), a more pessimistic view prevails. In these models, politicians are bribed and the agent with the highest bribe has the largest probability that a regulation in his favor is implemented. The effort put into bribing is a purely wasteful activity. See, for example, Liston-Heyes (2001) for an application to environmental economics.

Chapter 2 examines persuasive advertising. It is assumed that consumers experience a disutility when they consume a product that is not environmentally friendly. In this model the EG can directly influence preferences by increasing the disutility of consumers through advertising. The EG tries to minimize the sum of the cost of advertising and total environmental damage. In the market, a monopolistic firm is active. The firm can anticipate the EG's advertising by lowering the damage per unit of production. By letting the firm anticipate the moves of the EG, it is possible to see to what extent the EG can create or enforce product quality standards.

Chapter 3 studies informative advertising. Now consumers are unaware of the environmental damage a good causes, but both the firm and the EG can signal the extent of environmental damage to the consumers: either through the price of the good (the firm) or through the intensity of the advertising campaign (the EG). By comparing equilibria, I can infer who benefits and who loses from the advertising. Also the efficiency of the EG to create a product quality standard can be examined.

To start the discussion about the distinction between persuasive and informative advertising and the merit of each approach, observe that the distinction can be blurry: as Milgrom and Roberts (1986) show, even seemingly uninformative advertising can inform. Milgrom and Roberts show that if the quality of the product is unobservable, then advertising might inform consumers. But the message of the advert is irrelevant: the firm will always brag that it sells a wonderful product. However, the willingness of the firm to spend money on advertising can indicate that the good is of high quality.

There are pros and cons to both the persuasive and the informative approach. Historically, one of the reasons to investigate advertising has been the question whether there is an excessive amount of advertising. Informative ad-

vertising has the advantage that it does not change preferences which allows for straightforward welfare comparisons. Since preferences change when advertising is persuasive, it seems impossible to meaningfully compare *ex ante* and *ex post* outcomes. Informative advertising has none of these problems. However, a controversial article by Dixit and Norman (1978) demonstrates that in some cases welfare comparisons can be made. Yet, in general, persuasive advertising makes consumers' surplus extremely tricky to interpret. From the theorist's point of view, this controversy causes them to unambiguously rank informative advertising over persuasive advertising. For instance, Tirole (1988, pp.289–295) categorizes persuasive advertising as conventional wisdom. However, empirical evidence suggests that advertising contains both persuasive and informative elements, see e.g. Carlton and Perloff (2005). I therefore view both approaches as complementary.

1.2 Taxation: Chapters 4 and 5

These two chapters study two strategic effects of taxation: taxation for different market structures including a non-competitive market (in which strategic interactions are important) and tax diffusion.

Chapter 4 studies taxation of a polluting good, in particular cars and the fuels that propel them. Most European countries tax diesel less than gasoline, but tax diesel cars more than gasoline cars. Since diesel cars are more fuel efficient, if a consumer drives more than approximately 15000 kilometer, then it is usually beneficial to buy a diesel car. As Verboven (2002) demonstrates, this allows a car producer to sell diesel cars at a premium. Taxation in this market is needed since cars cause an externality: exhaust gases.

Economic research into (optimal) taxation in the presence of externalities dates back to the classic work of Pigou (1920). A general equilibrium analysis is provided by Sandmo (1975) and Cremer and Gahvari (2001). Taxation in the particular context of cars and fuels is hindered by the following problem: exhaust gases contain a multitude of pollutants but the number of tax instruments is limited and often indirect. A tax, using all available information, will always be a second-best outcome although Fullerton and West (2002) show that the second-best may be close to the first-best in this case. So far almost exclusively competitive markets have been studied, see e.g. de Borger (2001) in the context of optimal two-part tariffs in car taxation.

The first step in exploring non-competitive markets, a monopolistic car seller, is Verboven (2002). Being an empirical paper in the tradition of Bres-

nahan (1987) and Berry, Levinsohn and Pakes (1995), it builds a theoretical model of the car industry and estimates this model. Verboven finds conclusive evidence that a large part of the price differential between gasoline and diesel cars (adjusted for quality) can be explained by second-degree price discrimination. In Chapter 4, I extend Verboven (2002) in two ways: first, I add consumers that drive less if the price of fuel increases, i.e. I introduce a non-zero price elasticity. Second, this extension allows me to also model the fuel industry. The effects of tax changes will be studied for different market forms.

While Chapter 4 examines how taxed agents react to tax changes, Chapter 5 examines how competition among local municipalities shapes their tax policy. In particular, I study tax mimicking between municipalities in the Netherlands. Evidence of tax mimicking is regularly found in empirical studies: e.g. in Besley and Case (1995) with respect to sales, income and corporate tax among U.S. states, or in Brown and Rork (2005) with respect to lottery taxes.

I present the theory that tax mimicking is driven by simple externalities. Chapter 5 studies waste disposal taxes. Since 1998, 64 Dutch municipalities have made waste disposal taxes dependent on the amount of waste a household produces in addition to the 48 that already had implemented differentiated waste disposal taxes. This type of taxation might encourage households to dump waste but not only in the municipality in which they reside. Hence, a municipality has the following reason to introduce this tax: it reduces the amount of waste collected since the households produce less waste and, additionally, some of it is dumped in other municipalities. But if neighboring municipalities have already introduced such a scheme, then in order to countervail the illegal dumping of waste, a municipality might introduce a differentiated waste disposal tax as well. These externalities thus might enforce the introduction of this tax scheme.

From the viewpoint of the national government the end result of this contagiousness — less waste is produced — seems to be beneficial. Of course, in general, this is not the case. In the acid rain game as studied by Mäler and de Zeeuw (1998), the presence of externalities (transboundary pollution) leads to suboptimal pollution reduction.

In Chapter 5, data from the introduction of differentiated tariffs in Dutch municipalities for the period 1998–2005 is used to estimate the extent of the diffusion of differentiated waste disposal taxes.

1.3 The Participation Game: Chapter 6

The final chapter investigates a model that captures an essential aspect of strategic interactions in environmental economics. It is a public good game with binary contributions (a player either contributes or not). The structure of the game is simple: it is optimal to contribute if and only if nobody else contributes. Following Anderson and Engers (2005), I refer to the game as the participation game and the game in its most basic version is analyzed in several textbooks (see e.g. Dixit and Skeath, 1999, or Rasmusen, 2001). The model has a unique symmetric mixed strategy equilibrium in which each player participates with a certain probability. Hence the probability, that the public good is not provided, can be calculated. Examining this probability gives the following, paradoxical, result: the larger the number of players, the larger the probability that the public good is not provided. Although the phenomenon is well-known in social psychology, it is not clear who first observed this phenomenon in a game-theoretic context: despite a rigorous analysis of a game-theoretic version of this model, Palfrey and Rosenthal (1983) do not mention this fact. Chapter 6 checks how robust the result is by formulating a generalized version of the participation game and examining sufficient conditions.

An application to environmental economics could be oil spills in international waters like the North Sea. Suppose there is an oil spill in the North Sea and the oil is moving in the direction of the Netherlands and Germany. There are two options for each country: clean the oil immediately (and with minimal damage to the coastal regions of *both* countries) or wait and hope that the other country cleans up the mess. Since the oil is spilled in international waters, coordinating actions may be problematic. Both the Netherlands and Germany could benefit from the cleaning and both countries would prefer that the other would clean it. If a third country would be threatened (e.g. Denmark), then the probability that the problem is solved before it reaches the coast would decrease.