On the Efficiency and Effectiveness of Policy Instruments for the Procurement of Environmental Services

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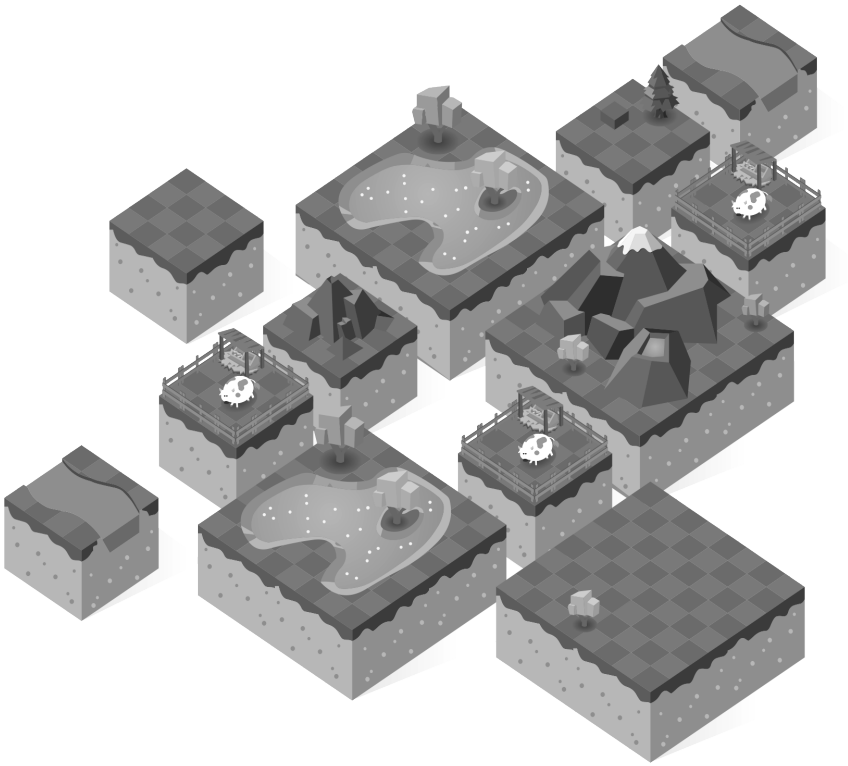
CHAPTER ONE

Introduction



1.1 The bigger picture

This dissertation was written as part of the Dutch *Knowledge for Climate* program (2007-2014). In this program, governmental organizations, private sector firms and research institutes closely collaborated on eight themes.[2] The research presented here was part of the *Governance of Adaptation* theme in which several university partners[3] aimed to integrate knowledge from the fields of public administration, economics, political science, spatial planning, legal studies, environmental studies and psychology. This thesis assesses the efficiency and effectiveness of specific policy instruments in the procurement of environmental services from private parties. Also in this theme, the thesis of Mees (2014) focuses on the question where public responsibilities should stop and where the private provision of environmental services should begin (see also Dovers and Hezri 2010, Berrang-Ford *et al.* 2011).[4] Chapter 2 of the current thesis touches upon this question: it offers a multidisciplinary effort to develop a method for policy makers to systematically assess and select suitable (mixes of) policy instruments in the public and the private domain. In the chapters that follow, we will focus on the options policy makers have to catalyze efficient private sector participation in environmental policy. We combine multiple theories and techniques to assess the efficiency and effectiveness of specific policy instruments aimed at stimulating the private provision of environmental goods and services in Chapters 3-6. But before doing so, we will summarize here which steps need to be taken before procurement of environmental services can even be considered.

The Economics of Ecosystems and Biodiversity (TEEB) – an initiative that was launched by Germany and the European Commission in 2007, with supported by the United Nations and many other national governments – offers an excellent review of the steps and methods that are required to

[2] Climate Proof Flood Risk Management, Climate Proof Fresh Water Supply, Climate Adaptation for Rural Areas, Climate Proof Cities, Infrastructure and Networks, High-quality Climate Projections, Governance of Adaptation and Decision Support Tools.

[3] Wageningen University, VU University Amsterdam, Radboud University Nijmegen, Erasmus University Rotterdam, Utrecht University, University of East Anglia, University of Oldenburg and Stockholm University (for more information see: http://www.knowledgeforclimate.nl/governance).

[4] Within the political science (and also the economic) literature, the most important consideration for public responsibility is market-failure, while the choice for private responsibility is typically motivated by efficiency gains (*cf.* Berkhout 2005, Mees *et al.* 2012 and Chapter 2).

improve the provision of environmental services (*cf.* TEEB 2009a,b).[5] The first step is the identification of environmental services such as soil retention, water regulation, habitat for wild plants and animals, *etc.* Obviously, the available range of environmental services will differ by country and region; PBL (2010a) offers an overview for the Netherland.[6] Again, we will focus on environmental services that can be provided by private parties. The key problem we tackle is that of an agency that has less information about the costs of supplying environmental services than the suppliers of these services; think of a conservation agency trying to secure habitat protection on private lands (see for example Latacz-Lohmann and Schilizzi 2005, Ferraro 2008). More generally speaking, we discuss problems in which private parties face costs to provide environmental services to society. This means that other social dilemmas (such as overfishing and deforestation), while closely related, will not be put on center stage here (but see Chapter 2).[7]

When the relevant environmental services are identified, the second step is the valuation of environmental services. It is argued that the lack of market prices for environmental services is the main reason that the benefits we derive from these services are usually neglected or undervalued in decision-making (TEEB 2009a,b). This is why the TEEB initiative endorses efforts to include measurements of natural, human and social capital to the Standard National Account (SNA), thus moving to a measure of 'extended' wealth, such as the System of Economic Environmental Accounting (SEEA).[8]

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[5] The TEEB initiative is inspired by the *Stern Review of the Economics of Climate Change* (Stern 2006) and stems from the Millennium Ecosystem Assessment (MEA 2005). In TEEB (2009b), it is argued that: *"Analyzing the value of biodiversity and ecosystem services not only enhances the case for strong international action to curb greenhouse gas emissions, but also highlights the inherent value for money in investing in natural capital to help both climate change mitigation and adaptation"*.

[6] de Groot *et al.* (2002) discuss a full range of environmental services, and offer a framework to systematically identify and value these services.

[7] Overfishing and deforestation are classic examples of common-pool resource problems (*cf.* Ostrom *et al.* 1999). In these problems, typically one needs to limit the 'negative externality' (*e.g.* the depletion of a common-pool resource) caused by private parties. Conversely, the main issue addressed in this thesis is one of stimulating private parties to supply 'positive externalities' (*e.g.* the supply of an environmental service) regardless of these externalities being common-pool resources or (pure) public goods. Hence, adaptation to climate change by private parties is part of our narrative, but our results apply to a broader range of environmental services. We therefore decided to use the private provision of environmental services as our key motivating example, but specifically refer to private adaptation to climate change when this is more suitable for the issue at hand (see for instance Chapters 2 and 6).

[8] See also Hamilton and Clemens (1999), Dasgupta (2006), Kubiszewski *et al.* (2013).

At the micro level, one can for instance measure the value of environmental services using indirect valuation techniques (also known as revealed preferences methods such as the travel cost and the hedonic pricing methods), or direct valuation techniques (stated preference methods, including contingent valuation and choice experiments; see de Groot *et al.* 2002, Hausman 2012, Haab *et al.* 2013, Brouwer *et al.* 2013). In the following chapters, we will assume that the (scientific and governmental) identification and valuation of environmental services has been accounted for when we discuss the final step: the procurement of environmental services. To analyze to efficiency and effectiveness of environmental procurement schemes, economists typically employ models based on incentive theory (or for instance auction theory) in so-called 'principal-agent problems'.

1.2 Principal-agent problems and solutions

"If you want something done right, do it yourself" is how Sappington (1991) describes his greatest concern with incentive theory and the typical principal-agent framework that is used to describe the problem. Principal-agent problems focus on tasks that are generally too complicated, too diverse or too costly for the principal to do herself. For those reasons, a principal is forced to hire an agent with specific skills or knowledge for the task at hand (*cf.* Holmström 1979, Laffont and Tirole 1993, Macho-Stadler and Perez-Castrillo 2001, Salanié 2005, van Soest and Dijk 2011). In the environmental economics literature, the principal is usually called a 'regulator' or a 'conservation agency', while it is typically the 'landowner' or the 'farmer' in the role of the agent who needs to be encouraged to supply environmental services. The principal-agent problem can be defined as the problem of designing mechanisms that induce agents to act in the interest of the principal. In most cases, the problem cannot be solved completely due to information asymmetries.[9] For instance, a conservation agency can face uncertainty about the landowner's (opportunity) costs to provide an environmental service. In this case, the landowner has an incentive to

[9] Asymmetric information problems focus on cases in which an agent has better information about either the benefits of his/her action to the principal, or the costs he/she incurs when undertaking the desired action (see Chapters 3-5). In the case of so-called *reverse* asymmetric information, we assume that the principal has better information about the (social) benefits of the agent's action than the agent himself (see Chapter 6).

convince the conservation agency that he has higher costs than he actually has. This is because the conservation agency will then offer a larger compensation for the services the landowner provides, causing his profits to increase. Hence, the conservation agency faces an asymmetric information problem as she tries to distinguish between landowners with high and low costs, and finding ways to solve this problem will increase the efficiency of procurement. However, the agency also needs to choose compensation levels such that sufficient participation is ensured – participation rates can turn out to be too low if many landowners face costs that are higher than the compensation level that is offered.

So-called menus of contracts (or 'smart subsidies') are a method to deal with inefficiencies and low effectiveness in the presence of asymmetric information (*cf.* Dasgupta *et al.* 1979, Guesnerie and Laffont 1984). Ferraro (2008) argues that the menu of contracts approach works as a revelation mechanism because it induces landowners to reveal whether they are high or low-cost types. For the revelation mechanism to work, the contracts should be designed in such a way that (i) a landowner is never better off choosing a contract intended for another type (the incentive compatibility constraint), and (ii) compensation payments are not smaller than the cost of providing the required service (the participation constraint). This revelation principle comes at a price; to encourage low-cost landowners to reveal their type, the regulator must compensate them at a level above their (opportunity) costs. Furthermore, to reduce the attractiveness of low-cost landowners claiming to be high-cost, the contracts intended for high-cost types require a lower output of environmental services. Note that this distortion in contracted output of environmental services from high-cost types (and the amount of informational rents going to the low-cost types) grows with the difference in costs between low and high-cost landowners and the proportion of low-cost landowners contracted (*cf.* Laffont and Tirole 1993). Hence, if there is heterogeneity in cost-types, and the regulator is unable to distinguish between them, the revelation of types using the menu of contracts approach comes at a cost of lower output of environmental services and informational rents, that is, as compared to the situation in which the regulator knows each landowner's cost-type with certainty; but see Chapter 3.

Another way to deal with the inefficiencies caused by asymmetric information is the use of procurement auctions to allocate compensation payments for environmental services (*cf.* Latacz-Lohmann and van der

Hamsvoort 1997, 1998, Cason *et al.* 2003, Cummings *et al.* 2004, Schilizzi and Latacz-Lohmann 2007, van Soest and Dijk 2011). Conservation auctions have two theoretical advantages over fixed-rate compensations, namely: auctions are more likely to reflect the marginal value of the resources used to produce environmental services, and auctions explicitly introduce an element of competition between landowners which will therefore 'compete away' (at least partly) their informational rents. However, these advantages can be negatively affected by strategic behavior during the bidding process; see Chapters 4 and 5.

There are many ways to model and analyze principal-agents problems, and we employ several of these throughout this dissertation. One popular method to test whether standard economic theories hold in practice is by means of economic experiments in a controlled laboratory environment. In Chapters 4 and 6, we do not only make use of standard economic theory, but we also rely heavily on insights obtained from psychology and behavioral economics. In the following section, we explain why we use economic experiments to test the hypotheses that are introduced in these chapters (see also Section 1.4).

1.3 Experimental economics

In the 1950s, Vernon Smith was one of the first to suggest that we can test economic theory using economic laboratory experiments – inviting human subjects to participate in appropriately designed games to observe their behavior. To conduct a proper laboratory experiment, a few principles need to be satisfied (see Plott 1979, Wilde 1980, Smith 1982). For instance, choices that subjects make in the experiment should be linked to (monetary) rewards in a way that is fully understood. This is why experiments typically start with a set of written instructions (that are read out aloud by the experimenter and are followed by test questions) before subject can make actual choices in the experiment. Other conditions that are required to run a proper experiment are that subjects' (monetary) rewards remain private information, and that the (perceived) costs of participating in the experiment are smaller than the rewards of participating in the experiment.[10]

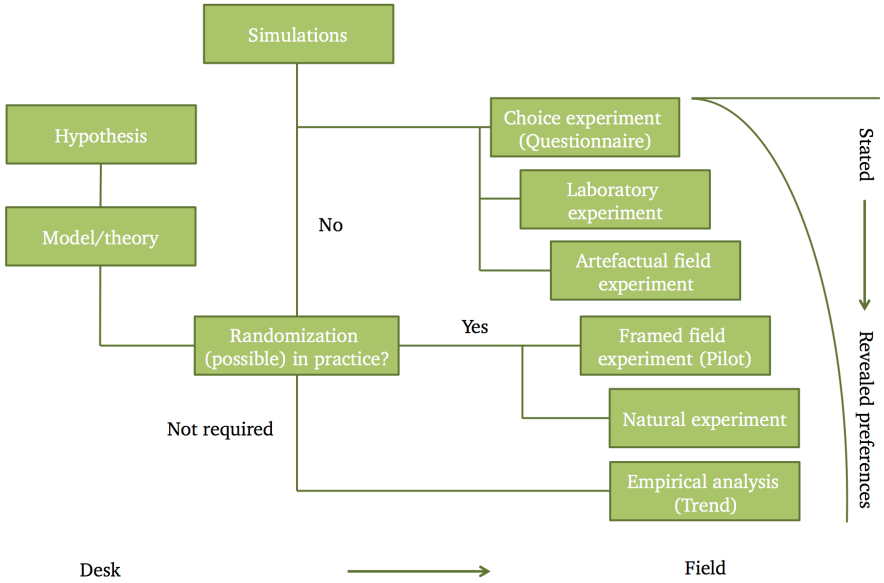
[10] This is why subjects are requested to collect their rewards in private (one-by-one) at the end of the experiment, and why (on average) students receive smaller rewards than for instance professionals (see Chapter 6).

Note that the biggest advantage of Smith's method was that he needed only one major assumption to identify a treatment effect – subjects needed to be randomly assigned into treatment and control. This was at a time that econometric methods such as instrumental variables regression were not as common as they are now. But even at present, other empirical methods typically require more and oftentimes debatable assumptions to identify causal relationships rather than correlations, while the randomization assumption of the experimental method is easily verified (*cf.* Smith 1962, 1964, 1965).

Two of the most important criticisms on the experimental method remain (*cf.* Levitt and List 2007). The first is that the outcomes in the lab may be the result of reference-dependent preferences (*e.g.* the role of the player in the experiment). Second, in contrast to real-world decision-making, the lab puts far too much emphasis on the process by which decisions and allocations are determined (*e.g.* by providing detailed experimental instructions on how choices are made and what the monetary consequences of these choices are). The reference-dependent preferences argument clearly is a reason for concern in experimental studies that try to design methods to elicit true valuation (see for instance List and Price 2013). However, the fact that valuations differ between buyer and seller roles is precisely why we employ the experimental method in Chapter 4. In the latter, we study the dynamics of bidding behavior in order to obtain an efficient design for procurement auctions, whether bids are equal to true valuation or not. The second criticism is perhaps the main reason why researchers such as John List advocate the use of field experiments, which are often considered the best of both worlds: they use the randomization into treatments of the experimental method, but in a real-world setting.

Figure 1.1 offers an overview of different types of experiments. In this overview, we present a move from the desk to the field (from left to right), and a choice for experimental methods with increasing likelihood of being based on stated or revealed preferences (from top to bottom).

Figure 1.1. From the lab to the field.



Source: Partially based on List (2007). This figure focuses on the different options a researcher has in the field of experimental economics.

One of the main arguments that is made in the field of experimental economics is that asking hypothetical questions (*e.g.* in a simple questionnaire) will not always reveal true preferences, and that by linking subjects' choices in an experiment to actual rewards (or fines) one moves closer to measuring true preferences. Although there is substantial support for the external validity of lab experiments (*cf.* Fréchette 2011, Noussair and van Soest 2014; see Camerer 2012 for an overview), properly testing the effect of a particular treatment on real-world behavior can only be captured using natural experiments. Let us now discuss the various steps researchers can take to (experimentally) test a hypothesis.

Research projects typically start with formulating hypotheses. And many researchers (among which economists) use a (mathematical) model, typically based on well-established (economic) theories, to make assumptions and predictions. When a hypothesis is empirically tested, two important questions are (i) whether randomization is required and (ii) whether randomization into treatment and control is available in the field. For instance, if one is interested in how the GDP of a particular set of countries has developed over time, randomization into treatment and control

is not required. However, when treatment and control groups are necessary – *e.g.* if one wants to test whether class size has an effect on student performance – the researcher's options depend on his/her ability to either introduce randomization to the field, or to exploit a natural occurrence of randomization into treatment and control groups. Note that one can also simulate the behavior of agents in a model, for instance when setting up a framed field experiment with many treatments (*e.g.* pilot auctions at different locations) is too costly or too complicated to implement; see Chapter 5. Although we were not in the fortunate position to be able to implement a natural field experiment, we were able to perform an artefactual field experiment in Chapter 6.[11] The latter has career professionals play a game in the controlled laboratory setting. This method brings the field to the lab and helps answer question such as: Would you reach similar conclusions about the prediction of a theory if you use the usual subjects (*e.g.* students) rather than subjects who are career professionals at the task the game being tested is supposed to represent?[12] As we will see in the remainder of this dissertation, many of the options that are depicted in Figure 1.1 are used to answer the research questions below.

1.4 Research questions

This dissertation studies the efficiency and effectiveness of specific policy instruments in the procurement of environmental services, and in doing so addresses several knowledge gaps in the (behavioral and) environmental economics literature. We address the following research questions:

[11] Note that Figure 1.1 includes natural experiments, but we should also distinguish between natural *field* experiments and natural *quasi* experiment. The former is setup by an experimenter who deliberately randomizes into treatments and control. For instance, to test for an optimal fund raising method for the WWF, one could have a control group receiving a letter requesting them to transfer an unspecified amount of Euros, while three treatment groups are asked to finish a form requesting to donate 5, 10 or 50 Euros. The natural quasi experiment pertains to studies that typically exploit a structural break in policy. For instance, one could test whether the minimum size of had an effect on the demand for health care if has changed Although the same policy change applies to all, one could employ a difference-in-difference analysis to control for the possible effect of time (*e.g.* inflation) and the composition of the subject pool over time (*e.g.* an aging population). Since the field is a messy place, one can find him- or herself somewhere in the middle – for instance if a natural field experiment ends up with randomization issues or location/time differences that need to be controlled for.

[12] See also Fréchette (2011).

1. Can we identify specific policy instruments in environmental procurement that efficiently and effectively deal with the problem of (reverse) asymmetric information?

2. In particular, how can the inefficiencies stemming for low (or high) participation rates in voluntary subsidy schemes be avoided?

3. Which steps should be taken to translate our theoretical and experimental results to practice?

The answers to these questions can be found in various chapters in this dissertation. Some chapters will offer an answer to just one question, while other address all three questions at the same time:

- Chapter 2 offers the reader a broad perspective on instrument selection before we shift our focus to the (more technical) descriptions of specific market-based (economic) instruments. In a case study on eco-friendly riverbanks, we showcase the usefulness of a multidisciplinary framework to select appropriate policy instruments (or mixes).

- Chapter 3 analyzes the design of efficient environmental contracts. Contrary to conventional wisdom, we show that the first-best menu of environmental contracts can be incentive compatible in the presence of information asymmetries, and we determine the circumstances under which this is the case.

- Chapter 4 employs a laboratory experiment with students to examine whether the efficiency of procurement auctions increases or decreases with repetition. We find that, due to the attenuation of a so-called endowment effect, average compensations asked continue to fall over time.

- Chapter 5 presents a model of bidding behavior in wildlife corridor auctions. The key result of the auction simulations is that a strategic buyout (*i.e.* buying out a landowner that is part of many possible corridors) prior to the auction can be more efficient and effective than an agglomeration bonus. The latter is the instrument that is typically

suggested in the procurement of crucial pathways to connect fragmented habitats.

- Chapter 6 studies the impact of trust, control and the role that information has on the intrinsic motivation to provide services to a principal (*e.g.* a conservation agency). We find that informed agents (*e.g.* landowners) have a higher propensity to supply services to the principal. Among other results, we find that professionals display more intrinsic motivation than students – implementing control may backfire and decrease intrinsically high service levels.

- Chapter 7 holds the conclusions that answer the first research question, and offers a discussion on the second and the third research question.