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

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In this dissertation, we study the efficiency and effectiveness of policy instruments in the procurement of environmental goods and services. In Chapter 2, we present a framework for the systematic exploration and assessment of public, private and interactive policy instruments using assessment criteria that are derived from economics, legal studies, and political science. The framework is intended to support public actors in systematically assessing and selecting policy instruments (or mixes). Under typical public governance, policy instruments such as legal requirements or subsidies can be employed, while private governance may for instance entail policy interventions that offer incentives on the insurance market (*e.g.* insurance premium discounts for those that take prevention measures). We showcase the usefulness of the selection method in a case study on eco-friendly riverbanks in the Province of Zeeland, the Netherlands. Chapter 2 thus 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 the following chapters. The instruments that are analyzed in these chapters allow the reader to familiarize him- or herself with different methods to deal with the problem of (reverse) asymmetric information[116] in the procurement of environmental goods and services. We present the menus of contracts approach in Chapter 3, repeated procurement auctions in Chapter 4, and wildlife corridor auctions in Chapter 5. In Chapter 6, we study the impact of trust, control and the role that information (*e.g.* on the benefits of providing an environmental service) has on the intrinsic motivation to provide services to the principal (*e.g.* a conservation agency).

In Chapter 3, we analyze the design of efficient environmental contracts. We assume that agents differ only in the rate at which they discount the future. Time preference heterogeneity implies that agents value specific environmental policies differently for two reasons. First, differences in discount rates imply that agents differ in how they value a particular stream of per-period benefits and costs. Second, decisions like how much to invest in abatement technologies or in land quality are influenced by time

[116] 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 (*cf.* Holmström 1979, Laffont and Tirole 1993, Macho-Stadler and Perez-Castrillo 2001, Salanié 2005 and 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 (*cf.* Banerjee *et al.* 2014 and Chapter 6).

preferences, and differences in specific abatement technologies or land qualities can make environmental protection more or less costly – and hence the stream of per-period benefits and costs may differ between agents too. Contrary to conventional wisdom, we show that the complete information menu of environmental policy contracts can be incentive compatible in the presence of information asymmetries, and we determine the circumstances under which this is the case when investments are sunk at the time the government initiates the environmental policy program, and also when they can be adjusted. While most assumptions in this chapter are well grounded in economic theory, we make use of a dataset collected by Tesfaye and Brouwer (2012) to see whether we can find empirical evidence supporting them. Using this dataset, we show that our assumptions (among which the relationship between a farmer's rate of time preference and the quality of his land, as discussed above) hold in practice.

In Chapter 4, we use an economic experiment to examine whether the market efficiency of discriminatory price procurement auctions increases or decreases with repetition. Procurement auctions are auctions in which one buyer tries to purchase goods or services from multiple sellers, and in discriminatory price procurement auctions the successful sellers receive the price they stated in their bid. In principle, discriminatory price auctions allow a conservation agency to purchase a specific amount of goods and services at lower expense than, for example, uniform price auctions, where participants receive a predetermined strike price if their bid is lower than that strike price.[117] Yet the realized cost savings tend to vary with factors like the number of auction participants and whether auctions are one-shot or repeated. Standard game theory predicts that repetition facilitates collusion among sellers in discriminatory price procurement auctions. Contrary to that, behavioral economics suggests that repetition may increase market efficiency because it attenuates the endowment effect – the phenomenon that ownership of a good tends to increase one's valuation of the good, which hinders trade because the median seller tends to ask a higher price

[117] Bidding one's true opportunity cost is a dominant strategy in uniform price procurement auctions while it is optimal to bid an amount higher than one's true costs in discriminatory price auctions. Yet the rents received by the low-opportunity cost sellers are typically lower in the discriminatory price auctions than in the uniform price ones, and hence the latter typically allows the auctioneer to pay less for a specific amount of goods or services procured (or, alternatively stated, has a higher market efficiency) than when uniform price auctions are employed.

than the median buyer is willing to pay. We find that of these two countervailing effects, the latter has the upper hand; average bids in the discriminatory price procurement auction continue to fall over time. This is comforting news for governments that want to use repeated discriminatory price auctions for nature conservation (Latacz-Lohmann and van der Hamsvoort 1998, Latacz-Lohmann and Schilizzi 2005) and other repeated auctions in which the endowment effect could play a role, such as the buy back of fishing licenses (Squires 2010, DePiper *et al.* 2013) or the buy back of irrigation licenses in case of droughts (Hailu and Thoyer 2007, Iftekhar *et al.* 2013).[118]

In Chapter 5, we present a general model of bidding behavior in wildlife corridor auctions. Given (i) some spatial configuration of landowners in a landscape, (ii) the landowners' opportunity costs, and (iii) the value of establishing the corridor, our model predicts individual landowners' bids, overall participation rates in the auction, as well as the expected net benefits to the conservation agency. We find that market efficiency of the auction increases in the number of potential corridors. We use simulations to compare a benchmark auction with two policy scenarios in a hypothetical landscape. In one scenario, members of a winning corridor receive an agglomeration bonus. In the other scenario, we buy out a pivotal landowner (the most connected landowner in the landscape) prior to the auction. Given equal budgets for the agglomeration bonus and the buyout, the agglomeration bonus is less efficient than a buyout for low budgets and vice versa. A conservation agency that wishes to avoid the risk of very costly procurement is however better off with employing the buyout policy. The reason is that the buyout simulations feature a narrower range of

[118] One could argue that farmers are not always asked to part with their land when considering participation in nature conservation programs, and therefore, farmers' sentiments cannot always be interpreted as an 'endowment effect' barrier to participation. However, these programs typically feature irreversible dedication of acreage to nature and the adaptation of time consuming managerial practices (*cf.* Vogt and Bizer 2013). For instance, Westerink *et al.* (2013) describe the Dutch 'Boeren voor Natuur' program as a drastic change of practice for participating farmers: 30 year contracts stipulate storm water retention, biodiversity and recreational goals that significantly reduce primary production and require large investment to dedicate acreage to nature. In particular, the case study in Chapter 2 suggests that high conversion costs can also constitute a barrier for converting land (that has been converted to nature) back to agriculture again at the end of a contract. Furthermore, in their international meta-analyses on the attitudes of farmers towards conservation programs, both Siebert *et al.* (2006) and Ahnström *et al.* (2009) report that farmers fear the potential restrictions, bans and limitations that may be placed on their lands when entering conservation contracts (*e.g.* due to biological surveys that designate habitat of endangered species on their lands).

procurement costs. Hence, although the average winning coalition bids are lower in the corridor auction with the agglomeration bonus, opting for the strategic buyout before the auction takes place reduces the risk that the corridor has to be procured at a very high cost.

In Chapter 6, we analyzed whether giving agents more or less information on the marginal benefits of a provided service adds another dimension to the hidden costs of control, *e.g.* the crowding-out of intrinsic motivation of the agent to cater for the needs of the principal. We find that informed agents have a higher propensity to supply services to the principal. For our student subjects, we find that information is a substitute for control. Extending information on the marginal benefits has a positive effect on the agent's propensity to supply the service the same way setting a minimum performance requirement has. Offering the principal the option to set a minimum performance requirement (*i.e.*, partially control the agent's action) when the agent already receives information (or vice versa) does not further increase agent performance with student subjects. The intrinsic motivation of students to cater for the needs of the principal is low – questionnaire results show that for them greed is the main driver. Professionals are more inclined to show crowding-out of intrinsic motivation when control is applied. Professional principals who choose high levels of control are thus more likely to decrease intrinsically high service levels of agents than students playing in the role of the principal. When asked for their considerations to exert effort in the role of the agent, professionals are also more likely than students to say that receiving information on the marginal benefits has a positive effect on their propensity to provide the service. For most professionals, efficiency and also fairness considerations are more important than signals of (dis)trust when deciding on their level of service provision.

Aside from finding effective and efficient ways to deal with the problems stemming from (reverse) asymmetric information, this dissertation shows that (i) dealing with the risk of low (or high) participation rates in voluntary subsidy schemes, and (ii) translating (theoretical and) experimental results to practice are key elements in the design of successful environmental policy.

Participation in subsidy schemes is typically voluntary, and hence governments need to ensure that the subsidies offered are sufficiently generous that all agents who should participate in the program decide to do

so – subsidies offered to these agents must not be smaller than the costs they incur when providing the environmental service. But the payments should also not be too generous in order to limit windfall profits and because raising funds for subsidy programs typically gives rise to efficiency losses elsewhere in the economy – after all, one of the most important sources of public funding is the (progressive) taxation of labor incomes that distorts, among others, labor-leisure decisions. Subsidies are thus not just mere transfers from the taxpayer to the agent, and hence the government faces a trade-off between environmental benefits of a program and the associated costs of distortionary taxation (Mirrlees 1971, Browning 1987, Ballard and Fullerton 1992).[119]

We suggest in Chapter 4 that the endowment effect is a plausible explanation for why participation rates in procurement auctions are typically low (*cf.* Brown *et al.* 2011, Bartolini *et al.* 2013, DePiper *et al.* 2013). Given the attenuation of the endowment effect over time, we show that conservation contracts can be procured in (more) stages more often than has been suggested before (*cf.* Latacz-Lohmann and van der Hamsvoort 1998, Latacz-Lohmann and Schilizzi 2005). Hence, a choice for repeated auctioning (instead of for-once-and-for-all auctions) may increase participation rates over time, as it gives landowners a second chance to be 'in the market' – *i.e.* those farmers that priced themselves 'out of the market' (for instance due to the endowment effect) in previous auctions (but see below). In particular, the wildlife corridor model in Chapter 5 shows that restricting procurement auctions to the procurement of corridors is expected to decrease participation rates, but also that agglomeration bonuses or strategic buyouts can help increase them. In Chapter 3, we show that high participation (with respect to the number of farmer types with different time preferences) can also lead to inefficiencies. Here, we find that the chance of the complete information solution being incentive compatible becomes smaller the larger the number of different types there are. Extending the model from two to multiple levels of (im)patience shrinks the range of parameters for which the complete information solution is incentive compatible. This leads us to suggest that if various types exist, optimal 'bunching' and/or exclusion of types needs to be considered. In other words,

[119] Of course, economists typically prefer taxing pollution or land conversion rather than subsidizing abatement or conservation, yet for political economy reasons governments typically prefer subsidies to taxes.

starting with n types distributed over a specific support, can we construct a menu of $m < n$ contracts that approximates the complete information solution?[120] This is especially important because this chapter also suggests that the probability of the complete information solution being incentive compatible is larger the larger the number of different characteristics agents have (think of risk preferences resulting in farmers choosing a specific land quality or a specific type of crop, in addition to their rates of time preferences – assuming that the two types of preferences are not perfectly correlated).

Let us now discuss which steps should be taken to translate our theoretical and experimental results to practice. In Chapter 3, empirical evidence on the relationship between agents' preferences (elicited for example via incentive-compatible economic experiments) and (truthfully revealed) required compensation levels (think of data generated from a uniform price procurement auction; *cf.* Chan *et al.* 2003, Cason and Gangadharan 2005, Hailu and Thoyer 2007, Ferraro 2008, Brown *et al.* 2011)[121] is needed to see whether the ideas of this chapter remain theory, or whether the insights can be applied in practice. Furthermore, it remains to be seen whether the results of the endowment experiments in Chapter 4 also hold when a (more realistic) participation decision is added (*e.g.* by making it costly to join the auction; *cf.* Latacz-Lohmann and van der Hamsvoort 1998). If some bidders decide not to participate, this increases the incentives of the remaining bidders to ask an amount that is higher than true valuation or to collude (*cf.* Latacz-Lohmann and van der Hamsvoort 1998, Latacz-Lohmann and Schilizzi 2005). For the wildlife corridor auction of Chapter 5, we predict that landowners can obtain large windfall profits even if only a few landowners decide not to participate. This is because the participation decision of a landowner not only has an effect on the bids of the other

[120] It is often claimed that bunching and/or the exclusion of some agents at the optimum is a generic property in multidimensional problems (Laffont *et al.* 1987, Armstrong 1996, Rochet and Choné 1998, Armstrong and Rochet 1999, and Salanié 2005, pp. 78-82).

[121] Ferraro (2008) argues that a conservation agency can gather information on observable landowner characteristics that are correlated with the opportunity costs and use these characteristics to obtain the required compensation levels. The intuition is that if the gains to contracting are substantial, high-cost landowners may signal that they are high-cost by expressing observable signals that are costly to fake for low-cost landowners. However, note that the ability of this method to reduce informational rents will still be as good as the strength of the correlation between the observable characteristics and the landowner types.

landowners, but also on the number of corridor that can be procured in the auction.

The results of Chapter 6 can be viewed as a stepping-stone in the design of environmental regulation that is based on providing (more) information to the agent. Catalyzing climate change adaptation in the private sector is a clear example here. Private parties often do not have access to sufficient information for adaptation action and governments can step in to generate and distribute such knowledge (*cf.* Berkhout 2005).[122] For the pooled sample, we found that informed agents have a higher propensity to supply services to the principal. However, one could argue that given the small sample size for the subsample of professionals, more data is required to support our conclusion that reducing the problem of *reverse* asymmetric information (see also Footnote 116) is an effective substitute for control in practice.[123]

While laboratory experiments using student subjects are not suited to make point predictions about real-world behavior, the comparative statics obtained tend to generalize to domains outside the laboratory (*cf.* Levitt and List 2007, Fréchette 2011, Noussair and van Soest 2014; see Camerer 2012 for an overview). As such, the results using student subjects in Chapter 4 can inform policy makers about the expected costs of increasing or decreasing the frequency with which nature conservation auctions are organized (that is, increasing or decreasing the length of the procurement contracts) prior to setting up (expensive) pilot studies in the field. Although there is substantial support for the external validity of lab experiments, it is an open question whether the 'ownership premium' (*e.g.* sentimental value) farmers attach to their land is larger or smaller than the premium students attach to a coffee mug they just received. Whether or not repetition reduces efficiency in real-world conservation auctions can only be answered using field experiments. Yet our results indicate that, given the costs associated with for-once-and-for-all policies, researchers and/or policy makers should seriously consider setting up field experiments to test this in practice. Implementing

[122] Other examples that come to mind are information campaigns that increase environmental awareness (Endres 1997, Mees *et al.* 2014) or a move towards self-regulation (*e.g.* participatory monitoring) and away from traditional command and control instruments (see for instance Sinclair 1997, Forester 1999, Brown *et al.* 2012).

[123] Fréchette's (2011) review on experimental studies that feature subject pools of both students and professionals can help remove this doubt. He finds that only in 1 out of 13 studies students and professionals behave different with respect to the theoretical predictions of these studies.

conservation auctions instead of fixed-rate compensations offers a fair and efficient way of selecting landowners when budgets are constraint (*cf.* Hellerstein *et al.* 2015). Nevertheless, policy makers will always have to find an appropriate balance between efficiency, fairness, and other considerations, such as providing income support to farmers or potentially undesirable distributions of conservation areas that can result from these auctions.