Behavioral Economics and Environmental Policy: Theory and Experiments

Elisabeth Gsottbauer

Institut de Ciència i Tecnologia Ambiental

Universitat Autònoma de Barcelona

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Author: Elisabeth Gsottbauer

Email: elisabeth.gsotbauer@gmail.com

Supervisors:

Prof. Dr. Jeroen C.J.M. van den Bergh

Dr. Giorgos Kallis

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Summary

The effectiveness, equity and efficiency of environmental policies depend very much on the underlying model of individual behavior. Only an empirically founded model of individual action and motivation can guarantee the design of adequate environmental policies and environmental agreements. The dominant theory of environmental policy is based on the standard (neoclassical) economic model of rational, self-interested behavior and stable preferences. This tends to favor policy instruments that attempt to influence behavior through price signals. More recently, behavioral economics has generated considerable experimental evidence that individual behavior deviates from full rationality and pure self-interest. This thesis attempts to take into account bounded rationality and social interactions to identify suitable environmental policy instruments. It contains five essays that investigate applications of alternative models of behavior to refine or alter insights within environmental economics and public policy theory. The thesis combines theoretical-analytical modeling and experimental economic research to study individual preferences and inform policy design.

The first essay offers an extensive and critical review of behavioral economics and its application to environmentally relevant behavior and concludes that assuming systematic decision anomalies and social preferences provides an improved starting point for effective environmental policy. The second essay presents a formal-theoretical analysis of the role of advertising in status- and norm-driven consumption with serious environmental impacts. This is captured by formulating a behavioral-economic model with a utility function that formalizes Veblen's idea of conspicuous consumption. The model combines therefore environmental and consumption externalities and shows which particular policy package is needed to restore optimal social welfare. The third essay investigates important non-pecuniary motives for sustainability behavior that standard models neglect. Framed field experiments of recycling are carried out, the results of which provide evidence for the relevance of social motives for sustainable behavior. The fourth essay explores the impact of bounded rationality and social preferences on stakeholder perceptions of gains and losses and bargaining dynamics in international climate negotiations. Main insights of behavioral economics are systematically applied to explain and predict how various types of stakeholders (citizens, experts, negotiators, politicians, interest groups) will act in climate negotiations. The fifth essay uses a laboratory experiment to assess preferences for, or contributions to, emissions reduction under different – gradual and abrupt – scenarios of natural disasters due to climate change. In conclusion, the present thesis shows that behavioral and experimental economics provide a powerful framework to study individual environmentally-relevant behavior and public decision-making. In addition, various new insights are generated about the preparation and design of environmental agreements and policy.

Contents

Chapter 1.

Introduction

1.1 Two alternative behavioral frames

Environmental problems present a policy challenge that requires the design of effective, equitable and efficient environmental policy instruments, so as to arrive at more sustainable decisions. A dominant theory of environmental policy has been proposed by environmental economists (Baumol and Oates, 1988). It is based on the core premise of rational agents, formalized as constrained maximization of utility or of profits. The associated behavioral frame is rational choice theory, which assumes that individuals behave consistently and selfishly.

Psychologists and behavioral economists alike have criticized the standard assumptions of individual behavior and have offered alternative explanations and theories. Most influential perhaps have been behavioral anomalies (Kahneman and Tversky, 1974), and departures from self-interest (Fehr and Schmidt, 1999; Fehr and Fischbacher, 2002), both of which were assessed in a large number of experimental studies. An important line of criticism states that some form of social interaction among individuals is not well represented in the rational agent model. In other words, individuals make decisions given fixed preferences and in isolation of what other decide. An example of a lack of social interaction is that the standard behavioral model does not allow for social status, i.e. that the utility of an individual depends on its relative income position or comparing welfare to relative other agents (Easterlin, 2001).

Various alternative theories to describe economic agents have emerged as a response to the previously discussed criticism dealing with the integration of psychological foundations of human behavior within economics and public policy (Rabin, 1993; Camerer, 1999; Kahneman and Tversky, 2000). The advantage of a behavioral approach is to avoid the unfounded and overly general assumptions of standard economics, namely perfect rationality and self-interest. Behavioral economics emphasizes instead bounded rationality, other-regarding behavior, and changing preferences. A variety of themes has been addressed, such as heterogeneous behavior, habits, status-seeking, group norms, nonlinear responses to risk (prospect theory) and cooperation preferences.

Although behavioral economics seems to enjoy increasing attention and support, applications of its insights and theories to sub-disciplines – such as environmental economics – are limited and have not resulted in a systematic set of policy recommendations. Adopting a behavioral model of individual decision making and choices by dropping the neoclassical

maximization hypothesis and adopting alternative assumptions can provide valuable contributions to environmental-economic theory. A variety of themes of importance to environmental economics are consumer theory, (optimal) incentive design, decision-making under uncertainty, and the role of cooperation and global public goods.

Consumer demand theory and environmental externalities represents one area in which a richer structure of human motivation may provide important insights. The design of policies oriented towards sustainable consumption requires particular information about the sensitivity of consumption to determinants that can be influenced or controlled by policies, as well as about the environmental impacts of specific goods and services. For example, certain types of consumption are conspicuous and sensitive to social status, which is captured by the old idea that consumption is socially conditioned (Duesenberry, 1949; Veblen, 1899; Hirsch, 1976). Many types of consumption are associated with considerable environmental pollution and an intensive commercial advertising effort. In spite of this, the effect of advertising on demand of harmful goods – whether with detrimental social, health or environmental impacts – is a topic that has been largely neglected in economic analysis. A possible explanation is that since effective advertising requires variable and even endogenous preferences, economic analysis has been unable to fit it within the standard model of consumer behavior that assumes fixed preferences. Therefore it remains unclear what happens to environmental policy recommendations if consumption depends on what others consume and on information provided by advertising. Social interaction models proposed by behavioral economics provide a good basis for studying this issue, and these will form the starting point of one analysis in this thesis.

Psychological aspects of motivation may also challenge standard incentive theory as proposed by (environmental) economics. Based on the narrow view of neoclassical economics, environmental behavior and choices by rational agents are motivated by monetary incentives only. A logical outcome is that environmental policy relies on price signals to ensure an efficient allocation of resources (Becker, 1976). Yet, pricing policies aimed at encouraging environmental behavior may also have a detrimental effect. A clear example is waste behavior as it includes the problem of free rider behavior (litter and illegal burning and dumping) in response to price regulation as traditionally favored by many economists (Fullerton and Kinnaman, 1996; Miranda and Aldy, 1998). The question is what other factors besides monetary gains motivate individuals and what this implies for environmental policy design? While economic incentives can certainly foster more sustainable behavior, the social, non-monetary aspects of such decisions are often ignored. Other incentives like the desire to gain social approval shape individual behavior and decisions (Fehr and Falk, 2002). People cooperate in order to improve their self-image and their reputation, hoping to feel proud or trying to avoid feelings of shame (Rege and Telle; 2004, Semmann et al., 2005). Some behavioral models in the literature already relate recycling efforts to the quest for a positive self-image (Bruvoll and

Nyborg, 2004; Brekke et al. 2009; Hage et al. 2009). These behavioral models suggest that changing reputation by public disclosure and non-monetary incentives can be an effective strategy to foster sustainable behavior and recycling. In a next step, these predictions can be tested with a suitable experiment to link theory with empirical relevance.

Cooperation in climate policy is another area in which behavioral models are likely to generate interesting new results and insights which can be used to design more effective (self-enforcing) environmental agreements. Striking a climate agreement to cap global emissions turns out to be extremely difficult as it requires costly behavioral changes by individuals, firms and countries alike (Barrett, 2007). Much existing theoretical analysis of international environmental regimes, notably in economics, assumes that sovereign countries (or agents) act as if they are rational individuals aimed maximize their payoff (Carraro and Siniscalco, 1993, Barrett, 1994; Finus, 2001). Although the design of more effective environmental agreements is a growing area of research, its microlevel foundations have received little attention or rational behavior is taken for granted. Recent advances in behavioral economics provide experimental evidence that decision-making in negotiation-like situations is influenced by bounded rationality and social interaction (e.g., Lange, 2006 and Dannenberg et al., 2010, who focus on fairness issues). Other prominent features of climate negotiations are uncertainty and risk perception associated with economic shocks and natural disaster. In general, decisions relevant to climate change negotiations are surrounded by uncertainty. It is likely that (biased) perceptions of the likelihood of climate change and its impacts will affect one´s willingness to support climate policy (Leiserowitz, 2006; Viscusi and Zeckhauser, 2006). It is therefore useful to consider what strategies might be chosen by countries using insights from behavioral decision research and behavioral economics to better understand individual and collective responses to (climate change) risks. One way to study individual decision-making under uncertainty, when faced with climate risks, is undertaking experiments. So far, only few studies have adopted this approach (Milinski et al., 2008; Tavoni et al., 2011; Barrett and Dannenberg, 2012).

1.2 Research objectives and questions

This thesis aims to analyze various aspects of environmental policy from the angle of particular theories within behavioral economics. The research is guided by three research objectives. The first is to examine alternative theories of individual behavior theoretically and derive general policy suggestions for environmental behaviors and agreements. To this end the thesis identifies the essential implications of non-standard preferences in general, and of risk, time and social preferences in particular. The second objective it to model individual decision-making regarding sustainable behavior when utility reflects social preferences. For this purpose a general equilibrium model is used to evaluate the impact of various environmental policies on social

welfare. The third and final objective is to elicit individual preferences for sustainable choices using field and laboratory experiments. By measuring preferences and decision characteristics of economic agents it is possible to draw a more realistic picture of individual motivation and choices as well as to identify adequate policy instruments and strategies. The various studies report here allow for answers to the following main research questions:

1. Which determinants of sustainable behavior other than income and prices are relevant, and which particular policies and instruments can influence them? How do alternative environmental policy instruments perform in terms of effectiveness and efficiency under particular bounded rationality conditions?
2. How does the combination of status- and norm-driven consumption and advertising affect optimal environmental pressure, policy and behavior?
3. What are the psychological determinants affecting pro-environmentality? How effective are non-pecuniary incentives in motivating such behavior?
4. Which behavioral factors influence cooperation in climate policy and how do alternative models of behavior account, or provide insights, for current climate negotiation strategies?
5. How is climate change perceived and which framing of it – abrupt versus gradual climate change – makes mitigation action more likely? Which decision biases and cognitive factors influence climate mitigation preferences?

1.3 Outline of the Thesis

The thesis is structured in five chapters to elaborate the research questions mentioned above.

Chapter 2 investigates opportunities to apply bounded rationality and other-regarding behavior to environmental policy theory to arrive at more effective policy recommendations. Established environmental policy theory is based on the assumption of rational economic agents. This means that people are seen as fully rational and acting in a self-regarding manner. In line with this, economics emphasizes efficient policy solutions and the associated advantages of economic instruments. Behavioral economics offers alternative, more realistic views on individual behavior. For this purpose, this chapter addresses behavioral theories classified into decisions made under risk and uncertainty, intertemporal choice, decision heuristics, other-regarding preferences and heterogeneity, evolution of behaviors and the role of happiness. Three aspects of environmental policy are considered in detail, namely environmental valuation, sustainable consumption and policy design. In addition, the implications for climate policy are illustrated. The chapter aims to make the ideas of behavioral economics accessible to environmental economists and scientists who are not familiar with behavioral research.

Chapter 3 explores the relationship between consumption norms, advertising and optimal environmental policy. The chapter offers a formal analysis of sustainable consumption when consumers do not just care about their absolute level of consumption but also about their level of consumption in relation to that of others. It captures that pollutive consumption is sensitive to advertising. A static general equilibrium format was chosen to assess the net welfare and environmental impacts of policy or lack of it, which means that non-strategic, price-taking behavior is taken as the (logical) starting point. While the model type is conventional, it allows addressing certain behavioral assumptions. In particular, rationality (optimizing utility) is combined with other-regarding preferences like status and social norms. Two utility specifications are examined. The first, linear one conceptualizes Veblen's theory of conspicuous consumption which reflects status sensitivity by consumers. The second, quadratic one describes imitation and conformity of consumption choices. The model can accommodate the cases of the externality created by advertising being positive or negative. Ultimately, optimal rules for a pollution tax, a subsidy or tax on advertising, and information provision by the government are derived.

Chapter 4 studies non-economic motivations for pro-environmental behavior. To investigate this issue, this chapter first examines psychological and behavioral drivers of pro-environmental behavior other than pure self-interest. It gives particular attention to behavior motivated by concerns for individual reputation. In a second step, a framed field experiment explores reputation formation as a driver in support of pro-environmental behavior like household recycling practices. This adds to the literature on other-regarding preferences and aims to test non-economic incentives provided by different disclosure treatments. To mimic reality, the actual experiment is based on a real recycling program, with participants who are heads of urban households in Costa Rica. The design of the experiment simulates a setting with peer approval or disapproval opportunities and thus tests which mechanism can lead to more recycling. In addition, the experiment consists of a further treatment simulating a standard regulatory policy instrument. The ultimate outcome of the field experiment is the recommendation of practical policy options based on non-economic motives reflecting households' recycling behavior.

Chapter 5 investigates the prospects of combining behavioral economics models with the study of cooperation in the context of an international climate agreement. So far, research on international negotiations considers rational actors rather than ones exhibiting some form of bounded rationality. The chapter offers an alternative for the dominant agent view and shows how insights will alter and which new questions will appear if rationality and isolated individuals are replaced by bounded rationality and social interaction. It illustrates how particular deviations from full rationality affect the incentives to cooperate. Of special interest are fairness preferences for burden-sharing rules and behavioral responses to different framings

of climate change and policy, as well as implications of these for communication about climate change. The analysis will further address different levels of representation climate negotiations, including of individual citizens, politicians, experts, and (professional) negotiators. The consequences of the most prominent nonstandard preferences and biases for negotiating a climate treaty are assessed and specific strategies to foster cooperation are suggested.

Chapter 6 considers the effect of climate change risks and disasters on international cooperation on climate policy. To investigate this issue, a laboratory experiment is carried out to compare how cooperation is affected by various climate damage scenarios. A key advantage of the experiment is that it introduces reality-like features such as, uncertainty about future climate change impacts and reasonable damage costs. The problem of reaching an international agreement is modelled as a public goods game. To distinguish between multiple interpretations of climate change the experiment offers a comparison between the effects of abrupt climate change and of continuous, gradual climate change. The experiment consists of three treatments in total including one standard public goods game as a control condition. Another treatment models abrupt climate change by linking damage costs to a surprising, exogenous disaster. The final treatment corresponds to gradual climate change in the form of continuous damage costs that are endogenous to agent decisions. The experiment addresses the somewhat neglected individual differences in cooperation and coordination in climate policy. Implications for international climate negotiations are derived.

Finally, *Chapter 7* draws conclusions.

Chapter 2.

Environmental Policy Theory given Bounded Rationality and Other-regarding Preferences [*]

2.1 Introduction

A good understanding of individual behavior and decision-making is essential to explain and predict how people will act concerning environmental issues and subject to specific environmental policies. Although behavioral economics enjoys increasing support, systematic application of its theories and insights to economic sub-disciplines like environmental economics is still very limited and has not resulted in a systematic set of policy recommendations. This Chapter sets out to offer a summary of findings on human behavior and their implications for environmental policy.

Economics traditionally uses a model of behavior commonly referred to as *homo economicus* to analyze the economic behavior of individuals when subject to public policy. This economic being is endowed with given preferences, perfect rationality and self-interest. Human action is reduced to an optimization problem: behavior can be fully explained by individuals maximizing their utility. This approach assumes that preferences are fixed and that behavior is influenced only by prices and income. In line with this, economic analysis proposes that generally a proper, socially desirable allocation of private and public goods is achieved where prices direct economic decisions. Policy advice drawing on standard theory suggests the use of monetary incentives to influence behavior. A clear example is environmental policy theory, developed by Baumol and Oates (1975), where price corrections capture negative environmental externalities.

Behavioral economics offers an alternative explanation of human action based on recognizing bounded rationality and limited self-interest. Economic psychology has provided a great amount of evidence against the neoclassical-economic model of individual behavior and, in response, a range of alternative theories of behavior and models of choice have been developed. Some influential studies are Simon (1955), Kahneman and Tversky (1974), Kahneman and Tversky (1979), Thaler (1980), Andreoni (1990), Rabin (1993) and Fehr and Schmidt (1999). Behavior not complying with the standard model can be categorized as "bounded or limited rationality" when decisions are constrained by cognitive processes and

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available information, and as "other-regarding behavior" when motives like fairness, reciprocity, and self-identity affect decisions. There are several good reviews now summarizing findings from behavioral economics (Kahneman et al., 1986; Camerer, 1995; Conlisk, 1996; Rabin, 1998; McFadden, 1999; Camerer et al., 2004; Loewenstein, 2007; Meier, 2007). A few articles have addressed the application of behavioral theories to environmental economics focusing on particular instances (van den Bergh et al., 2000; Shogren, 2002; Shogren and Taylor, 2008; Venkatachalam, 2008; Gowdy, 2008; Brekke and Johansson-Stenman, 2008).

The aim of the current Chapter is to reflect on the main alternative assumptions of behavioral economics so as to be able to offer a more realistic account of effective and efficient environmental policy. Designing adequate policies and incentives requires a good understanding of how people behave and make decisions within different contexts. Insight into behavioral failures and motives other than self-interest can lead to adjustments of traditional advice on policy design. This involves assessing responsiveness to policy incentives and interventions, drivers of consumer choice, and non-economic factors affecting individual decision-making.

The remainder of this Chapter is organized as follows. Section 2.2 offers a brief overview of behavioral economics and responses to it. This involves a classification of behavioral failures and motives violating rationality and other preference assumptions, notably regarding social context. Section 2.3 discusses several other ideas that extend, or may be combined with, the behavioral economics approach, namely preference heterogeneity, decisions by groups and organizations, a non-representative agent approach, population models in evolutionary economics, and insights from research on happiness or subjective well-being. Section 2.4 reviews applications of behavioral economics to environmentally relevant behavior, focusing on environmental valuation and sustainable consumption. Section 2.5 discusses lessons for environmental policy under bounded rationality and other-regarding preferences, paying particular attention to non-pecuniary incentives and the topical issue of climate policy. Finally, Section 2.6 concludes while Section 2.7 discusses potential research avenues.

2.2 An overview of bounded rationality and other-regarding preferences

Behavioral economics strives to integrate the psychological foundations of human behavior into economic analysis. It relies on evidence generated mainly by laboratory and, to a lesser extent, natural or field experiments. These generally find that individuals systematically deviate from rational decision-making. This involves two main insights. Firstly, people do not make optimal decisions, as they are boundedly rational due to cognitive limits, lack of information and limited willpower. For instance, people regularly use decision heuristics – so-called rules of thumb or decision shortcuts. Secondly, people have limited self-interest, i.e. they are also driven by other-regarding preferences like fairness or reciprocity when making decisions. Many examples of

such behavior exist in the context of consumption activities: heuristics and mental accounts influence product choice (Cheema and Soman, 2006), pro-social behavior affects donations or volunteering (Meier and Stutzer, 2008), and status and habits drive consumption (Lindbeck, 1997). Behavioral economists have opened the way to alternative models of behavior which adjust or replace the rational, maximization model and its predictions, such as prospect theory, hyperbolic discounting, heuristics, habitual behavior, status seeking, self-identity concerns, and theories involving social preferences.

As one might expect, there is also criticism of behavioral economics. This stresses two lines of reasoning to justify the relevance of rational agents: market selection (evolution) and learning (summarized by Mullainathan and Thaler, 2000). Several economists have argued that behavioral failures do not matter in the market as they are eliminated or mitigated by mechanisms like arbitrage and competition. By contrast, behavioral economists claim that there are limits to arbitrage. This has been repeatedly shown in research on financial markets where individuals are found to regularly deviate from behavior as predicted by expected utility theory. Financial theory has, in fact, moved in the direction of behavioral models in response to the bounded rationality of investors (Levy et al., 2000; Shleifer, 1999).

Another line of criticism states that the presence of evolutionary mechanisms supports the irrelevance of behavioral anomalies. However, evolution is consistent with bounds on rationality and should not be simplified as leading to optimal behavior. Alchian (1950), who argued that firms that are profit seekers and those successful in achieving profits will be selected by the market mechanism and survive. Friedman (1953) even went further and proposed that profit "maximization" rather than "seeking" is selected by the market, thus trying to find support for the idea that profit maximization, although not universal, will be the sure outcome of selection by the market. Winter (1964) criticized both previous authors, arguing that the explanation lacks a transmission mechanism for successful behavior. As a result, winning in one period is unrelated to winning in another period. If profit seeking or maximizing is not deliberate or conscious, then it cannot be passed on to, or learned by, others (Hodgson, 1988: p. 78). This means winning remains a largely random process, as shown by the profits of many firms fluctuating erratically over time. Moreover, even if the Alchian-Friedman argument was correct, it would only pertain to profit, not utility maximization. In other words, the rational consumer behavior model would have to be saved by a different type of argument. Another, more recent criticism on the foregoing evolutionary argument in favor of rationality comes from behavioral economists who claim that there are limits to arbitrage. This has been repeatedly shown in research on financial markets where individuals are found to regularly deviate from behavior as predicted by expected utility theory. Financial theory has, in fact, moved in the direction of behavioral models in response to the bounded rationality of investors (Levy et al., 2000; Shleifer, 1999).

A second defense of rational choice theory is as follows. Individuals who systematically make mistakes might learn to overcome them. However, instead of costly investment in increasing knowledge, learning often takes the form of low-cost, social learning through imitation of frequent behavior or superficial features of successful behavior without understanding the nature of such success (Boyd and Richerson, 1993). This comes down to agents copying the behavior of other boundedly rational agents, which does not lead to rational behavior.

Behavioral economics relies strongly on evidence generated by experiments. These have, however, been criticized for lacking external validity, meaning that behavior assessed in experiments might not correlate with, or resemble, real-world behavior. Empirical evidence and observations outside the experimental laboratory can overcome problems with external validity. Already Simon (1986: 209) acknowledged that behavioral economics requires "[…] an empirically founded theory of choice that specifies what information decision makers use and how they actually process it. This behavioral empirical base […] is essential for enhancing the explanatory and predictive power of economics". In response, attention has shifted somewhat to field and large-scale social experiments. These provide empirical evidence on the relationship between laboratory and field behavior (List, 2006; Carpenter and Cardenas, 2006; Ehmke and Shogren, 2008). On one hand, such studies confirm many of the findings on bounded rationality of laboratory experiments and thus provide support for the validity of lab results. On the other hand some studies suggest that bounded rationality is slightly less pronounced in the field. Recently, laboratory experiments have even questioned the robustness of certain behavioral failures. For example, Gunnarsson et al. (2003) find that market arbitrage removes preference reversals, while Cherry et al. (2003) find a similar result for environmental lotteries.

We classify insights from behavioral economics into two broad themes: bounded rationality and limited self-interest. Bounded rationality involves behavioral anomalies[1] in choice under risk and uncertainty, intertemporal choice, and other inconsistencies in decision-making. Other-regarding preferences or limited self-interest includes all types of other-regarding behavior and motivations, such as fairness, altruism, reciprocity and preferences for self-identity like status. In line with these various behavioral categories we consider relevant alternative behavioral theories. Table 2.1 provides a summary.

2.2.1 Limited rationality

Herbert Simon (1955) defined psychological principles of individual behavior and first recognized the imperfect access to information and limited computational capacities of individuals, which he called "bounded rationality". Simon argued that only when choices are

[1] Similar terms like behavioral anomaly, deviation, failure, bias and judgment problems describe behavior deviating from perfect rationality.

very simple and transparent does an individual behaves like a utility maximizer. However, when decisions are more complex, choices generally deviate from perfect rationality. In practice, decision-making occurs under time constraints, cognitive limitations and imperfect or costly information. According to Simon, people are then unable to maximize their utility and instead will "satisfice", i.e. make a choice that is "good enough" (Simon, 1959). Subsequent research has strongly supported Simon's intuitive assessment of human behavior and its departures from rational choice axioms. Alternative theories of economic behavior grounded in psychological findings have been proposed and are presented next.

2.2.1.1 Choice under risk and uncertainty

Many patterns of observed economic behavior under risk can not be explained by standard expected utility theory. Examples are people not cutting consumption expenditure after facing a wage cut, consumers usually choosing the default insurance offered to them, and cab drivers always quitting around daily income targets. Field observations (Camerer, 2004) and laboratory experiments (Kahneman et al., 1990) describe such behavioral patterns. They find that utility depends on a reference point, and is sensitive to gains and losses relative to this point. This involves loss aversion, describing the fact that the disutility of giving up something is greater than the utility associated with acquiring something. This can explain the insensitivity of consumption to bad news about income or the tendency of cab drivers to work longer hours on "low-wage days". Loss aversion can clarify a famous financial puzzle, namely the equity premium, with stocks having a much higher return than bonds (Mehra and Prescott, 1985). An explanation for the large difference in returns found is that investors are loss-averse, demanding a higher premium as compensation for a higher risk of losing money.

Based on experimental findings, Kahneman and Tversky (1979) present an alternative model of choice, labeled prospect theory, which challenges standard expected-utility theory by integrating certain psychological aspects of decision-making. An important behavioral feature is that people overweight probabilities of outcomes that are considered certain in relation to other outcomes. This is called the certainty effect which involves a risk-averse preference for a sure gain over a probable gain with a larger expected value, and to a risk-seeking preference for a probable loss over a certain loss with a smaller expected value. A generalization of this is the reflection effect, which specifies that individuals are risk-averse when the outcome is positive and risk-seeking when it is negative. This can explain, for example, that people trading in stock markets hold losing stocks too long, and sell winning stocks too soon. In behavioral finance, this is known as the disposition effect. The isolation effect is an example of a decision anomaly from the viewpoint of expected-utility theory. Inconsistent preferences result from individuals basing their choices on differentiating characteristics between alternatives and not on shared characteristics.

Table 2.1 Concepts and theories in behavioral economics.

General category	Specific category	Rational choice theory	Behavioral theory	Main behavioral insights	Behavioral anomalies and other-regarding preferences	Effects
Bounded rationality	Choice under risk and uncertainty	Expected utility theory	Prospect theory and rank dependent utility theory	Preferences violate the axioms of expected utility theory: they are reference-dependent, asymmetric to losses and gains and probabilities are weighted non-linearly	Reference-dependent preferences Ambiguity	Loss aversion Certainty effect Reflection effect Isolation effect Framing effect (bracketing) Endowment effect Status quo effect (superstition) Equity-premium (disposition effect) Asymmetric elasticity Default bias Context effect Preference reversal Lexicographic preferences Ambiguity-aversion
Bounded rationality	Intertemporal choice	Discounted utility theory	Time-inconsistent preferences and self-control problems	Time-inconsistent preferences affect individual's decision-making, i.e. valuing the present more than the future	Hyperbolic discounting	Myopic behavior Immediacy effect Lack of self-control Magnitude effect Sign effect (gain-loss asymmetry) Delay-speed up effect Sequence effect Negative discounting "Gestalt" effect Habit formation
Bounded rationality	Judgment	Utility maximization under perfect information and perfect cognitive abilities	Heuristics	Mechanisms underlying people's judgment and decision-making in order to overcome complexity and lack of information	Heuristics	Availability Representativeness Anchoring and adjustment Mental accounting
					Judgment bias	Self-serving bias Overconfidence Context effect Focal effect Isolation effect Misinterpretation effect Order effect Process effect Projection effect Prominence effect Rule-Driven behavior Saliency effect Emotions
Limited self-interest	Preferences	Utility maximization under perfect self-interest	Other-regarding preferences	Individual utilities depart from pure self-interest	Social preferences	Fairness (inequality aversion) Altruism, impure altruism (warm glow) Social norms (moral, intrinsic motivation) Reciprocity, conditional cooperation
					Self-identity	Status, relative income, positional goods Social approval and disapproval

The case of the decision maker being uncertain about probabilities of outcomes, referred to as ambiguity, represents another limitation to applying the expected-utility framework to individual decision making. Ambiguity is also referred to as Knightian uncertainty based on the seminal contribution of Knight (1921) who distinguished between measurable and unmeasurable uncertainty, i.e. ambiguity. Under conditions of ambiguity maximization of expected utility is not possible as this would imply knowing the probabilities of various outcomes. Decisions under uncertainty are affected by whether decision makers are ambiguity-averse or not. According to Ellsberg (1961), people prefer situations involving precise probabilities (risk) to situations with unknown probabilities or ambiguity. Several experimental studies have examined ambiguity aversion (e.g., Slovic and Tversky, 1974; Moore and Eckel, 2003). Camerer and Weber (1992) list different sources of ambiguity such as credibility of the information source, disagreements among experts, amount of available information, and weight of evidence. Many real life decisions involve ambiguous information about risk, such as vaccination decisions (negative health effects?), protection against environmental hazards (how likely is a natural disaster?) and adoption of innovations (which benefits?). Thus people are reluctant to vaccinate, buy insurance in order to self-protect against any uncertain outcomes, or buy a new, unknown product.

Another relevant bias is the framing effect, according to which individual choice between alternatives is affected by the way a problem is presented. Kahneman and Tversky (1979) framed a hypothetical choice about combating a disease in two different ways. Probabilities of events were the same, but in one case the alternatives were described in terms of saving people and in the other case in terms of deaths. The experiment showed that the certainty of saving people was judged disproportionately attractive, and the certainty of deaths disproportionately aversive, which violates classical expected utility theory. Other phenomena better explained by prospect theory than by standard theory are the endowment or status quo effect, the default bias and mental accounting.

The notion of placing a higher value on something we own has been repeatedly shown in experiments and also observed in real life situations. That is, people tend to value goods more if they involve ownership, i.e. they express a preference for a particular reference point, namely the endowment. This contradicts standard theory which says that preferences are invariant with respect to the current endowment. Evidence from Kahneman et al. (1990) is based on dividing students into three groups. One group was given a choice between a mug worth $4.95 and a chocolate bar worth $6.00, and 56 % chose the mug over the chocolate bar. A second group first got the mug and was then given the opportunity to trade it for the chocolate bar; here, 89% chose to keep their mug. Students in the third group were first given the chocolate bar and then the opportunity to trade it for a mug. 90 % chose to keep their chocolate.

Further experimental evidence has identified reference points other than initial endowment, referred to as status quo or default bias. For example, individuals were asked to make a choice about investment options with different risk ratings. It was found that an option became significantly more popular when it was designated as the status quo or default. One other effect worth mentioning is that loss aversion implies asymmetric price elasticities of demand, reflecting the fact that consumers are more sensitive or responsive to price increases (for normal goods) than price cuts (Kahneman et al., 1991; Camerer, 2004).

A main departure from the linear processing of probabilities in expected utility theory is provided by prospect theory, which models individual attitudes toward probabilities with a so-called 'probability weighting function'. It allows for different weights on gains and losses. Useful insights emerge from extensions of prospect theory. Kahneman and Tversky (1992) propose a modification of their original theory, which is sometimes referred to as cumulative prospect theory, using a probability weighting function on probability ranks of outcomes[2] instead of single probabilities. This function is able to accommodate the commonly observed overweighting of extreme events with low probabilities and high consequences. Another modification of expected utility theory is prospective reference theory by Viscusi (1989). He suggests that next to expert assessments of risks individual perceptions of risks play an important role in individual decisions. The latter may deviate considerably from risk judgments by experts. Therefore, behavior may be different from what is expected if one would assume a fully rational assessment of risk by individuals. Decisions are made according to a perceived risk which is a function of a prior risk belief and experts risk assessment. The discrepancy between an individual's perceived probability and the actual risk may lead to decision biases. For example, the choice of the level of insurance depends on the perceived risk. Factors that restrain this relationship may decrease the incentive and willingness to protect, i.e. the purchase of insurance. Hence, failure to adequately perceive risks may lead to inadequate precautions or level of insurance. Viscusi (1995) suggest two policy interventions to alleviate such failures. Biases that distort individual decisions can be restrained by altering risk perception through information provision or regulation of risk, e.g. offer mandatory insurance. Risk information and risk control may alter and influence risk perceptions and consequently decisions. Related work on decisions involving risk illustrates the limits of human rationality. Kunreuther (1978) and Slovic (1982) provide empirical evidence documenting such biases with respect to natural disaster, insurance decisions and responses to hazardous activities. They find, for example, that self-protection might be hampered by bounded rationality. Zeckhauser and Viscusi (1990) argue for improved information mechanisms through government interventions to overcome human limitations on individual choices.

[2] The rank of a positive outcome x, or good-news probability, is defined as the probability of getting an outcome better than x.

Behavioral economics has regularly found preference reversal, also referred to as constructed preferences, which is a violation of procedure invariance. The latter means that certain preferences are invariant with regard to the procedure used to elicit them. Experimental evidence shows that the procedure for eliciting choices affects the order of preference, showing that there are no pre-defined preferences but that these are, in some way, constructed in the elicitation process (Lichtenstein and Slovic, 1971; Tversky and Thaler, 1990).

2.2.1.2 Intertemporal choice

Normative theory proposes the standard discounted utility model, weighting utilities by an exponentially declining discount factor. Exponential discounting yields time-consistent preferences, meaning that individuals act according to their long-run interest when making decisions over time. However, individuals show behavior over time that is inconsistent with this. For example, they regularly show time-inconsistent preferences in decision-making characterized by discount rates varying over time. This means they have distinct preferences over nearby and distant choices, violating the principle of exponential discounting. Instead they employ short-run discount rates which are higher than long-run ones, known as hyperbolic discounting. Such behavior might imply that people make short-sighted decisions when cost and benefits are immediate, referred to as the immediacy effect or myopia choice behavior. This type of behavior has been interpreted as a lack of self-control or present-biased preferences, with choices being dominated by immediate benefits (Laibson, 1997; O'Donoghue and Rabin, 1999). This can result, for example, in individuals consuming their savings (Ashraf et al., 2006), buying addictive products, or showing bad habits such as smoking (Thaler and Shefrin, 1981; Wertenbroch, 1998; Frederick et al., 2002). Happiness research (Frey and Stutzer, 2006) supports the role of time-inconsistent preferences by providing empirical evidence that individuals put a heavy weight on the present situation, focus on immediate utility and make inconsistent choices over time. This has immediate policy implications: for instance, whereas standard economic theory predicts that a tax on smoking will reduce not only one's consumption but also one's well-being, happiness research suggests a positive effect on subjective well-being.

Many instances of economic behavior can be explained by habits, which can be described as well-practiced activities of everyday behavior (Verplanken and Aarts, 1999). According to rational choice theory, habits are a type of addictive behavior. Becker and Murphy (1988) propose a model of rational addiction that accounts for past consumption effects. Behavioral economics emphasizes that habitual behavior can be explained by having time inconsistent-preferences. Indeed, habit formation is defined as follows: "[…] the more of the product a person has consumed in the past, the more he desires the product now" (O'Donoghue and Rabin, 2000: 1). As a result, individuals sometimes make decisions which are not in their

best long-run interest. The interaction between habits and choice behavior has also been approached from an evolutionary point of view. This involves concepts like routines, automatic behavior, behavioral lock-in and path dependency (Hodgson, 2004).

Other anomalous temporal choice patterns include, among others, the magnitude effect – discount rates for losses being higher than for gains; the sign effect – gains being discounted more than losses; the sequence effect – individuals preferring improving sequences such as an increasing wage profile; and negative time discounting – utility can be derived from the mere anticipation of a future gain. For more effects and details see Loewenstein and Prelec (1992), O'Donoghue and Rabin (2000) and Frederick et al. (2002).

2.2.1.3 Judgment problems

Behavioral economics proposes that people do not behave rationally in the case of complex and infrequent decision-making. Experiments have assessed that they make use of heuristics in order to reduce complexity in decision-making. In general, heuristics can be quite useful when time and cognitive abilities are limited, but they also can lead to systematic errors of judgment, violating standard statistical laws and Bayes rule. The three most common heuristics in probability judgment are the availability, representativeness and anchoring heuristics.

The availability heuristic describes people's assessment of the probability of an event where the probability of recent instances and events with a relatively large class is overestimated because these are more easily mentally available and imaginable. An example is that the subjective probability of traffic accidents rises temporarily when one sees a car overturned by the side of the road. People using the representativeness heuristic are likely to evaluate probabilities by the degree to which one event is representative of, or resembles, other events. In addition, people judge a frequency by comparing the similarity of the case with the image or stereotype of the class, often to the exclusion of prior probabilities, base-rate frequencies, sample size, and other factors that should affect probability judgments. The anchoring or adjustment heuristic reflects the fact that estimates are heavily biased towards a given starting point or initial value. For example, in an experimental study people being asked to estimate the number of African countries in the United Nations were given an arbitrary number between 0 and 100 (starting point) before their evaluation. Their estimate was reported as being biased towards the assigned arbitrary starting point (Kahneman and Tversky, 1974).

The tendency to reach judgments that reflect a self-serving bias, i.e. mixing what is fair with what benefits oneself, presents another behavioral anomaly in decision-making. This is evident in many judgment situations, such as people overestimating their own contribution to joint tasks, people tending to attribute their successes to ability and skill, but their failures to bad luck, and people being likely to arrive at judgments of what is fair or right which are biased on the direction of their own self-interests. Similarly, the optimism bias shows that people are

overconfident about their own relative abilities and unreasonably optimistic about their futures. Overconfidence can explain, for example, a high rate of business failures (Camerer and Lovallo, 1999).

Besides violations of probability judgment, behavioral decision theory describes other cognitive anomalies where individual decision-making deviates from rational choice axioms (Rabin, 1998; McFadden, 1999). Some findings are as follows. Decision anomalies arising from the way individuals process information include: order effects – individuals establish aspiration levels (reference points) and set goals relative to these benchmarks, or are influenced by ethical and superstitious beliefs; primacy (recency) effects – initial (most recent) experiences are more readily recalled than ones in between; focal effects – categorical approximations are used to minimize recall and reporting effort; isolation or cancellation effects – common aspects of alternative lotteries are ignored when they are compared; and segregation effects – riskless components of a lottery are evaluated separately. Choices are also influenced by the context in which they are made. For example, the addition of another option to a choice problem may enhance the attractiveness of the existing options. Information that seems most relevant at the moment may be overemphasized in relation to other information, known as the saliency or prominent effect. The projection effect means that individuals might make judgment errors because their decision is misled by a broader but irrelevant context. And the misinterpretation effect reflects the fact that individuals misinterpret judgments due to a real or perceived strategic advantage.

Next, the concept of mental accounting[3] by Thaler (1980) provides further evidence that consumers act in a manner that is fundamentally inconsistent with standard economic theory. Mental accounting is the activity of individuals or households to organize, evaluate and keep track of their financial activities. People keep mental accounts for different expenses, such as food, clothing, entertainment and education. This violates the standard view that money is fungible, i.e. that any unit of money is can be replaced by another (Thaler, 1999).

Recent research has introduced emotions into economic decision-making models. Neuroeconomics has helped in obtaining insights about behavior and explaining visceral influences like emotions or fatigue in decision-making. Neuroeconomics combines economic theory with a broader understanding of the mechanics of the brain. For example, emotions do not necessarily comply with utility maximization rules. It is found that immediate emotions, i.e. affectiveness or feeling which is unrelated to the decision at hand, can have a significant impact

[3] The idea that choices are altered through the introduction of boundaries, named choice bracketing is a related concept. It describes the grouping of individual choices together into sets (Read et al., 1999). Similarly, rule-driven behavior is described by McFadden (1999: 85) as judgment being "…guided by principles, analogies, and exemplars rather than utilitarian calculus". For example, people develop rules for money, so-called accounts, applying to living or food expenses.

on choice. An example of the emotional influence on decision-making is that due to current arousal people make decisions they will regret later on (Loewenstein and Lerner, 2003).

2.2.2 Limited self-interest

Standard economic theory on which environmental policy theory is based assumes that economic behavior is explained by people pursuing only self-interest. Any other-regarding preferences are excluded. People holding other-regarding preferences value outcomes of other people either positively or negatively (Camerer and Fehr, 2006). For example, people voting or making voluntary contributions to public goods, such as blood donations and voluntary collection and recycling of waste, cannot be explained solely by pure self-interest. Behavioral economics suggests that the individual utility function has to be modified to take account of two types of other-regarding preferences: (1) non-selfish motives or social preferences, such as fairness, reciprocity, altruism and intrinsic motivations; and (2) self-identity concerns, such as reputation, self-respect and status. Several studies have examined how economic behavior is influenced by other-regarding preferences (Andreoni, 1989; Rabin, 1993; Frey, 1997; Lindbeck, 1997; Fehr and Schmidt, 1999, Bénabou and Tirole, 2006).

An important line of experimental research suggests that fairness motives affect people's behavior. Fairness is generally defined as people caring about equitable outcomes and is also referred to as inequality aversion, which denotes the fact that people prefer equal distributions of payoffs (Smith, 1991; Fehr and Schmidt, 1999). Experimental games, such as ultimatum and public goods games, have shown that people hold preferences which depart from pure self-interest. In particular, people care for equitable outcomes and behave fairly and cooperatively in many situations where the self-interest model would predict complete defection. Kahneman et al. (1986) document that consumers' strong sense of the fairness of a firm's pricing decisions can explain why monopolists have to set the price below the price predicted by theory, and thus cannot fully exploit their monopoly power. Some studies have combined ethnographic and experimental approaches to provide cross-cultural evidence for fairness preferences in the field (Heinrich et al., 2001).

Experimental evidence supports another type of social preference, namely reciprocal behavior (Fehr and Gächter, 2004). Reciprocity means that, in response to friendly actions, people frequently react more cooperatively than suggested by standard theory. Likewise, negative reciprocity also exists, i.e. people respond non-cooperatively to hostile actions (Rabin, 1993; Falk and Fischbacher, 2006). Research has shown that reciprocity can have important economic implications in areas like work motivation and contract enforcement (Fehr and Gächter, 2000). Falk (2004) extends findings on reciprocity by using field data to assess motives behind charitable giving. Related to reciprocity is the concept of conditional cooperation, asserting that people cooperate if others cooperate too. For instance, pro-social behavior is

conditional on other people's cooperative behavior. In particular, the persistence of such behavior has been explored in the context of social dilemmas or collective action problems, such as tax compliance, common pool resource use, democracy and "not in my backyard" situations (Ostrom, 1998; Kahan, 2005).

Altruism means that individuals help others while making sacrifices. Altruistic traits can have important consequences for economic behavior in the family and work place (Simon, 1992). Andreoni (1989, 1990) suggested that people derive utility from the act of giving, labeled the "warm glow effect". This model of human behavior is also referred to as impure altruism. In addition, studies document heterogeneity in altruistic behavior. Besides pure and impure (utilitarian) altruism, a third type is encountered, namely people undertaking altruistic or pro-social activities in order to improve their self-image. However, this may mean they do not care as much about the outcome of their pro-social behavior as they do about the way their behavior affects their self-identity. In order to self-signal reputation or status, people undertake activities such as conforming to social norms (Bénabou and Tirole, 2006).

An agent's consumption behavior is best understood within a social context, as it is shaped by imitation, comparison with and learning from others, and status effects (Heinrich and Boyd, 1998). Happiness research has provided strong evidence that welfare is affected by many factors other than income and consumption, including status (Postlewaite, 1998; Weiss and Fershtman, 1998; Easterlin, 2001; Frank, 2005a). Social status relates to the relative position of an individual in a society and can be expressed in many forms: social recognition, self-respect, honor, esteem, social standing, and prestige. Individuals strive not only for material reward in terms of money payoffs but also for social rewards. For example, a car might not only be bought for its use value but also to attain status. Veblen (1899) already noted the function of consumption in attaining social status and power. Consumption displays not only one's income and wealth to others but also one's position in society. In his seminal contribution Duesenberry (1949) acknowledged that relative income determines the consumption and saving patterns of households. Brekke and Howarth (2000) note the symbolic meaning of goods, stating that commodities may serve to communicate one's self-image to others or reinforce it.

Many of these ideas relate to evidence that, in various cases, people behave as if they were intrinsically motivated rather than stimulated by any financial reward (material self-interest), as suggested by standard economic theory. For policy, there is supporting experimental evidence on the conflict between external incentives (rewards or punishment) and intrinsic motivation. Deci (1972) reported that, in order to increase the intrinsic motivations of children, employees or students, policy makers should beware of concentrating on external incentives, like monetary rewards, because they can decrease such motivations. Experimental and field evidence has confirmed that external incentives can crowd out intrinsic motivations (Frey, 1997; Bénabou and Tirole, 2003), sometimes referred to as moral motivations (Brekke et

al., 2003). For example, increased pay for workers can undermine their intrinsic motivation to work. Another example provided by Gneezy and Rustichini (2000) shows the effect of monetary incentives on stimulating parents to pick their children up on time. It is found that a monetary punishment leads to the reverse of intended effect – parents arrive even later. Carpenter and Myers (2007), using data on volunteer firefighters, find that pro-social behavior can be crowded out by extrinsic monetary incentives. Frey and Jegen (2001) review other evidence.

The effect of non-pecuniary incentives on pro-social behavior has received relatively little attention in economic policy analysis. Extrinsic incentives in the form of social approval, ostracism, or public embarrassment can serve as a punishment or reward to stimulate certain types of behavior. Such social incentives operate through feelings of status, esteem, pride or fear. Concrete channels to implement them are public disclosure and awards or prizes. For example, Frey and Neckerman (2008) have studied social awards in the form of public recognition as a mechanism to improve cooperation in a work place setting. They point out that the main difference with monetary compensation is that awards stimulate social recognition and social reinforcement and so are less likely to crowd out intrinsic motivations. In addition, incentives in the form of awards have a long term effect in the sense that they create role models and thus distribute information about desirable behavior. Another example showing the positive effect of non-pecuniary incentives on fostering altruistic behavior is an experimental study by Ellingsen and Johannesson (2007). They illustrate that anticipated verbal rewards and punishments in the form of written feedback induce a higher rate of altruistic behavior. Positive feedback result from symbolic rewards evoking feelings of pride, while negative feedback is due to symbolic punishment causing feelings of shame which individuals tend to avoid.

In addition to looking at the separate effect of immaterial punishment or rewards, some studies have examined their interaction with material incentives. For example, Noussair and Tucker (2005) find that contributions to a public good are higher when material and informal punishment mechanisms are applied in combination than when only one of the two forms of punishment is used. An empirical example of using social incentives for rule enforcement is the implementation of a public embarrassment mechanism in the form of a public mocking campaign in the city of Bogota to endorse compliance with traffic laws. In order to promote rule compliance by individuals, the public administration made use of mimes in the city's streets to shame traffic violators. This type of public disclosure of citizen behavior makes use of peoples' aversion to be disapproved or shamed in front of others (Caballero, 2004).

2.3 Heterogeneity, evolution and happiness

This section is intended to broaden the picture somewhat, focusing on three interrelated themes. It will not offer a full review of all relevant issues associated with each theme. This would require a book format. Instead, we want to clarify the way in which the translation of rather abstract and isolated insights from behavioral economics to policy can be made more relevant, complete and effective.

Standard economic theory generally assumes representative agents, even though a population of heterogeneous agents is more typical of reality. People show varying degrees of bounded rationality, and self- versus other-regarding preferences (Andreoni and Miller, 2002). For instance, Fischbacher and Gächter (2006), performing a public good experiment, find heterogeneity of social preferences. An important implication of the existence of heterogeneity is interaction between these different agents. For example, other-regarding individuals can generate a cooperative outcome if they provide incentives for selfish individuals to behave pro-socially. Likewise, self-interested individual can trigger non-cooperative behavior. Thus, the interaction of heterogeneous preferences of individuals may affect the aggregate outcome (Camerer and Fehr, 2006; Gächter, 2006). Therefore, taking multiple, heterogeneous individuals into account can lead to a better and more realistic view of behavior and prediction of outcomes. Also, in order to specify a complete model of relative positions, status, imitation and information diffusion, the representative agent model needs to be replaced by a model of interaction between multiple, similar but heterogeneous agents. This implies an evolutionary approach in which selection and innovation interact to change the diversity of behaviors. Such an evolutionary view of economic behavior and interaction has various implications for public policy (van den Bergh and Kallis, 2009).

Findings from evolutionary psychology can enhance our understanding of how preferences, beliefs and rationality are shaped (Robson, 2002). Recently, Robson (2001, 2002) has written on the biological basis of economic behavior. He argues, much in line with evolutionary psychology, that our behavior was shaped during millions of years living in small hunter-gatherer groups. This might imply that our behavior is inappropriate for, or at least not well adapted to, current circumstances, including the objectives of sustainable consumption and development (Jackson, 2000; Siebenhüner, 2000). Robson make some interesting points. Fitness suggests that relative success is more important than absolute success, which can translate to interdependent preferences and relative welfare. The evolutionary explanation of human intelligence as resulting from strategic, social interactions – through runaway selection, or an arms race of rational features – seems to have created a much greater capacity for rational behavior in social contexts than in abstract or laboratory situations. This can be explained by the evolution of a ‘theory of mind’ or advanced form of empathy. This, in turn, raises some doubt

over findings by experimental economics and is somewhat supportive of rationality. Robson argues that by considering the two hypotheses – ecological (evolution in response to environment or other species) - and social – explaining the evolution of human intelligence – more can be understood about the limits and anomalies of human intelligence.

Besides experiments, happiness research has contributed considerably to a better understanding of the determinants of behavior and subjective well-being (Frey and Stutzer, 2002). It allows for evaluating the effects of cognitive biases or social motives on well-being. Whereas standard economics regards certain types of behavior as welfare-decreasing, using an abstract formulation of welfare, from the point of view of subjective well-being there often is no clear loss of welfare. For instance, Meier (2007) finds that other-regarding behavior like volunteering can contribute positively to well-being. Happiness research can also help to assess whether individuals make systematic errors in consumption decisions, i.e. not showing utility-maximizing behavior. For instance, Stutzer and Frey (2006) document empirical findings on subjective well-being suggesting that self-control problems, such as smoking, influence life satisfaction. Last but not least, happiness research assesses the heterogeneity of individuals' preferences, which can serve as input for modeling heterogeneity in populations of interactive agents as outlined above.

2.4 Implications of behavioral economics for individual decision-making and the environment

An integration of psychology and economics as in behavioral economics can lead to better predictions of economic behavior and, subsequently, to better policy descriptions (Camerer, 1999). Limitations to rationality and self-interest in individual decision-making mean that certain policies will not be as effective and efficient as predicted by standard theory. Below, we will translate insights from behavioral economics to the context of individual environmental decision making.

Table 2.2 lists important behavioral findings, associated behavioral theories, and their consequences for environmental economics. The assessment is based on a review of relevant theoretical, empirical and experimental studies covering four important areas relating to environmental policy where individual behavior and decision-making matter: environmental valuation, sustainable consumption, policy design, and the particular and the topical case of climate change policy. This section and Section 5 present details for each of these areas.

Table 2.2 Studies on the interface between behavioral and environmental economics.

Environmental domain	Subtheme	Behavioral theory	Behavioral anomalies and social motives	Relevant insights
Environmental valuation	Non-market valuation	Prospect theory Heuristics Other-regarding preferences	Loss aversion Endowment effect Status quo Ordering effect Lexicographic preferences Warm glow Intrinsic motivation	One explanation for repeatedly reported differences between WTP and WTA values in contingent valuation studies is bounded rationality.
Sustainable consumption	Energy Travel Waste	Prospect theory	Status quo Loss aversion Default bias	Value of consumer choices in monetary terms is influenced by inertia (status quo), loss aversion and default bias, which effectively means that cost savings are neglected. To promote pro-environmental behavior, green alternatives should be presented as the default option to the consumers.
		Time-inconsistent preferences	Habits	Many environmentally significant behaviors have a habitual character. Habits play a key role in many energy consumption activities. The formation of good habits may be encouraged by monetary incentives. If intrinsic motivation is strong, such incentives can be counterproductive. Instead, other policies like "deliberation intervention" can work better.
		Other-regarding preferences	Altruism (warm glow) Intrinsic (moral) motivation Self-identity (conformity)	Households having greater concern for the environment or stronger altruistic attitudes (warm glow) are more sensitive to participation and early adoption of green alternatives. Marketing efforts through environmental and charitable organization as well as concentrated and repeated information provision to households can increase participation rates. Social motives and self-image concerns (e.g. buying/showing less environmentally damaging products/behaviors) generate utility. Moral motives can lower the cost of environmental activities like waste sorting. Influencing beliefs and expectations about others' behavior can impact green consumer behavior (e.g. adoption of green electricity).
	Public goods		Altruism Intrinsic motivation Social Norms Reciprocity Self-identity	Social motives are positively correlated with pro-environmental behavior and lead to cooperation in social dilemmas. External regulations (e.g., financial incentives) can crowd out social preferences. Social rewards and punishment can be an option to increase cooperative behavior. For example, social approval, e.g. identity revelation, can increase voluntary contributions to a public good.
Policy design	Regulatory choice and design	Prospect theory Heuristics Time-inconsistent preferences Other-regarding preferences	Endowment effect Status quo Framing Habits Status Altruism	Market-based instruments like emissions trading might not work efficiently. Policy instruments might not look attractive to policy makers, public officers, the business community or the general public due to framing effects. Market-based instruments might be framed as giving a "right to pollute" rather than taking it away from polluters, meaning a framing as an environmental loss. Status-seeking and habits raise the level of efficient consumption and income tax rates. Social preferences can affect optimal Pigovian taxation.
Climate change	Risk	Prospect Theory Heuristics	Status quo, myopic behavior, optimistic bias, ambiguity aversion,, availability and representativeness heuristic	Small-probability high-impact scenarios are better captured by prospect theory. Participatory processes can overcome decision heuristics leading to inadequate policy enforcement.
	Discounting	Time-inconsistent preferences	Hyperbolic discounting Framing	Long-run environmental problems are sensitive to the assumed discounting pattern or method. Spatial and time frame are important for the communication of climate-related information
	Negotiation Cooperative behavior	Other-regarding preferences	Social preferences	Social preferences can lead to voluntary environmentally responsible behavior. Social punishment and reward mechanisms set in place can be useful for climate change policy negotiations and voluntary emissions reduction.

2.4.1 Pro-environmental behavior, consumption and the environment

Consumers make choices in a number of domains that have environmental impacts. They buy products, use water and energy, and discard waste. Standard neoclassical-economic analysis focuses on policy that emphasizes the impact of income and prices on behavior. As we have seen in previous sections, this, however, does not represent a correct and complete picture of individual behavior. Bounded rationality and factors other than price and income, such as loss aversion, social interactions, imitation and status, determine consumer preferences. A behavioral approach to the analysis of consumer behavior acknowledges the limits to rationality and self-interest. It also needs to account for psychological factors (van den Bergh, 2008).

The important role of bounded rationality in individual decisions on energy use and conservation is supported by many studies (van Raaij and Verhallen, 1983; Stern, 1992; Faiers et al., 2007). A well-known finding is the energy-efficiency paradox. It refers to the persistence of a gap between current and optimal (cost-effective) energy use and thus conservation. The literature suggests market failures are the main cause of the slow spread of energy efficiency. Examples of such barriers include adaptation, lack of public concern for energy issues and limited information (Jaffe and Stavins, 1994; Levine et al., 1995). In addition, behavioral anomalies, such as risk aversion, inertia or routines and habits, affect energy use (Rohdin et al., 2007; Wilson and Hadi, 2007). Prospect theory has been used to study household switching behavior in electricity markets (Defeuilley, 2009; Ek and Söderholm, 2008a; Juliosson et al. 2007). This includes addressing behavioral anomalies like loss aversion, default bias and the status quo effect as possible explanations for consumer behavior. Ek and Söderholm (2008a) find empirical evidence that the choice of households to switch to other service providers is influenced by a status quo effect. Pichert and Katsikopoulos (2008) offer an experimental analysis of consumer decision-making relating to green electricity use. They examine peoples' motivation for choosing green electricity in a laboratory experiments and find that default options have a strong influence on consumer choice. A policy lesson drawn is that, in order to promote pro-environmental behavior, green electricity should be presented as the default option for consumers. A more theoretical study of adoption, consumption and green products is Janssen and Jager (2002).

Another strand of research examines time-inconsistent preferences, considering the role of habits and routines in (un)sustainable consumption (Jackson, 2005; Stern, 2000). This mainly deals with two particular domains, namely energy use and transport issues. A fairly extensive literature in psychology addresses habitual car use behavior (Gärling and Axhausen, 2003; Verplanken and Aarts, 1999). In addition, experimental studies have been devoted to examining the context of habits and travel choice behavior. For instance, using data from a field experiment in Sweden, Eriksson et al. (2008) argue that habitual behavior appears as a key

factor in choosing means of transport. A reduction in car use may be facilitated by interrupting habitual car use by means of a so-called "deliberation intervention", in particular if the car user has both a strong car habit and a strong moral motivation to reduce personal car use (Carrus et al., 2008). With regard to energy consumption, habits have served as an explanation for the efficiency paradox mentioned above (Marechal, 2009; Schleich and Gruber, 2008). Empirical studies also demonstrate how to direct energy saving choices in the presence of habits (Stern, 1992; Barr et al., 2005). One policy lesson is that a behavioral change in lifestyles fostering energy saving might be facilitated by promotional techniques like the provision of information in various ways (Abrahamse et al., 2005).

Standard analysis sees pro-environmental behavior, i.e. voluntary contributions to a public environmental good or natural resource, within the context of social dilemmas. Traditionally, the private provision of a public good fails due to its characteristic of being non-rival and non-excludable. Selfish individuals have no incentive to contribute, and may free ride on its provision. However, from a behavioral economics perspective, concerns about social preferences and self-identity can lead to voluntary contributions to an environmental public good. Not only are these motivations important for purely social dilemmas but they may generally influence consumer decisions about buying and using goods and services (with environmental impacts).

Studies assessing additional motives for behavior use empirical data on household energy use (Clark et al., 2003; Menges et al., 2005; Kotchen and Moore, 2007) or recycling activities (Ackerman, 1997; Berglund 2006). For instance, Kotchen and Moore (2007) analyze the motivation of households to participate in green electricity programs using empirical data from the US. Presenting a theoretical framework which covers different participation mechanisms for green electricity programs, their results show that households which have a greater concern for the environment or stronger altruistic attitudes are more likely to adopt green electricity. Similarly, Clark et al. (2003), in a study of Dutch households, investigate the influence of internal (altruism) and external variables (demographics) on household participation in green electricity programs. They also find that a high intrinsic motivation and values like altruism may explain early adoption of green electricity. Another study by Menges et al. (2005) is worth mentioning. It performs an experiment instead of an empirical analysis to test for the presence of "warm glow" motivation when adopting green electricity programs. The authors conclude that people receive benefits from solely contributing to environmental quality when participating in a green electricity program. Recycling and waste disposal at household level is costly, i.e. messy and time consuming. Households might not be aware of the social benefits gained through proper waste management because they are hardly noticeable, which makes free riding more likely. Individual moral and social motives for recycling activities are important determinants of people's willingness to pay for sorting waste. These motivations

significantly lower the costs associated with household recycling efforts which will affect the adequate regulatory policy. Brekke et al. (2007) analyze recycling of household waste as a prime example of voluntary contribution to a public good, since collecting and recycling are costly and any environmental benefits resulting have a clear public good character, i.e. are non-rival and non-excludable, and are hardly noticeable to the household itself. In an empirical study conducted in Norway it is found that civic duty orientation is an important motive for recycling behavior. Ackerman (1997) found that altruistic considerations dominate in collection and recycling efforts undertaken by households. Similarly, Berglund (2006) shows that people may derive positive "warm glow" feelings by contributing to a better environment through recycling. Halvorsen (2008) uses empirical data on recycling activities by Norwegian households to study how social and moral norms affect their utility. Norm-based incentives like feelings of self-respect and "warm glow" turn out to contribute significantly to recycling efforts.

Some studies include psychological factors like status or behavior by others in their analysis of environmentally relevant behavior. Ek and Söderholm (2008b) do this in a study of electricity use, and Johansson-Stenman and Martinsson (2006) in a study of car purchase. The latter study acknowledges that the status effect is difficult to disentangle using consumption data for goods and thus it is not always clear how important status is when making consumption decisions. Ek and Söderholm find that a choice between green and other electricity is determined not only by economic factors but also by the presence of status behavior and relative positions. Their analysis shows that self-image is affected not only by the behavior of others but also by the purchase of green goods. Such findings are in line with Bénabou and Tirole (2006) who suggest that people undertake activities to highlight their good traits, such as pro-social activities, in particular pro-environmental behavior.

Experimental evidence from common-pool resource and public good games supports the influence of, amongst others, reciprocity, fairness, social norms and self-identity concerns within the framework of social dilemmas. Behavioral economics suggests that the establishment of conditions under which people cooperate and show reciprocity behavior can solve social dilemmas (Fleishman, 1988; Ostrom, 1990; Brown and Stewart, 1998). In particular, field experiments associated with common-pool resources such as fisheries and forests confirm the importance of these issues in natural settings (Velez et al., 2008; Cardenas et al., 2000; Cardenas and Ostrom, 2004; Rodriguez et al., 2008). Other examples are reciprocal behaviors found in the context of blood donations (Titmuss, 1970), contributions to a social fund (Frey and Maier, 2004), and employment relations (Gneezy and List, 2008) (see also Section 2.2). Only a few natural field experiments investigate the role of reciprocity within a specific environmental context. For example, Alpizar et al. (2008) offer an analysis of the importance of reciprocity for voluntary contributions to a national park in Costa Rica using a natural field experiment. They find that reciprocity behavior induces more people to contribute financially to

the park. Their results highlight that information about the determinants of voluntary contributions can assist in the design of strategies and policies aimed at increasing contributions to the financing of public goods. Biel and Thøgersen (2007) review motivations for submitting to environmental compliance, like social norms supporting cooperation behavior.

2.4.2 Environmental valuation and individual decision-making

There is a considerable literature on the monetary valuation of environmental goods. Two important reasons for undertaking valuation research are to inform policy makers about the value of non-market goods and the size of environmental externalities. Several studies have connected valuation research approaches or outcomes to behavioral economics. This involves examining responses to contingent valuation surveys, including potential psychological biases and social preferences For example, experimental evidence reported by Kahneman et al. (1990) supports the endowment effect, a decision anomaly of expected utility theory, as a reason for response behavior in valuation studies. Here, a reference position shapes preferences, that is, the value of a good is affected by ownership. Evidence for the importance of other-regarding preferences is provided by Kahneman and Knetsch (1992) who found that an individual's contribution to a public good makes them feel good, something they referred to as "purchase of moral satisfaction", leading to a gap between stated willingness to pay and real economic preferences.

The role of preference anomalies in contingent valuation studies and other preference elicitation methods questions the validity of cost-benefit analysis to inform public policy. If revealed preferences deviate from rational choice theory, then cost-benefit analysis using results from monetary valuation studies, which assume rational agents, might be misleading. In order to assure robust results from cost-benefit analysis it is suggested to either "uncouple" cost-benefit analysis from the assumption of preference coherence (Sugden, 2005)[4] or incorporate "suitable controls" for the type of errors that may arise (Braga and Starmer, 2005). Neither of these proposals, however, seems to have been very well elaborated yet. A more radical alternative is rejecting cost benefit analysis and replacing it by multi-criteria analysis or participatory approaches (see for example, Munda 2004). These evidently are not free of criticism either.

We do not offer further details here as unlike the other intersections of behavioral and environmental economics, this one has been covered quite well in recent reviews. Johansson-Stenman (2002) and Hanley and Shogren (2005) provide surveys of the evidence of anomalies and their impact on preference elicitation methods and cost-benefit analysis. For a summary of field data on preference inconsistencies and their impact on US policy makers see List (2005).

[4] Sugden (2009) concludes that values based on hedonic prices may be less susceptible to WTA/WTP disparities than values obtained with stated-preference methods.

2.5 Implications of bounded rationality and limited self-interest for environmental policy theory

Several authors have attempted to use alternative models of individual behavior to provide a foundation for the theory (or theories) of environmental policy and institutions (Ostrom, 1990; Sanstad and Howarth, 1994; Norton et al., 1998; van den Bergh et al., 2000; Shogren, 2002; Vatn, 2005). Early experiments in environmental economics on environmental valuation, public goods and the Coase theorem (Bohm, 1972; Hoffman and Spitzer, 1982; Brookshire, Coursey and Schulze, 1990), as well as more recent research (List, 2006; Shogren and Taylor, 2008), explore specific behavioral anomalies in relation to environmental policy.

We consider environmental policy under a range of behavioral assumptions, consistent with findings of behavioral economics as documented in previous sections. Inspired by Hahn (1989), who investigated whether the patient (environmental policy) followed the doctor's advice, this Chapter aims to examine if the doctor (environmental economics) is prescribing the right medicine (i.e. using correct behavioral assumptions).

2.5.1 General policy insights

This section addresses the question of the implications that observed bounded rationality and other-regarding behavior have for the design of environmental policy. Only a few studies have devoted explicit attention to this. Shogren and Taylor (2008) define a new, behavioral environmental second-best problem. That is, they regard bounded rationality as a type of market failure which needs correction through public policy. Environmental policies should thus be considered to correct not only for traditional market failures but also for behavioral or rationality failures. Environmental policy should, then, generally be designed in such a way that it corrects for both market failures (environmental externalities) and behavioral failures. For example, regarding firm behavior, Venkatachalam (2008) notes that status quo bias can explain lobbying activities by polluting companies. They prefer the present situation and prefer to stick to inefficient command-and-control policies instead of having their emissions controlled through more efficient, market-based instruments. These observations imply a less optimistic view of efficient policy than neoclassical economics.

Inconsistencies and biases due to heuristics in individual decision-making can lead to inconsistent evaluation of public policy. In particular, framing effects are relevant for the evaluation of tax policy (McCaffery and Baron, 2006). Nash (2006) analyzes the effect of framing on environmental policy choice by the policy-maker, and indirectly by society and its various stakeholder groups (consumers, voters, business community, environmental NGOs). He finds that framing effects affect public perception of and reaction to the choice of command-and-control policies over market-based instruments. For example, market-based instruments

give the "right to pollute" rather than take it away from polluters (i.e. before regulation they implicitly had a right to pollute). This means they are framed as creating an environmental loss. In order to reduce such biases, he suggests educational measures or changes in the way a regulatory instrument is framed. For instance, when framing a tradable permit system, permits might be referred to as "emission penalty" rather than "right to pollute". Löfgren and Nordblom (2006) present a formal analysis answering the question how consumption of a habitual good, which causes a negative external effect on the environment, affects environmental taxation. They find that the magnitude of tax rates is affected by habit formation. A stronger habit tends to increase consumption, so the optimal correcting tax should also be increased. Johansson (1997) analyses behavior driven by social preferences and environmental taxation. More specifically, he studies the effects of different kinds of altruistic behavior on the design of a Pigovian tax to correct for an externality. He finds that altruism affects the size of the tax.

Theoretical studies have examined the environmental regulation of household consumption behavior in the presence of status effects and relative positions (Hirsch, 1976; Howarth, 1996; Brekke and Howarth, 2000; Brekke et al., 2002). Howarth (1996) presents a theoretical analysis of the relationship between status, consumption levels and environmental degradation. He modifies preferences by incorporating status effects into a standard model of pollution. Status has a positive effect on consumption. In order to arrive at a social optimum, consumption taxes are needed in addition to environmental taxes. For environmental policy, this really means that Pigovian taxes should be adjusted upwards in the presence of status effects (see also Wender, 2005). Brekke et al. (2002) evaluate the Hirsch (1976) hypothesis, i.e. status seeking increases consumption at the cost of environmental degradation. They conclude that this only holds true when status is defined as the difference between one's individual consumption and the average consumption of society, and if status and non-status goods are poor substitutes.

Standard criteria for policy instrument selection are economic efficiency, effectiveness and equity. Behavioral failures and other-regarding behavior will affect the performance of environmental policy instruments on these three criteria. This is qualitatively assessed in Table 2.3 by combining the four types of behavioral features discussed in Section 2.2 with the three policy performance criteria. Although it is not possible to make definite statements in this respect, due to a lack of systematic research on policy performance under bounded rationality and other-regarding behavior, a few general speculations can be offered here. Generally, performance in terms of efficiency and effectiveness can be expected to be weaker under bounded rather than perfect rationality. For example, economic policy instruments are based on the assumption that desirable changes in behavior can be achieved by providing monetary incentives. But if agents are boundedly rational or act in accordance with social motives, economic incentives may have not the intended effect on behavior, reducing policy effectiveness. Moreover, if individuals are not reaching their individual optimum or efficient

outcome due to bounded rationality, society as a whole is unlikely to arrive at a socially optimal outcome. On the other hand, institutions and policy instruments that stimulate social preferences like reciprocal behavior might improve the effectiveness of policy. It is difficult to make general statements about the equity implications of policy under bounded rationality and other-regarding preferences. One possible effect is that other-regarding preferences imply that individuals may be more concerned with equity and fairness. This in turn can lead to individual outcomes (in terms of welfare or utility) under environmental regulation being more in line with one another than without such inequity-averse preferences. A more equitable welfare distribution may then result. This holds even more so if the policy is designed to recognize and reflect these preferences.

Bounded rationality in an intertemporal choice setting, in particular hyperbolic discounting, means that long-run outcomes receive greater weight, which can stimulate more equal intertemporal welfare distribution. The same result might hold true for decisions in line with Prospect theory regarding long-run impacts of environmental change characterized by small-chance/high-impact scenarios. Judgment biases might have little effect on equity or a small positive effect if they result in less perfect, selfish decisions, so that the outcome is a less polarized welfare distribution, i.e. a move to the mean. Note that in the table we assess judgment biases as having a relatively severe impact on policy performance with regard to efficiency and effectiveness, because these biases basically affect every decision being made by individuals and because there are so many judgment biases around. This is not to deny that in a long-run context climate change and policy performance might be more severely affected by boundedly rational decision-making related to risk and uncertainty and intertemporal choice. Finally, the combination of various behavioral features like those listed in the first column of Table 2.3 may mean not just an addition of specific effects on policy performance, but possibly a synergy. For example, judgment biases combined with intertemporal choice may mean that the policy performance comes out worse in terms of efficiency and effectiveness than one would estimate based on adding performance failures for each separately.

Table 2.3 Change in performance of environmental policy when behavioral theories are accounted for.

	Efficiency	**Effectiveness**	**Equity**
Risk and uncertainty	+	+	0/+
Intertemporal choice	+	0/+	0/+
Judgment	++	++	0/+
Other-regarding preferences	0/+	0/+	+

Note: Signs denote changes relative to (policy under) traditional theory with rational, self-regarding agents: "+" better performance, "++" much better performance and "0" about equal performance

Behavioral research can inform consumer policy, accounting for cognitive biases and decision heuristics behind household decision-making. Consumers often do not react to price signals and do not take into account future (energy) costs because decisions are influenced by various biases. Alternatives to price-based regulation are as follows. To promote switching and pro-environmental behavior, green electricity should be presented as the default option to consumers and information cost should be lowered, e.g. through standardized electricity bills. Van den Bergh (2008) proposes many alternatives to price-based policies which might be effective under bounded rationality: technical and product-use standards, communicative instruments (education, public awareness campaigns, providing information) and making green alternatives like renewable energy, waste collection and "green products" more easily accessible or available to consumers. In general, better information and educational measures can have a positive effect on sustainable consumption behavior (Abrahamse et al., 2005). For example, concerning the adoption of green energy Ozaki (2009) finds that social information may be more important and successful than traditional regulation in informing consumer choices about innovative green products as these link up with identity and self-image attributes. This suggests communication of the benefits of adoption at an emotional and social level, where the latter relates to phenomena like comparison, imitation and status seeking. For diffusion of green products it is important to offer clear messages and create social norms and a critical mass through different types of communication channels. Insights from social marketing to encourage pro-environmental behavior may be useful here. Interventions by means of paternalistic-type policies can help boundedly rational consumers to make better decisions (Camerer et al., 2003). Examples of such policies are food content labels, warnings on cigarette packs or mandatory retirement savings. Although such policies may be seen as inconsistent with consumer sovereignty, they seem legitimate if consumer preferences are inconsistent with long-run sustainability (Norton et al., 1998).

Experimental studies of time preferences, habit formation, and self-control problems provide useful information about the effectiveness of different policies on quitting and changing habits, or even creating new ones. Examples can be found for health-related behavior (Gneezy and Rustichini, 2000; Hammar and Carlsson, 2001; Charness and Gneezy, 2008). Using experiments Charness and Gneezy (2008) perform a test of the effectiveness of different policy interventions to encourage the development of a good habit, such as going to the gym or quitting smoking. In particular, the effect of monetary incentives on fostering good habits or stopping bad habits is found to substantially increase the probability of stopping a bad, or starting a good habit. However, intrinsic motivations can potentially alleviate the effect of the intervention, as in some situations economic incentives can discourage such preferences (see Section 2.2.2).

Recent research stresses the importance of other-regarding preferences, like reciprocity, fairness, altruism and self-identity, for pro-social behavior. Social norms imply social rewards instead of behavior motivated by monetary incentives. This includes norms in favor of work habits or voluntary behavior. Some of the insights have relevance for environmental policy. For example, the principle of inequality aversion, which predicts that people dislike inequality, can be important for various policy issues, ranging from tax morals to environmental negotiations. In addition, the presence of reciprocity behavior can increase the effectiveness of policy. Alpizar et al. (2008) provide experimental evidence that if people receive a small gift before having to decide about contributing to a public good, this increases the number of people making a positive contribution. On the other hand those individuals who would contribute without a gift are relatively unaffected. Stimulating the social norm of reciprocity may improve the effectiveness of policy, i.e. increase the number of donations. Other insights emerge from compliance with norms shaped by whether one's behavior is publicly shaped or self-determined. For instance, Benabou and Tirole (2006) identify image-related rewards or punishment, like concerns for social reputation and self-image, as important drivers of pro-social behavior. A public good experiment conducted by Rege and Telle (2004) shows that social approval can considerably increase voluntary contributions to a public good. The authors suggest identity-revelation as a relevant policy for increasing cooperation.

From a policy perspective, the crowding-out effect of other-regarding behavior has important implications for the provision of public goods and management of natural resources. Several experimental studies have been conducted to provide evidence of the way that external interventions can undermine natural resource conservation (Ostrom et al., 1994). Crowding-out is not only limited to monetary incentives but also may result from rule enforcement, i.e. exogenously (externally) vs. endogenously (through self-organization) enforced (Bowles, 2008). These categories link to formal and informal regulation, respectively. For example, Cardenas et al. (2000) conduct economic experiments with local users of ecosystems and find that regulations imposed from outside a community can crowd-out social preferences in favor of greater self-interest. This suggests that external regulations may do more harm than good and may reduce social efficiency to lower levels compared to the case without any outside regulation. For policy it is also of interest to know whether economic incentives and social preferences are substitutes of any kind, in the sense that external incentives crowd-out social preferences, or sort of complements, meaning that specific incentives stimulate the appearance of social preferences (Bowles and Hwang, 2008). In summary, experimental evidence suggests that other-regarding motives may be affected by economic incentives and standard policy may therefore fail, or even be counterproductive when applied to environmental problems.

In Section 2.3 we briefly touched upon three themes related to behavioral economics, namely heterogeneity, evolution and happiness. Heterogeneity and evolution are closely

connected as evolutionary thinking involving a framework developed around the notions of diversity, population, selection, inheritance, innovation, coevolution, group selection, path-dependence and lock-in. This relates to an often misunderstood relationship between evolution and progress, where 'what is' is often confused with 'what ought to be'. However, the long-standing debate on evolutionary progress suggests that evolution has some elements of directionality and progress, although it is not identical with continuous progress, among other reasons because selection is a local search process and adaptation is a compromise between different objectives, due to historical constraints that limit evolutionary improvements, and because of the presence of coevolution, which means that the notion of optimization in a fixed setting is lost. Van den Bergh and Kallis (2009) consider evolutionary policies at two levels: institutional, i.e. policy change itself, and policy design. Central at the first level is the idea that political and economic environments impose selective pressures on alternative political strategies and that political agents adapt their strategies to this selection environment which is multi-dimensional (media, elections, public opinion, power and lobbying). Historical constraints or path-dependencies are relevant, leading to the notion of "policy paradigm", which reflects the fact that earlier historical events greatly influence and hamper political and institutional developments at a later stage. This view of evolutionary policy is most developed in the literature on innovation policy (Witt, 2003) and, more recently, analysis of transitions to sustainable energy and transport systems (Safarzynska and van den Bergh, 2010), but may also hold promises for environmental regulation given that behaviors are heterogeneous and interactive. It even allows for studying types of instruments other than traditional equilibrium analysis based on representative, rational agents. An example is a model by Nannen and van den Bergh (2010) which assumes that the fitness of an economic strategy is determined by the relative welfare of the associated agent compared to its immediate neighbors in a social network. This enables the study of policies affecting relative positions of individuals. Two innovative policies are analyzed, namely "prizes" or rewards, directly altering relative welfare, and "advertisement", affecting the social network of interactions. The study illustrates the fact that evolutionary analysis enlarges the scope of economic policy analysis. Finally, some of the main policy findings in the happiness literature, notably on status good taxation, have already been mentioned. These not only show that relative positions matter for the environmental impact of human behavior but also for human well-being. They underpin the relevance of environmental policy instruments like information or status taxes (Brekke and Howarth, 2002) that recognize or make use of such behavioral features.

2.5.2 Implications for climate policy

The most important current area of environmental policy making is undoubtedly climate policy, covering both the mitigation and reduction of emissions of greenhouse gases and adaptation to

climate change. Most current proposals for climate change policy rest on assumptions of rational behavior. Behavioral economics is particularly useful as an alternative basis for climate policy analysis, as it offers distinct views on decision-making under risk and uncertainty and in intertemporal settings. Few studies have so far addressed this issue (Gowdy, 2008; Brekke and Johansson-Stenman, 2008). We have summarized evidence here which indicates that climate policy as proposed might not work as efficiently and effectively as intended due to bounded rationality and other-regarding preferences.

The assessment of the psychological dimension of adaptation to climate change has been so far grossly neglected. Clearly, individual decisions about adaptation to climate change are influenced by psychological and cognitive factors, in particular concerning the evaluation of risk probabilities and risk perceptions. It is important to understand the determinants of decisions under uncertainty in order to improve individual risk judgment. The literature suggests that the effects of decision heuristics and cognitive biases on policy success can be profound. There is a fairly large literature on one particular cognitive factor, namely risk perception. Empirical evidence supports biases in risk perception influencing notably insurance and self-protection decisions focusing on natural disasters. For example, Viscusi and Zeckhauser (2006) assess behavioral responses in the realm of risk connected to climate mitigation actions. Some of the behavioral biases or irregularities they observe are "percent thinking bias", i.e. individuals having problems to perceive percentages correctly, and lack of accessibility of information, both leading to magnified estimates of risk. Similarly, Kunreuther et al. (2010) assess behavioral failures under uncertainty. They argue that individuals use simplified decision rules and fall back onto psychological strategies that depart from economic rationality, e.g. using heuristics such as underweighting the future, myopia in planning, underestimating risk, optimistic bias, and forecasting errors which limit people's ability to invest in hazard mitigation measures. Such failures to adequately perceive risks and process information may lead to inadequate levels of insurance and in turn to losses from natural disaster which could have been prevented. Inefficiencies that arise from decision making deviating from rationality assumptions in the realm of natural disasters can be ameliorated, among others, by the following policy measures: improving risk communication and implementing risk control mechanisms such as mandatory insurance (Viscusi, 1995); setting prior steps to disasters to ensure efficient behavior of those expose to the risk, such as regulations in the form of zoning restrictions (Kunreuther and Pauly, 2006); restrict voluntary choices and impose stricter regulations; and guide individuals to make more efficient protective decisions through readjusting insurance contracts and tax incentives (Kunreuther et al., 2010).

An interesting experiment providing information about how to improve risk communication is Wakker et al. (2007) providing experimental data on the effect of statistical information on risk and ambiguity attitudes and on rational insurance decisions. From a policy

perspective they recommend that in order to maximize the number of insurances taken, providing particularly individual cost information can increase adoption of insurance products. The first theoretical analysis using behavioral economics of the role of insurance in response to climate change risks is by Botzen and van den Bergh (2009). They take into account alternative theories of individual decision-making under uncertainty, namely Prospect and rank-dependent utility, to investigate whether there is a potential for a private market for natural disasters. This has important implications for climate policy as no insurance against natural hazards such as floods is currently available in the Netherlands, even though insurance might be a useful instrument to promote adaptation to increased flood risk. They test whether individuals are willing to pay for private insurance and estimate risk premiums for flood insurance under different climate change scenarios. This leads to higher WTP values than under expected utility theory assumptions. As a result, a private insurance market for floods in the Netherlands turns out to be feasible. Overall, making more realistic assumptions about individual behavior and decision-making can increase the relevance of insights for policy makers as well as for insurance companies.

Patt and Schröter (2008) examined decisions by farmers and policy makers to implement and adopt measures against the risk of flooding. Using quantitative and qualitative data, they found that farmers exhibit a status quo bias. This means that any adaptation action taken is likely to be avoided because decision and adaptation behavior is influenced by certain heuristics. Also policy makers were found to judge the seriousness and likelihood of climate-related events as greater than farmers living in the affected area. This difference in the risk perception of the two groups can be due to the use of mental shortcuts, as represented by the availability or representativeness heuristics (see also Marx et al., 2007). Grothmann and Patt (2005) include risk perception and perceived adaptive capacity as important cognitive constraints in studying adaptation decisions. For example, they find that individual risk perception of farmers deviates from objectively assessed risk which is in line with probability weighting theory. This means that they underweight large and overweight small probabilities. As a result, individual decision-making subject to such cognitive bias does not lead to optimal adaptation decisions. This in turn means that policies are enforced inadequately and can fall short of their intended goals. One solution suggested is to involve people not only in the process of implementing climate adaptation policies but also in designing them. In other words, a participatory mechanism might contribute to policy success. In addition, a broader model of human decision making by these authors suggests that policy makers remove any cognitive barriers to adaptation, for example, through better risk communication to improve adaptive capacity. The complete list of cognitive factors hampering human rationality (Table 2.1) and leading to decision biases indicates a large set of factors affecting adaptation decisions and

adaptative capacity. More research is needed to assess the magnitude of the various biases in order to design adequate (effective and efficient) policies.

Others have focused on explaining the psychological aspects of mitigation behavior, i.e. a reduction of greenhouse gases. Lange and Treich (2008) present a theoretical framework illustrating some implications for climate policy of in particular ambiguity on individual decisions making. While the majority of studies find that ambiguity reduces mitigation efforts, they show that ambiguity might lead to stricter abatement policies. Ambiguity is relevant to climate policy as experts disagree in their predictions of future climatic change and potential damage (although the large majority, united in IPCC, agrees about broad strokes of climate change). The authors assume an ambiguity-averse decision maker who deviates from the assumption of expected utility maximization and show that ambiguity aversion can cause decision makers to react to uncertainties regarding future damages by reducing emissions. Other insights come from studies analyzing effective communication of ambiguity, for example, on the basis of IPCC reports on the state of climate science to inform the international policy process. In this context, Kandlikara et al. (2005) recommend to incorporate definitive quantitative evidence if available while Risbey and Kandlikara (2007) suggest reducing linguistic sources of ambiguity. Notice that IPCC is very careful in its use of language related to uncertainty, such as “likely”, “very likely”, “more likely than not”, “likely in some regions”, etc.

Some studies have examined cognitive factors, including knowledge and feelings and their importance for public support concerning the reduction of greenhouse gas emissions. O'Connor et al. (2003) find that individuals who can more accurately identify the causes of climate change and who expect bad consequences from climate change are more likely to undertake voluntary actions and to support stringent government policy. Furthermore, cognitive variables such as knowledge of the causes of climate change better explain mitigation decisions like the purchase of energy-efficient appliances than economic variables do. Lorenzoni et al. (2007) study psychological barriers to behavioural change in the context of adopting alternative energy options. They find that a number of cognitive barriers hinder individual responses to climate change, including habitual use of cars, lack of knowledge, scepticism as a response to uncertainty, distrust in information sources, externalisation of responsibility (blaming others), and pressure of social norms. Similar to what was found for the adaptation literature, these results highlight the necessity for policy to manage and use communication mechanisms more effectively. One suggestion from this study is to better meet the need for basic information in a (more) credible and transparent way. This may include using social marketing techniques to create awareness, acceptance and norms in respect of climate change action among social groups and their networks. More credible communication can also be realized through conveying climate change solutions more personally, that is, by emphasizing and reinforcing the connection between personal action and impact on the climate. Education in schools, books and

newspaper can play a major role in facilitating a social change by creating appropriate knowledge and norms. In addition, interventions can be designed to interrupt habitual behaviours and to encourage consideration of green alternatives (e.g., stimulating public transport).

The discussion in Section 2.5.1 about framing and how policy makers, researchers and the public differently frame and interpret climate change problems and how this in turn affects individual mitigation decision is explored by Yarnal et al. (2003). They did a survey where global warming was once framed in terms of the local impacts and once in terms of the national impacts of taking mitigation measures. Respondents' willingness to support government policies turned out to be significantly different between these two frames, and also the level at which they are willing to take voluntary action differs. Different frames can lead to different responses from individuals. This has implication for the use of local and national scenarios for communicating climate change. In particular, there seems to be an added value of downscaling mitigation scenarios to local measures and strategies. In other words, translating and framing climate change as a local issue can enable the public to work with this problem in a local context. Framing it as a national or global issue, the dominant approach right now, may make it more difficult for individuals to understand why climate change may be relevant for them personally or for their local community or city. Against this background, the campaign Cities for Climate Protection (CCPC) (Lindseth, 2004) which has taken the local level as the relevant geographical space for climate protection may be an effective approach to organize responses to climate change. Not only spatial but also other frames such as those relating to time dimensions may affect responses to climate change. Time framing means that information about weather and climate (change) can be provided on a daily, weekly or monthly basis. The time factor may be especially relevant for responses by farmers and insurancers.

The question how people trade off the cost and benefits of future consumption is of crucial importance to long-run environmental problems like climate change. Environmental conservation is determined by time preferences, i.e. preferences for current versus future states. Behavioral economics suggests hyperbolic discounting, implying that future cost and benefits receive greater weight than under the traditional assumption of exponential discounting. This generally results in a stronger support for stringent, safe climate policy and project choices more in line with long-run sustainability. Hyperbolic discounting in relation to climate change has been discussed by Arrow et al. (1996), Dasgupta et al. (1999), Howarth (2003), Settle and Shogren (2004), Karp (2005), and Brekke and Johansson-Stenman (2008).

Climate protection can be regarded as a large-scale social dilemma, as it involves a global public good (the atmosphere or climate conditions). The study of climate negations and voluntary cooperation therefore involve features of public goods as well. However, much of this research excludes other-regarding preferences, including fairness, reciprocity and social

approval, and instead assumes self-interested motives only. Especially the interaction of particular risks and social preferences has been neglected. A rare experimental study of this interaction is Hill and Buss (2010). They find that positional and status concerns can reverse the well documented certainty effect. In other words, concerns for relative positions can lead to increased risk taking. This insight highlights the relevance of the connection between social preferences and preferences for risk where social comparison may stimulate risky behavior. Other experimental research has found that agents in climate negotiations hold social preferences. Dannenberg et al. (2007) used data from interviews with policy makers to find that they have a strong equity preference in climate negotiations, which can explain cooperative behavior observed in international climate negotiations. Lange and Vogt (2003), in a game theoretical approach, argue that fairness orientations, i.e. preferences for equity, can serve as an explanation for countries signing environmental agreements. The strength of social preferences can be important for the design of incentives and institutional institutions for negotiations (see, Fehr and Falk, 2002 analyzing principle-agent relationships). For instance, the desire to reciprocate or gain social approval through voluntary actions in the context of climate negotiations should be recognized and perhaps stimulated. Alpizar et al. (2010) using a framed field experiment study the effect of risk and ambiguity on farmers' willingness to cooperate when adapting to climate change. It was found that in particular communication improved coordination under ambiguous conditions and lead to reduced adaptation costs.

In addition, material incentives, social rewards and punishment might be an option for increasing cooperative behavior. Indeed, price based instruments such as emission trading may not work effectively when other than price factors influence market behavior. Experiments discussed in Section 2.2.2 show that cooperation can be established if a punishment opportunity, such as an incentive in form of social disapproval, exists. Besides material punishment, social disapproval can lead to more cooperative outcomes compared to situations with incentives that are due to formal regulatory policy. Thus, in order to improve the effectiveness of a bargaining system Brekke and Johansson-Stenman (2008) suggest introducing an institutional structure involving punishment and sanctioning mechanisms to leverage reciprocity norms and cooperation. This will benefit the equity outcomes of negotiations and improve the effectiveness of a bargaining system.

The existence of other-regarding preferences is not only relevant to climate agreement negotiations but also in the context of individual emission reduction through more stringent climate policy in areas like transport, energy and consumption. The reason is that other-regarding preferences, like social norms, intrinsic motivation, and altruism, can lead to voluntary environmentally responsible behavior (see also Section 2.5.2). Rauscher (2006) presents a theoretical model analyzing the effect of imposing an emission tax on voluntary cooperative behavior. He finds that behavior motivated by social motives and intrinsic

motivation may be undermined by the implementation of a standard policy instrument originally designed to affect self-interested individuals. This is in line with the wider literature on regulatory policy crowding-out intrinsic motivations. Clearly, the introduction of a regulatory tax may, overall, reduce voluntary abatement efforts and, in the worst case, even lead to an increase in emissions.

Two examples of non-pecuniary incentives having a significant impact on behavior and climate protection relate to status and social norms. Recent experimental research shows that potential gains from social reputation act as a strong incentive for investing in climate protection measures. It is found that individual investments in climate protection are highest if subjects are aware that their investment decision is made public, hence giving room to social reputation effects (Milinski et al., 2006). In the context of climate policy, effective public disclosure mechanisms can take the form of publicizing GHG emissions and people's energy usage or placing stickers on environmentally pollutive cars (Novak and Rand, 2009). An empirical example comes from the City of Austin, which during a period of drought decided to publicize information about the highest water use by private homes. This form of public disclosure substantially decreased water consumption (McKinley, 2008).

Reputation effects can also be important for the purchase of green products. Griskevicius et al. (2010) argue that buying a green product may enable an individual to signal pro-social behavior to others. Activating status or self-image concerns might therefore lead people to engage in "conspicuous conservation". This hypothesis was examined in an experimental study that analyzed the influence of status on the choice of non-green and green products. In view of this, green products might be advertised in a way that links them to status attributes. For instance, the visibility of status-enhancing acts can be promoted by using badges, signs or tags so that individuals can display their pro-social acts. An experimental study by Alpizar et al. (2005) estimated the degree of positionality for a range of goods finding that even insurances are prone to relative concerns and positional effects. For climate adaptation this could mean that marketing of insurances through activating status might be an effective strategy to increase adoption of insurances and self-protection.

Another powerful driver of human action is social norms and social pressure. Research in social psychology by Cialdini (2003, 2007) suggest that communication employing social-norm based appeals to elicit pro-environmental behavior can sometimes be superior to traditional mechanisms such as price changes, probably within limits. Their argument is that social influence aimed at complying with social norms leads to two distinct benefits: maintenance of social relationships and of a favourable self-image. Behavior by others can be a strong personal motivation to spur compliance with environmental responsible behaviour. Therefore, social cognitive factors deserve greater attention in environmental policy design. For example, Ayers et al. (2009) illustrate that peer pressure can be successfully used to promote

energy conservation. Using field experiments they show that if individual behavior is compared with conservation practices of neighbours, people can be persuaded to reduce emissions and energy consumption. It is found that those who are provided with information about the energy conservation of their neighbours are more likely to conserve energy themselves. They suggest that mechanisms like peer comparison and feedback, benchmarking, and ranking can contribute to stimulating socially desirable behavior.

Nannen and van den Bergh (2010) is a rare study which combines behavioral economics (bounded rationality and relative welfare) and evolutionary or population interactions between individuals in order to study climate policies affecting the choice between investment in fossil fuel and renewable energy technologies. As discussed in the previous section, this model employs two new types of instruments, namely "prizes" and "advertisement", which are compared in performance with traditional environmental externality taxes. The new instruments have the advantage that they stimulate the spread of information and network formation in a world characterized by imperfect information and bounded rationality. Similarly, Schwarz and Ernst (2009) combine empirical data with agent-based modeling in studying the diffusion of water-saving innovations in Germany. Besides recommending strong regulations for the adoption of such innovations, they suggest that information campaigns using different types of public information channels can support the diffusion of such sustainable innovations. Hence, communication strategies influencing social networks may be a complementary policy strategy to diffuse innovations.

Policy lessons from the happiness literature suggest that, as a result of an income threshold above which happiness is at best weakly correlated with income (Easterlin, 1974), stringent climate change policies in developed countries might not have the intended strong, negative effects on individual well-being as predicted by standard economics (Sekulova and van den Bergh, 2010). This threshold effect is due to basic needs being satisfied, the presence of relative welfare effects, and people's tendency to adapt to changing circumstances. The latter would mean that individuals are capable of adapting to new circumstances and after a brief transition period will approximate or restore their original well-being level (Cohen and Vandenbergh, 2008). However, this will not occur with regard to all changes. Especially extreme climate change may affect feelings of security and basic needs of people, notably in developing countries, which is likely to negatively affect well-being. All in all, happiness research seems to suggest a more stringent, precautionary climate policy than traditional economics informed by classical cost-benefit analysis (van den Bergh, 2010).

Based on the results and arguments in this section, we suggest to adapt and complement regulatory climate policy in three ways: (1) ameliorate decision biases or errors relating to decisions under uncertainty, risk and ambiguity, common to the context of climate change, through corrective policy; (2) develop non-pecuniary strategies to trigger social preferences and

include social context aspects in communication strategies to encourage pro-environmental behavior; (3) be aware of geographical and temporal framing effects in designing policies and communicating information.

2.6 Conclusions

Standard economic theory assumes that individuals are fully rational and act in a self-interested manner. This has provided a very clear perspective on what efficient and effective environmental policy entails. Evidence from psychology and economics has enhanced our understanding of how people behave and make certain decisions. It turns out that observed behavior, notably in experiments, deviates from rational behavior or at least challenges its strong assumptions. In response, behavioral economics has developed alternative explanations for, and theories of, economic behavior. In particular, bounded rationality and other-regarding preferences are psychological regularities which alter the design of effective and efficient policy. This research stresses the relevance of behavioral anomalies and social motivations affecting individual decision-making in a wide range of environmental contexts ranging from energy decisions by households to negotiations for an international climate agreement. By assuming a more realistic picture of individual behavior, behavioral economics makes it possible to draw robust environmental policy conclusions under conditions of bounded rationality and other-regarding preferences.

Boundedly rational agents are unable to make optimal decisions, which has implications for many aspects of environmental policy design. This covers a wide variety of issues, such as the effectiveness and efficiency of environmental regulation including the use of economic (market-based) instruments, the consistency of sovereignty of preferences and paternalistic policy with long-run sustainability, specific policy framing to improve policy success, and recognizing adaptation (in well-being terms) to changed circumstances like higher energy prices. An important finding of behavioral environmental policy analysis is that policy should go beyond price-based regulation or market-based instruments; that is, it should not place its trust only in price signals – without denying that the latter are an essential part of many good, effective policies. From an environmental welfare perspective, more competition in retail markets might not be enough to encourage a behavioral change towards a sustainable transition, such as the large-scale application of green alternatives (e.g., renewable energy technologies) but rather requires additional polices. For example, presenting green alternatives as the default option for consumers, lowering information costs (deliberation, information, marketing campaigns, and education) and increasing taxation on status and habitual goods with high environmental impacts can have a positive effect on sustainable consumption behavior. This holds true for environmental polices seeking to stimulate behavioral change in everyday,

habitual activities with environmental significance. For example, using higher fuel prices in an attempt to change transport behavior might not be enough to break bad habits or even to establish and create pro-environmental habits. The formation of good habits may be encouraged by monetary incentives, but, if intrinsic motivations are strong, such incentives can be counterproductive. Even though some policies of this kind may be seen as inconsistent with respecting consumer sovereignty, they seem legitimate if consumer preferences are inconsistent with long-run sustainability. Indeed, in other areas like public health (smoking, sexual behavior, driving behavior), consumer preferences are not taken for granted as public policies are aimed precisely at changing them.

The review suggests that not all economic decisions can be reduced to self-interested consumer choice. Economic psychology supports the existence of social norms contributing to voluntary environmental behavior, i.e. consumers' pro-environmental behavior being founded in altruistic preferences, moral motivation, social duty orientations and other social preferences. Empirical evidence indicates that consumers are sufficiently altruistic (pure or impure altruism), care about the expectations of others (status and conformity) and hold general concerns about their social responsibility. Policy strategies can include the stimulation of social preferences, for example, to foster voluntary environmental action and agreements. Effective policies to address these situations include social rewards and punishment mechanism, such as the activation of citizen duty through social punishment (social stigma), and information channels including the media, marketing campaigns and education, through which social norms can be mediated and linked to a variety of environmental externality problems. This may have implications for equity preferences and international environmental agreements. In particular, social punishment and reward mechanisms put in place can improve the effectiveness of international climate policy negotiations.

As the purchase of "green goods" is strongly connected to self-identity concerns, meaning that commodities may serve to communicate or reinforce one's self-image to others, the revelation of identity and information about the behavior or expectations of others (conformity) may have some impact on "green consumer behavior". The mechanism behind these norms is not fully understood and there is more to learn concerning the formation and stability of voluntary environmental preferences based on social norms in order to inform environmental policy.

Next, an important finding of norms and rules in social dilemma situations is that externally imposed, formal regulation can reduce or completely destroy informative, voluntary and often evolved cooperative behavior, notably in common-pool resource situations. Such regulatory policies may then perform poorly or even become counterproductive. The reason is that such policies do not take into account social interactions that influence an agent's behavior. Indeed, much can be gained by activating social motives like fairness, reciprocity or moral duty

in support of cooperation. Policy can be linked to stimulation or activation of norms through trust, communication, social interaction and contribute to the formation of preferences supporting cooperation. For instance, the stimulation of reciprocal behavior can increase donations to public goods. Linking policy to a variety of social, non-selfish and other-regarding preferences can "crowd-in" and stabilize rather than "crowd-out" voluntary environmental behavior. Other policy strategies involving social interactions between individuals include more intense self-regulation (informal rules) due to reciprocity and repeated interactions and the support of participatory mechanism in the design of adaptation strategies to climate change. Not only the presence of these sentiments but also the incongruence of social preferences with existing institutional structures like property rights needs to receive attention in policy design. This also serves as an explanation for the existence of many environmental conflicts around the world, whereas traditional economic theory suggests that Coasean solutions in the negotiation between polluter and victim would be more common.

A final conclusion is that behavioral theories have important implications for climate policy. Decisions relevant to climate change are made under conditions of uncertainty where cognitive and psychological constraints influence individual risk judgments about the probability of outcomes and extreme events. Incorporating more realistic assumptions based on evidence that individual decisions on particularly adaptation measures rely on heuristics can improve the design of incentives and institutions, such as those promoting natural hazard insurance. Other policy recommendations are the implementation of effective risk communication practices and participatory mechanisms in order to improve the decision-making capacity of individuals and organizations regarding appropriate adaptation measures. Like cognitive issues, other-regarding preferences and social norms affecting environmental decision-making have been sporadically addressed in the analysis of climate policy. Only a few studies have considered these issues in the context of climate negotiations. Institutional arrangements accounting for behavioral and social features of individuals are necessary to overcome large scale collective action problems such as climate change. Our proposal is that regulatory climate policy includes corrections to ameliorate decision biases relating to decisions under uncertainty, is extended with non-pecuniary strategies to encourage pro-environmental behavior and accounts for geographical and temporal framing effects in communicating information about policies.

2.7 Potential research avenues

The recent import of insights from behavioral economics into environmental economics means that there are still many unresolved issues. We therefore end this Chapter by listing some suggestions for further research.

Research on sustainable consumption and pro-environmental behavior needs to address the question which combination of pecuniary and non-pecuniary instruments works most effectively in terms of reducing environmental impact of household and individual behavior. In designing and evaluating the effectiveness of non-pecuniary policy strategies aimed at communicating the individual and social benefits of pro-environmental behavior, it may be useful to examine what can be learned from social marketing approaches which can stimulate reputation effects in social networks to create responsible environmental behavior. In addition, experiments with an explicit environmental setting can be aimed at examining the impact and effectiveness of a variety of incentives – working through reputation, approval and fear – on people's willingness to behave pro-environmentally, choose green products or invest in adaptation to climate change. The assessment of policy effectiveness should further take into account potential (energy or environmental) rebound effects, which possibly may arise when attention in policy shifts from regulation to information provision and moral suasion. The outcome of such considerations may improve our insight on the right balance between the various instruments.

Efficiency has been the dominant criterion for evaluation and comparison of policy instruments in environmental economics. Since social efficiency (or more limitedly, cost-effectiveness) depends on individual efficiency, which is lower in the case of bounded rationality, the efficiency evaluation of policy needs possibly to be adapted or at least done with more care for cases where bounded rationality matters. Taking a broader perspective, Table 2.3 provided a qualitative assessment of the consequences of the various classes of behavioral features identified in Section 2.2 on core policy criteria, including also equity. Further research is needed to arrive at a more definite judgment on this.

Another potential research avenue is the role of status-seeking behavior in the consumption of goods and services with a relatively high contribution to environmental pressure. Somewhat related is the role of (social) marketing in stimulating such consumption, and how potentially misleading information can be controlled or countered with beneficial impacts in terms of both reducing environmental pressure and improving individual well-being. This is the negative side of status-seeking. On the other hand, status feelings might be employed to stimulate the adoption of cleaner products and services, such as hybrid cars. Research on this is lacking.

Regarding the link between monetary valuation and policy, it is relevant to understand what bounded rationality means for biases in valuation of environmental externalities, and in turn for the formulation of externality regulation through (optimal) charges or levies, as well as for the formulation of monitoring-and-control through the setting of fine levels. At least we should try to get a general idea about whether biases are upward or downward under certain conditions or for specific types of environmental problems.

Many of the general policy insights can be immediately transferred to climate change, while the latter also provides specific problems and instances of behavioral issues and in turn specific problems for the design of climate policy. The impact of ambiguity of climate change and its consequences evidently needs more research and some of it is already underway. The role of bounded rationality in the formation of international climate agreements might receive more attention, to arrive at realistic views on the limits and opportunities for agreement-making. Another relevant topic is the impact of social context and information about low-probability/high-impact scenarios on adaptation decisions, such as the purchase of insurances, which has received only sporadic attention so far.

Chapter 3.

Dirty advertising? Consumption norms, status sensitivity and environmental policy *

3.1 Introduction

The standard economic theory of environmental policy assumes that individuals make decisions about consumption given fixed preferences and in isolation of what others consume. In the presence of environmental externalities this gives rise to the standard economic theory of optimal environmental policy with a Pigouvian tax as the basic result (Baumol and Oates, 1975). Although this may be a logical first approximation, and a sufficiently accurate approach for certain types of consumed goods and services, a more realistic model for many other types of consumption needs a richer structure. Notably, certain types of consumption are conspicuous and associated with an intensive commercial advertising effort as well as considerable pollution during the life-cycle of the good or service involved. However, the traditional policy model neglects the social context of individual behaviour and strategies by firms and governments to influence individual preferences. In other words, feedback from the system as a whole to individuals, apart from market or price information, is absent, causing individuals in the model to be sort of "isolated".

The objective of this Chapter is to develop a model of environmental policy that includes interactions between individuals through a consumption norm and the impact of advertising on consumption through this norm. This captures the idea that consumption is socially conditioned. The norm is not necessarily a social norm in the sense that it directly and only depends on others' consumption. It can also be motivated by information about products as provided by advertising. As such information affects everyone, or a sizeable social group, one might see it as a social norm as well. In addition, our model will be shown to be able to accommodate an alternative interpretation of advertising impact, namely fostering the seeking of social status through the purchase of conspicuous goods and services.

Conspicuous consumption is the use by consumers of socially visible goods to achieve and demonstrate social standing or status (Hirsch, 1976). Typical conspicuous goods are luxury cars, jewelry, fancy homes, furniture and holidays while certain types of clothes, food and beverage (e.g. wine) can also serve to display wealth and prosperity. For example, the role of

* This chapter is based on a manuscript under review. Wouter Botzen gave valuable comments on an earlier draft of this manuscript.

conspicuous consumption decisions about cars is analyzed by Johansson-Stenman and Martinsson (2006). They find that consumers generally are more concerned with the status value of a car than any other factor. Our modelling study is inspired by this growing empirical literature which reveals the importance of conspicuous goods.

Advertising messages in various media – television, radio, newspapers, magazines, and increasingly internet – is an integral part of modern life and stands in stark contrast with the scant attention advertising has received in general economics, including environmental economics. Notable exceptions are formal approaches by Dixit and Norman (1978), Becker and Murphy (1993) and Brekke and Howarth (2002, Chapter 4)[1]

The neglect of advertising in economic theory and textbooks is surprising given that it relates to imperfect information and information asymmetry which generally have received much attention in economics. A possible explanation is that since advertising operates under the assumption of variable and even endogenous preferences, economic analysis has been unable to fit it within the standard model of consumer behaviour.

Behavioural economics offers various social interaction models which provide a good basis for studying the individual and social welfare effects of advertising. Past empirical and experimental research has provided strong evidence that welfare is affected by social context variables (Easterlin, 2001; Fehr and Fischbacher, 2002). This may take various forms, related to concepts like relative welfare, status, imitation, conformism, altruism and norms. Relative welfare denotes that the utility of individuals depends on their relative income position, that individuals compare their economic situation with that of others, seek conspicuous consumption, and are sensitive to status (Duesenberry, 1949; Veblen, 1899; Hirsch, 1976; Frank, 1985; Weiss and Fersthman, 1998). Related notions are conformity bias and imitation behaviour which denote that some individuals will (sometimes) conform to choices made by the majority of people in a peer group (Henrich and Boyd, 1998). The widespread nature of customs fashions testifies to the strong desire in humans to imitate others and conform to the most common consumption behaviour of the group. This supports the view that consumption norms matter for consumer choices, that is, the value of a product is a function of the number of other consumers consuming it. A consumption norm may determine not only what to consume (e.g., norms about dress codes) but also how much of certain products and services should be consumed (e.g., food portions, possession of household appliances, frequency of holidays).

[1] A range of broader studies has devoted attention to notions like conspicuous consumption, status, "overconsumption", manipulation of perceptions and preferences, and dynamic preferences, and have recognized or criticized the role of advertising in modern economies. The best-known ones are Galbraith (1958), Kaldor (1950), Hirsch (1976), Scitovsky (1976), Daly and Cobb (1989), Frank (1999) and Schor (1999). Other relevant studies are Nelson (1974), Norton et al. (1998), Rubin (2008) and Witt (2011). None of these have, however, provided an in-depth, formal analysis of advertising.

Corneo and Jeanne (1997) show in a theoretical model that consumption norms generated by private firms are not always socially optimal, despite generating private profits. They note that consumption norms are mediated by marketing strategies like penetration pricing. This is the charging of a low price at market entry in order to create a positive consumption externality. This works through stimulating consumer conformity, which then ultimately results in a positive impact on firms profits (Amaldoss and Jain, 2005). Commercial advertising equally thrives on such conformity or consumption norms and tries to influence them in directions that are favourable to company profits. Ironically, in this sense marketing research (by companies and universities) and practice reflect a better understanding of the fundamental features of consumer behaviour than general economics.

Combining environmental policy analysis with behavioural economics is receiving increasing attention (Shogren, 2002; Gowdy, 2008; Brekke and Johansson-Stenman, 2008; Gsottbauer and van den Bergh, 2011). Concrete policy suggestions have focused the attention on status-seeking behaviour, positional goods and rivalry in the consumption of goods whose production involves pollution externalities (Howarth, 1996; Brekke and Howarth, 2000; Brekke et al., 2002; Kallbekken et al., 2010).Three studies come closest to the approach presented here. Howarth (1996) develops a model which considers the combined effect of status seeking and environmental externalities on welfare. In the presence of status signalling, consumers understate the true social benefit of environmental quality. Howarth shows that consumption taxation is necessary to offset incentives to over-consume at the expense of environmental quality. He finds that environmental policy requires Pigouvian taxes to be adjusted upwards in the presence of status effects. However, no attention is given to the role of advertising. Ireland (1998) argues that pure taxes on status goods are not practical as the nature of status goods changes over time, and therefore he suggests an income tax to control status seeking behaviour. In a similar vein Frank (1999) proposes a strongly progressive income tax to reduce competition for status consumption.

We present here a first policy model of consumer behaviour that combines advertising by firms with the social context of consumption, i.e. satisfaction from goods being co-determined by social norms. The production of the consumed good (or service) causes pollution which creates a negative environmental externality on the utility of consumers.[2] In addition, advertising generates an information-related externality that can be positive or negative, the latter being the more general case as will be argued and empirically validated in Section 3.2.3. The reason is that advertising affects the social norm to consume – a type of information available to all consumers – which then influences the utility of each individual. Since this

[2] Some illustrative examples are cars, houses, and vacation flights. With respect to car purchases, Johansson-Stenman and Martinsson (2006) find that most people are more concerned about the status value of a car than about its environmental performance.

effect operates outside the realm of markets, by definition it represents an externality. The model is used to analyse a policy package that includes environmental regulation (a pollution tax), regulation of advertising (an advertising tax or subsidy), and information provision by the government that counters the impact of advertising on the social norm.

We should acknowledge that our static model represents a first, simplified approach to analyse this problem, as it neglects the typical dynamic context of the impact of advertising and more generally marketing. In effect these are aimed at encouraging future demand, which then will result in market (share) growth and more sales, revenues and profits. Past studies have mainly adopted game-theoretic approaches with the aim to understand the emergence of norms (Young, 1998; Lindbeck et al., 1999) or advertising allocation strategies (Friedman, 1958). Moreover a number of dynamic advertising models have been proposed in the marketing literature (Sethi, 1973; Sethi, 1977; Feichtinger et al., 1994). The issue with these models of advertising is that they do not take a social planner or welfare approach, which is needed to address public policy issues. In line with similar studies on externalities and other-regarding preferences we use a static general equilibrium format, because non-strategic, price-taking behavior is a logical starting point. Furthermore, given the social behavioural dimension a dynamic model would considerably complicate matters. So this does not offer an obvious starting point for analysis, although it is worth considering it as a subsequent approach.

The remainder of this Chapter is organized as follows. Section 3.2 discusses economic writings on, and formal models of, negative welfare effects of advertising, and their connection with environmental economics. In addition, this section motivates the need for regulation of advertising, and offers an overview of policy options. Section 3.3 formulates and solves a model of social welfare given consumer behaviour with consumption norms, environmental and advertising (or marketing) externalities, and a package of policy instruments. Section 3.4 formulates the associated competitive market equilibrium and derives optimal policy rules. Section 3.5 provides more explicit solutions for, and interpretations of, the policy rules and associated social optima, using two sets of functional specifications. Section 0 concludes.

3.2 Welfare and regulation of advertising

Advertising and more generally marketing[3] can be regarded as activities aimed at creating or stimulating demand for consumed goods and services in the near or distant future.[4] There is

[3] We do not make a sharp distinction here between marketing and advertising, even though marketing includes more activities. This is captured by, for example, the "four P's": Product, Price, Place and Promotion, the latter covering advertising.

[4] Marketing is defined by the American Marketing Association (AMA) as "… the activity, set of institutions, and processes for creating, communicating, delivering, and exchanging offerings that have value for customers, clients, partners, and society at large." Interestingly, this partisan definition suggests that marketing only has social benefits.

ample evidence that overall demand, sales and brand loyalty can be affected by marketing activities. Due to these activities, consumers may switch choice from one to another brand, leading to a shift of market shares. There is also evidence that marketing has a significant overall demand effect, i.e. consumers buying more than usual (for price advertising see Gupta, 1988; Chintagunta 1993). This Chapter focuses on the specific instance of purchase of consumer goods and services being stimulated by promotional advertising.

There are multiple drivers of marketing. In consumer goods industries product differentiation forced by competition is one of them (Kotler and Keller, 2006). Differentiation takes the form of advertising that suggests that a certain product by one firm (e.g. a car) is more attractive than the same product from another firm. Competition and differentiation occurs between alternative products (e.g., different brand of cars) at a point in time. This is known as "branding". Of course, some marketing is especially meant to stimulate consumers to replace a product by a new version. The differentiation of goods along key features can be sought in a number of ways. Exclusivity and status symbols is one. We address this in Section 3.5.2 by choosing a model reflecting status sensitivity by consumers.

What is the magnitude of advertising? Global expenditures on advertising in 2010 are estimated to be equal to US$ 450 billion (approximately the GDP of Norway of 2010), a figure which is expected to grow in 2011 by 4.5 % (GroupM, 2010). In the US the increase of advertising expenditures is to a large extent driven by the car industry, fast food restaurants, and pharmaceutical companies. This is consistent with the fact that in especially the first two areas consumption norms are well established, which indirectly contribute considerably to environmental pollution and unhealthy eating habits. In addition, advertising expenses as a percentage of sales reveal that a relatively high percentage of sales revenues are invested in advertisings in the selected industries. For example the advertising-to-sales ratio is for the car industry 20 %, for (fast food) restaurants 10 %, for women clothing 8 %, and for jewellery 5.5 %.[5] This can be partly explained by the fact that this type of consumption is conspicuous and the associated products are to a large extent sold on the basis of image and status, which require a significant advertising support. In comparison, in other sectors such as insurances or public transport the ratio is below 1 %. At a national level, US data on spending on advertising as a percentage of GDP has been relatively constant during the 20th century, representing roughly 2% (with a range of 2-2.5 % during the last 20 years) of GDP.[6] Table 3.1 gives the top ten product categories in terms of advertising spending for the US and associated focus on norm or status consumption (or both). Note that the product/service category "Direct Responses" which covers retail call centre services aimed at providing advertising for other firms. This

[5] Source: Data from Schonfeld and Associates, 2011: Advertising Ratios & Budgets.
[6] Annual U.S. Advertising Expenditure since 1919. Galbithink.org.: http://www.galbithink.org/ad-spending.htm. Retrieved 12 March 2012.

service is widely advertised. So here we have a second level of advertising, i.e. ´advertising advertising´.

Table 3.1 Outlays on advertising in the USA (data for January - June 2011) and focus on conspicuous consumption and status by consumers.

Rank	Product category	Spending on advertising (in Million $)	Predominant focus of advertising: conspicuous consumption/status
1	Cars	$6870	x
2	Local Services	$4876	
3	Financial Services	$4647	
4	Retail	$4523	
5	Telecom	$4509	x
6	Food	$3268	
7	Personal Care Products	$3253	x
8	Direct Response	$3153	
9	Restaurants	$2971	x
10	Travel and Tourism	$2927	x
	Total	$40982	

Source: KMR (2011).

In contrast, public expenditure on information like health campaigns and independent consumer reports and product reviews only form a fraction of the total expenditures on commercial advertising (this excludes basic education in schools). For example, in the UK the government (including all levels) ranks as the fifth largest spender on information behind top brands and corporations promoting commercial products and services. Regulating this asymmetry between advertising by private firms and adequate sources of independent (and likely more reliable) information can improve the quality and quantity of overall information presented to consumers and help to reduce any social costs associated with commercially provided information.

The field of marketing studies is surprisingly uncritical, or defensive even, of marketing efforts and expenditures. The possibly most famous textbook on marketing (Kotler and Armstrong, 2008, p. 578) states: “Criticisms [on marketing and advertising] overstate the power of business to create needs. People have strong defences against advertising and other marketing tools. Marketers are most effective when they appeal to existing wants rather than when they attempt to create new ones.” Perhaps these “strong defences” explain why so much money has to be spent by firms on advertising. They are also in line with the observation that preference change stimulated by marketing is not always very stable, since firms that own a very famous brand (e.g., Coca Cola) continue a high level of marketing expenditures to maintain loyal consumer preferences. Not surprisingly, marketing textbooks teach students all kinds of strategies to affect consumers’ buying decisions, tastes and wants. Kotler and Armstrong go so far as to suggest that marketers are capable of “… understanding customer needs even better than customers themselves do and, creating products and services that meet existing and latent needs, now and in the future” (p.11). Interestingly, this statement does not seem entirely consistent with the previous one.

One might argue that the profession of marketing (including researchers, teachers and actual marketers) unashamedly fosters strategies to increase consumption. Its practitioners understand very well the bounded rationality of consumers which involves unconscious desires, status concerns and conformity behaviour which in turn provide a fertile basis for marketing strategies (Stole, 2006). A more positive view is that advertising provides information which helps consumers search for suitable goods and services that satisfy their given preferences, or which fosters price competition between firms leading to more reasonable prices for consumers. This assumes that product information is reliable, business interests coincide with consumer interests, and consumer preferences are fixed. All three assumptions are, nevertheless, debatable and lack empirical validation. A recent contribution by Armstrong et al. (2009) looks at the welfare effects of limiting advertising as a type of consumer protective policy. Its starting point is that less advertising reduces the proportion of well-informed consumers, which assumes honest and high quality informative advertising. This then allows firms to charge higher prices, causing a decrease in consumer welfare. Moreover, a large literature is devoted to the study of the impact of advertising on price sensitivity of consumers. A general conclusion of this is that nonprice advertising allows firms to charge higher prices to consumers, whereas price advertising may make consumers more sensitive to prices (Kaul and Wittink, 1995).

3.2.1 Welfare effects of advertising

While within business economics advertising and marketing are generally seen as useful and even necessary, in general economics, including environmental economics, they have been largely ignored. This also holds for public policy analysis, where potential social costs of advertising have not been taken into account. Kaldor (1950) was the first economist to refer to a social cost of advertising. He argued that it constantly tends to make consumers dissatisfied with their current consumption. Galbraith (1958, 1967) elaborated this idea stating that the central feature of advertising is to ensure that people buy what is being produced. He mentions the notion of a dependence effect, which reflects that the expansion of a firms output must be accompanied by a consistent advertising effort. In particular, he observed that as a society becomes increasingly affluent, new wants for goods and services are ever more created by firms that produce or supply them. Galbraith emphasized that "want creation" through advertising cannot be assumed to increase welfare, but that at best the latter will remain constant. Both Kaldor and Galbraith realized that the widespread presence of advertising conflicts with the assumption of fixed preferences and tastes, which is common in most of economic theorizing as well as empirical applications.

A rare study which treats advertising as a type of misinformation, thus emphasizing its negative informational value, is Glaeser and Ujhelyi (2010). It asks how government policy can respond to misleading advertising, in particular misinformation about socially harmful products

such as cigarettes or fast food. It is shown that if all advertising is misinformation then it is welfare improving to impose a ban (a quantity restriction) or a tax on advertising. Under some circumstances, counter-advertising by the government – i.e. informative advertising about the real cost and benefits – can serve as an additional policy instrument to restore social welfare.

The social welfare relevance of advertising is twofold. First, marketing activities divert scarce resources (labour, capital, energy) away from core productive activities (e.g., manufacturing). Indeed, every firm faces the choice problem of devoting more or less scarce resources to either core activities or to marketing. Second, advertising creates dissatisfaction with current consumption, stimulates comparison with other individuals (captured by status and norms), and creates new wants. As a consequence, advertising leads consumers to supply more labor, at the expense of (non-advertised) leisure, to increasing purchasing power. The existence of consumption externalities – utility of a consumer depending negatively on the (rising) average consumption level in society – has been empirically confirmed (Chao and Schor, 1998; Alpizar et al., 2005). In this sense, the direct effect of advertising is a reduction of consumer welfare for the purpose of generating private profits. However, these direct welfare effects or social costs are not taken into account by firms deciding about advertising efforts, which mean that they are – by definition – negative externalities. If advertising through positive information effects (i.e. social marketing) would contribute to a rise in welfare, this would mean the existence of positive externalities (which might be subsidized). Evidently, this does not represent the general case.

3.2.2 Arguments against regulation of advertising

One reason for the limited attempts to seriously regulate the quantity of advertising (apart from its specific contents, for which regulation exists in most countries) may be reluctance against public control of private information based on the argument of free speech. This is in line with Coase (1977) arguing against regulating the "market for ideas" or market of information. His arguments go hand in hand with rational choice theorist defending consumer rationality and consumer sovereignty. The problem with the defenders of consumer sovereignty is that they forget that preferences are not fixed but formed partly by experience and information, including commercial advertising. While public guidance of preferences for social goals is generally seen with scepticism by defenders of consumer sovereignty, commercial advertising for private gains is uncritically accepted. Coase suggested as a policy lesson that government regulation in the market for goods is desirable but not in the market for ideas (information). However, he also acknowledges that reducing the quantity of advertising slightly would clearly be beneficial to society.

The crucial question is of course whether the market for information works well and can ensure a socially optimal supply of information without public intervention. Rubin (2008)

argues that advertising of truthful information, i.e. information about product availability, price and its quality should not be prohibited. One obvious question is whether much advertising is truthful, and another is whether the regulator can distinguish between truthful and other information in the form of advertising. These questions are beyond the scope of this article but clearly important in thinking about the relevance and formulation of regulation of advertising. Stigler (1961) goes as far to argue that false advertising can improve social welfare. This, however, is based on the outdated assumptions of perfect consumer rationality, fixed preferences and perfect information, under which consumers can well differentiate and validate advertising information. Others have highlighted the positive direct effects of advertising on social welfare. This includes the informative function which makes consumers aware of particular goods and thus enhances competition and lowers prices (Nelson, 1974). Another argument is the ability of advertising to stimulate adoption rates of innovations and hence new product development and diffusion (Litter, 1994). This is of course based on the unproven thesis that product innovation is always good, i.e. has only net social benefits. Moreover, large marketing efforts by incumbents support their dominance and thus contribute to creating a serious barrier for the diffusion of new competing brands and products.

One is easily tempted to argue that money going into commercial advertising campaigns would be better spent on more objective product information and systematic comparisons of products (and different models and brands) by independent consumer organizations. This in turn would improve the quality of information available to consumers as well as stimulate firm competition in terms of relevant product diversity and a good relation between product quality and price. This argument might also convince those emphasizing the importance of free market competition and associated information availability. Unfortunately, few economists seem to be concerned about these issues.

3.2.3 Regulation options

The policy options that have been proposed to control advertising include limitations on the content and placement of advertisements, total advertising bans in one or more media, voluntary self-regulation by industries, and taxation of advertising. The most common measure has been its restriction in selected media. This can control the information content (particularly non-informative messages and false information) as well as reduce its overall quantity. Saffer and Chaloupka (2000) analyze the effect of bans on tobacco advertising on overall consumption levels and show that only comprehensive bans on advertising can reduce consumption whereas bans in selected media encourage media substitution and will only have a limited or no effect.

Several countries and cities have already implemented such censorship on advertising in public spaces. For example, tobacco and alcohol advertisements have been banned from television and radio in numerous European countries. The city of São Paulo in Brazil has

implemented a ban on all outdoor advertising in its urban spaces to eliminate a type of "visual pollution" created by billboards. Similarly, Beijing has issued a ban on outdoor advertising of luxury goods, thus acknowledging individual preferences for status and aiming to reduce segregation between income groups. Taxation of advertising has not been applied yet anywhere despite the fact that the taxation of activities that generate negative externalities is generally seen as useful in economics[7], except when a full prohibition makes more sense, like in the case of extremely toxic, cancerous or radioactive substances (e.g., Saffer, 1991). A tax on advertising might induce firms to internalise the associated social cost of advertising in their private costs, which would bring private decisions in line with social interests. This in turn could reduce advertising to a socially acceptable level, which in some cases could be positive and in others possibly zero.

In addition to regulation of advertising by governments, in some instances, firms have created their own standards of advertising behaviour ("code of conduct") as a form of industry self-regulation (Boddewyn, 1989; Ashby et al., 2004). This represents a voluntary response to reduce the negative social and environmental impacts of their marketing activities. Nevertheless, one should realize that the main reason for such voluntary action is avoiding strict control by the government. Some practical examples of self-regulation can be found for alcohol advertising (Jones and Donovan, 2006), consumer privacy and personal data usage (Okazaki et al, 2009), and child-directed advertising (Preston, 2000). However, some argue that self-regulation of advertising is in effective and does not completely correct market failures. For example, industry self-regulation has been shown to be inadequate to regulate privacy issues with respect to consumer data protection in the mobile phone industry, notably the providers of phone services (King and Wegener Jesse, 2010), and voluntary self-regulation of alcohol advertising has not prevented the indirect targeting of adolescents in print media (Garfield et al., 2003). It is possible that self-regulation may partially improve consumer and social welfare, but because of a lack of evidence this option is not considered in the following analysis. Instead, it is accepted that the best course of action is government regulation and so the question is how best to achieve this end.[8]

3.2.4 Economic models of advertising and social welfare

Although since Galbraith many economists have expressed concerns about the social welfare effects of advertising, very few formal economic models have explored this issue. Here we discuss the few available studies.

[7] The prime example being Pigouvian taxation of negative environmental externalities.

[8] In the first place our results can be interpreted as a public policy solution in the absence of self-regulation. In the second place, one can wonder what evidence there is for self-regulation to be able to address the problem of marketing of environmentally pollutive goods and services. We know of no such self-regulation that is serious and restrictive. One would also not expect this on the basis of logical reasoning.

Among economists there is controversy about the sign of the effect of advertising on social welfare. Becker and Murphy (1993) argue that advertising is able to create social benefits. They develop a model with advertising entering the fixed preferences of consumers, suggesting that advertising is regarded as a good which can be consumed. Here advertising may not only favourably affect the demand of other goods but also social welfare due to the indirect effect of advertising on prices of the advertised good. This is assumed to hold even if advertising directly lowers utility, as it still raises the marginal utility of the advertised good. It is not surprising that Becker and Murphy find a positive effect of advertising on welfare as they assume fixed preferences.

Three studies have modelled the impact of advertising by relaxing the assumption of fixed preferences and full rationality. For example, Dixit and Norman (1978) assume advertising to be capable of inducing changes in consumer preferences that are profitable to firms. They distinguish between pre- and post-advertising tastes and apply welfare economics to three distinct market constellations, namely a monopoly, an oligopoly and monopolistic competition. They find that in all three cases advertising is provided at a socially excessive level. As a consequence, in a monopoly situation where only one product is advertised the demand price in the pre-advertising state is always below the price the consumer is willing to pay after she has been subjected to advertising. Kotowitz and Mathewson (1979) analyze the welfare implications of advertising by a monopolist and derive optimal firm strategies. They find that a firm might supply excessive advertising in the presence of demonstration effects, i.e. consumers informing each other about the product. However, their conclusions assume that advertising supplies correct and truthful information. Brekke and Howarth (2002, chapter 4) develop a simple model in which advertising affects consumer preferences through creating the belief that the consumption of a certain good is necessary to conform to the (consumption) norm of a group. This can yield a loss of social welfare as the direct benefit of consumption to the consumer is smaller than the cost (her disutility) of deviating from the norm generated or supported by advertising efforts. The shortcoming of this model is that it is limited to a monopolistic firm setting. Further, none of the previous models includes environmental externalities.

An alternative to such static analysis is dynamic optimization and game-theoretic models studying the allocation of optimal advertising expenditure (Friedman, 1958; Sethi, 1977). The main advantage of a dynamic approach over a static equilibrium format is that it considers advertising affecting present and future demand and can explicitly describe changes in tastes and preferences over time. In particular, it is possible to develop competitive advertising strategies. An example of this approach is Sethi (1973).

In this Chapter, however, the focus is instead on social welfare and public policy implications, for which another approach, as explained in detail in the next section, is more

suitable. This approach based on general equilibrium and social welfare optimization will allows us to make more precise statements about advertising, in terms of interactions between environmental and advertising externalities and the associated loss of welfare. As long as environmental externalities associated with consumption and production are not optimally regulated, which is the case for the most important environmental problems – notably, global warming due to anthropogenic greenhouse gas emissions – marketing and advertising activities will magnify such negative externalities – illustrated by very pollutive consumption of cars and exotic holidays (involving flights by air) which are targeted by considerable commercial advertising. But even without environmental externalities or in the presence of optimal environmental regulation, advertising will impose social costs through its capacity to create dissatisfaction with current consumption and new desires, thus lowering the utility of current consumption. The way we will model this effect is through an endogenous consumption norm influenced by commercial and public information. The presence of such a variable and endogenous norm results in preferences being variable and endogenous as well.

3.3 A model of consumption norms, advertising and pollution

We introduce a model of consumer behaviour with consumption norms, advertising, environmental externalities and various policy instruments**.** Our model combines elements of the basic environmental externality model (Baumol and Oates, 1988) and a behavioural economics model with norms (e.g., Leibenstein, 1950; Bernheim, 1994; Brekke and Howarth, 2002; Azar 2004).[9] The model describes the production and consumption of a good whose production generates environmental externalities through pollution. The more is consumed, and thus produced, of the good, the higher is the level of environmental pollution.[10]

3.3.1 Preferences, technology and accounting equations

We assume there are *N* consumers who are sensitive to a norm for consumption, meaning that they desire to conform to this norm while any deviation from it results in a lower utility. Leibenstein (1950) referred to such behaviour as the bandwagon effect: utility derived from a good is increased by others also purchasing and consuming it. The utility function of an individual consumer is given by:

[9] The model type is conventional. However, within such a setting a variety of (though not all) behavioural assumptions can be addressed. This means that the separation between neoclassical and behavioural economics is not as sharp as is often thought. In our case, rationality (optimizing utility) is preserved while other-regarding preferences are added.

[10] One reader suggested to combine a "consume and pollute social norm" with a "don't-pollute social norm" (environmental conscious consumer). We agree this might be interesting, but it is the topic of different, separate study. Moreover, the first norm is much more widespread than the second one, which makes it a logical primary focus of the analysis here.

$$U_i(c_i, n_i, l_i, P) \qquad i = 1, \ldots, N \tag{1}$$

Here c_i denotes private consumption, n_i is a measure of deviation from the consumption norm, l_i is leisure, and P is environmental pollution caused by production. The utility function is concave and increasing in c_i and l_i and decreasing in P. Utility can be increasing or decreasing in n_i depending on the value of consumption relative to the social norm. When deriving policy rules in sections 4 and 5 we will consider the different cases.

Production is a function of total labour, pollution and marketing:

$$Q = f(L, P, M) \tag{2}$$

Production is increasing in labour L, pollution P (which may also be interpreted as a resource input that then, as a result of mass balance, generates waste and pollution), and marketing or advertising M. Note that although a direct effect of advertising is that it diverts scarce factors away from real production (manufacturing), the net effect on production has to be positive for it to make sense from the perspective of firm profits (Dixit and Norman, 1978).[11] This can be seen as capturing the dynamic effect of marketing and advertising, as discussed in the introduction. In this sense, advertising is somewhat comparable to an investment in product improvement or R&D as these also have a dynamic effect on demand and supply. We assume later that the relative cost of marketing to the firm is small or negligible, as we focus on the external cost of it. One might use a different, in particular dynamic, model set-up to more carefully address the cause-effect chain associated with marketing, information stock, supply-demand interaction and product quality dynamics. Alternatively, one could introduce stochastic model elements to address uncertainty of consumers' perception and response to advertising information. However, this is all beyond the general equilibrium approach adopted in this Chapter.

Aggregate labour supply is the sum of labour supply by all N consumers, where it is assumed that the sum of leisure and labour is equal to 1 for each consumer:

$$L = \sum_{i=1}^{n} (1 - l_i) \tag{3}$$

Note that while labour is limited in supply, and pollution will be limited because of its negative impact on utility (i.e. the environmental externality), marketing (advertising) is constrained by a maximum, finite value $\overline{M}$.

Output is allocated to consumption and public provision of information G:

[11] An alternative approach would be to assume that advertising allows firms to reap more benefits because they can charge higher prices for their product.

$$\sum_{i=1}^{n} c_i + G = Q \tag{4}$$

The norm function provides a measure of deviation from a social norm, which then enters the utility function to reflect the utility an individual derives from conforming to the norm. This function can be defined as dependent on consumption *c* and the (endogenous) norm $\overline{n}$:

$$n_i = h(c_i, \overline{n}) \qquad i = 1, \ldots, N \tag{5}$$

One can assume that $\partial n_i / \partial c_i \geq 0$ and $\partial n_i / \partial \overline{n} \leq 0$ or, alternatively, that these conditions hold for $c \geq \overline{n}$ and the signs are reverse for $c \leq \overline{n}$. When interpreting results later we will consider the various cases. Our model assumes the social norm is variable and can be influenced by two counteracting forces, namely advertising M and government information and education G . This is formalized as follows:

$$\overline{n} = g(G, M) \tag{6}$$

This social norm $\overline{n}$ denotes the level of consumption that individuals use as a reference. A higher norm means more consumption is needed to be satisfied. It is assumed that $\partial g / \partial G < 0$ and $\partial g / \partial M > 0$, that is, marketing increases the social norm of consumption while information provision by the government G lowers it.

Equations (5) and (6) together capture that private firms may affect the norm by engaging in advertising activities. If as a result of this $\overline{n}$ increases, individuals previously complying with the norm start to deviate from it and will lose utility as can be seen from equation (2). This can be regarded as an unintended, external effect since advertising is meant just to raise sales (if the intention would be to deprive consumers from utility then it might better be considered a crime). An interpretation of this effect is that if $\overline{n}$ increases it becomes harder for consumers "to keep up with the Jones".

Note that the presence of a variable, endogenous norm in the utility function effectively means that preferences are not fixed. This can be seen from rewriting the utility function in (1) as:

$$U_i(c_i, h(c_i, \overline{n}), l_i, P) \qquad i = 1, \ldots, N \tag{7}$$

This shows that the variable consumption norm $\overline{n}$ can be regarded as a (variable) parameter of the associated, redefined utility function with arguments c_i , l_i and *P*. A change in the norm alters the latter function, which means that preferences at this level change.

3.3.2 Social welfare optimization

The social welfare maximization problem can now be formulated as follows:

Max. $U_1(c_1, n_1(c_1, \overline{n}), l_1, P)$

subject to:

$$\sum_{i=1}^{n} c_i + G = f(L, P, M) \tag{8}$$

$$\overline{n} = g(G, M) \tag{9}$$

$$L = \sum_{i=1}^{n} (1 - l_i) \tag{10}$$

$$U_i(c_i, n_i, (c_i, \overline{n}), l_i, P) \geq u_i^* \qquad i = 2, \ldots, n \tag{11}$$

In addition, all variables can take only positive values. The decision variables of the maximization procedure are: private consumption c_i, leisure l_i, norm $\overline{n}$, and environmental pollution caused by production P, labour supply L, advertising M and government information and education G.

The resulting first-order conditions[12] for an interior solution can be rewritten into the following system of equations:

$$\sum_{i=1}^{n} \left(\frac{\partial u_i}{\partial c_i} + \frac{\partial u_i}{\partial n_i} \cdot \frac{\partial n_i}{\partial c_i} \right)^{-1} \left(\frac{\partial u_i}{\partial n_i} \cdot \frac{\partial n_i}{\partial \overline{n}} \right) = \frac{1}{\frac{\partial g}{\partial G}} \tag{12}$$

$$-\sum_{i=1}^{n} \left(\frac{\partial u_i}{\partial c_i} + \frac{\partial u_i}{\partial n_i} \cdot \frac{\partial n_i}{\partial c_i} \right)^{-1} \left(\frac{\partial u_i}{\partial P} \right) = \frac{\partial f}{\partial P} \tag{13}$$

$$-\sum_{i=1}^{n} \left(\frac{\partial u_i}{\partial c_i} + \frac{\partial u_i}{\partial n_i} \cdot \frac{\partial n_i}{\partial c_i} \right)^{-1} \left(\frac{\partial u_i}{\partial n_i} \cdot \frac{\partial n_i}{\partial \overline{n}} \right) \frac{\partial g}{\partial M} = \frac{\partial f}{\partial M} \tag{14}$$

$$\sum_{i=1}^{n} \left(\frac{\partial u_i}{\partial l_i} \right)^{-1} \left(\frac{\partial u_i}{\partial c_i} + \frac{\partial u_i}{\partial n_i} \cdot \frac{\partial n_i}{\partial c_i} \right) = \frac{1}{\frac{\partial f}{\partial L}} \tag{15}$$

$$\frac{\partial g}{\partial G} = -\frac{\frac{\partial g}{\partial M}}{\frac{\partial f}{\partial M}} \tag{16}$$

Possible interpretations of these results are as follows. Equation (12) states that the socially optimal level of expenditures by the government on information provision is defined by

[12] See the resulting Lagrange function and related first-order conditions in the Appendix A at the end of this Chapter.

equalizing the marginal cost of these (equal to 1) to the sum over all consumers of the marginal utility effects of this information, operating via its impact on the social norm of consumption, and normalized (divided) by the marginal utility effect of a change in consumption, since the right-hand side (marginal cost of information provision) is not in utility terms but in output (consumption) units.

According to equation (13) the socially optimal level of pollution is defined by setting the marginal productivity of pollution equal to the sum over all consumers of the marginal utility effects (marginal external costs) of pollution, normalized (divided) by the marginal utility effect of a change in consumption, since the productivity effect is also in output (consumption) units.

Equation (14) says that the socially optimal level of marketing activity is such that the marginal cost of marketing in terms of lost production opportunities is equal to the sum over all consumers of their marginal utility changes (normalized by the marginal utility of consumption) due to marketing efforts, running via the norm and then the consumption choices by all consumers. From (14) we also see that the marginal cost of marketing is only zero if $\partial g / \partial M = 0$ or $\partial n_i / \partial \overline{n} = 0$ which represent extreme (unrealistic) cases.

According to equation (15) in the social optimum the sum of the marginal rates of substitution between leisure and consumption for all individuals is equal to the marginal productivity of (total) labour.

Finally, equation (16) relates the socially optimal levels of commercial advertising and information provision by the government. The marginal effect of information provision on the social norm of consumption is equal to the negative value of the similar marginal effect of marketing on this norm, normalized by the marginal productivity effect of advertising or marketing. In effect, this says that in terms of impact on social welfare a higher productivity of advertising can compensate for a higher norm-related effect of it.

3.4 Competitive market equilibrium and policy instruments

Here we formulate the competitive market equilibrium and add policy instruments to it. We assume that the government has three instruments, of which two are taxation (or possibly subsidy, i.e. negative tax) instruments: a Pigouvian tax on pollution and an advertising tax (or subsidy) to influence the social norm of consumption and indirectly consumption decisions by individuals. The latter can be interpreted as discouraging (stimulating) advertising and thus ameliorating an upward bias of the social norm of consumption. Moreover, the social planner can reduce this norm directly through a third instrument, namely information provision through campaigns and education. Since the social planner taxes pollution and advertising, a set of lump-sum transfers to individuals is required as well.

3.4.1 Market equilibrium

Consumer *i*'s budget constraint is given by:

$$p_c c_i = w(1 - l_i) + t_i \qquad i = 1, \ldots, N \tag{17}$$

where w is the wage rate, p_{ci} price of the consumption good and t_i a set of lump sum transfers. Consumers are supposed to maximize utility with respect to consumption c_i and leisure l_i, subject to the consumers budget. This maximization problem gives rise to the following Lagrange function (for each individual *i*):

$$\mathscr{L} = U_i(c_i, n_i(c_i, \overline{n}), l_i, P) + \lambda_1 \left(w(1 - l_i) + t_i - p_c c_i \right) \tag{18}$$

where λ_1 is the Langrage multiplier. Optimizing with respect to consumption and leisure time yields the following first order conditions:

$$\frac{\partial \mathscr{L}}{\partial c_i} = \left(\frac{\partial u_i}{\partial c_i} + \frac{\partial u_i}{\partial n_i} \cdot \frac{\partial n_i}{\partial c_i} \right) - \lambda_1 p_c = 0 \qquad i = 1, \ldots, N \tag{19}$$

$$\frac{\partial \mathscr{L}}{\partial l_i} = \frac{\partial u_i}{\partial l_i} - \lambda_1 w = 0 \quad i = 1, \ldots, N \tag{20}$$

Algebraic manipulation yields the following first-order condition:

$$\left(\frac{\partial u_i}{\partial c_i} + \frac{\partial u_i}{\partial n_i} \cdot \frac{\partial n_i}{\partial c_i} \right) \cdot \left(\frac{\partial u_i}{\partial l_i} \right)^{-1} = \frac{p_c}{w} \qquad i = 1, \ldots, N \tag{21}$$

Equation (21) states that each individual's marginal rate of substitution between consumption and leisure is equal to the price ratio of these.

Profit maximization implies that labour is paid its marginal product so that $w = \partial f(L, P, M) / \partial L$. The price of the good does not appear here as it is chosen to be the numéraire, i.e. it is set equal to one. The government not only taxes pollution at the unit rate τ_P, but also marketing activities at a rate τ_M to account for the external effects it imposes on consumer welfare. We assume the cost of marketing for the firm, apart from advertising taxes, is zero. This is done to simplify the analysis and to focus on the external cost of marketing. Moreover, the cost of marketing is relatively small for most industries (see Section 3.2.1). If firms minimize costs the following conditions hold:

$$w = \frac{\partial f}{\partial L} \tag{22}$$

$$\tau_P = \frac{\partial f}{\partial P} \tag{23}$$

$$\tau_M = \frac{\partial f}{\partial M} \tag{24}$$

Equilibrium for this economy is defined once the government specifies a pollution tax, advertising tax (or subsidy), expenditures on information provision G and lump sum transfers T. These obey a balanced budget condition:

$$T + G = \tau_P P + \tau_M M \tag{25}$$

with $t_i = \frac{1}{N} T$ $\qquad\qquad$ $i = 1, \ldots, N$

3.4.2 Optimal policy rules

We now specify a set of policies required to achieve Pareto efficiency in competitive equilibrium. Combining equations (13) and (23) yields the efficient pollution tax (26):

$$\tau_P{}^* = -\sum_{i=1}^{n} \left(\frac{\partial u_i}{\partial c_i} + \frac{\partial u_i}{\partial n_i} \cdot \frac{\partial n_i}{\partial c_i} \right)^{-1} \left(\frac{\partial u_i}{\partial P} \right) \tag{26}$$

The pollution tax is equal to the sum over all consumers of the marginal utility effect of pollution in the optimum, weighted by the marginal utility of consumption. The latter includes the direct effect of consumption changes on utility and the indirect effect due to the tendency to conform to a norm. The term behind the summation sign can also be interpreted as the marginal willingness to pay to reduce pollution by each individual.

Equation (27) shows the standard Pigouvian tax in case the norm is (incorrectly) not considered in the calculation of the pollution tax:

$$\tau_P = -\sum_{i=1}^{n} \left(\frac{\partial u_i}{\partial c_i} \right)^{-1} \left(\frac{\partial u_i}{\partial P} \right) \tag{27}$$

Comparison of equations (26) and (27) shows that in (27) the marginal utility of consumption only accounts for direct effects of consumption whereas (26) also accounts for the indirect effect of consumption running through norm compliance. If the marginal utility of a norm is strictly positive it is likely that the tax in (27) provides a weaker incentive to reduce consumption and thus pollution.

The tax (or subsidy if $\tau_M^* < 0$) on advertising is found by combining equations (14) and (24):

$$\tau_M{}^* = -\sum_{i=1}^{n}\left(\frac{\partial u_i}{\partial c_i}+\frac{\partial u_i}{\partial n_i}\cdot\frac{\partial n_i}{\partial c_i}\right)^{-1}\left(\frac{\partial u_i}{\partial n_i}\cdot\frac{\partial n_i}{\partial \overline{n}}\right)\frac{\partial g}{\partial M} \tag{28}$$

This tax (subsidy) is equal to the sum over all consumers of their marginal utility changes due to marketing efforts, which first affect the norm and indirectly the consumption choices by all consumers, and subsequently the utility. In the case of a direct positive utility from conforming to the norm $\partial u_i / \partial n_i > 0$ and an indirect disutility from $\partial n_i / \partial \overline{n} < 0$ the advertising externality requires a tax policy. If $\partial u_i / \partial n_i > 0$ and $\partial n_i / \partial \overline{n} > 0$ then a subsidy is the appropriate instrument. The advertising externality is then positive.

The optimal provision of public information G is defined by the condition $1/\frac{\partial f}{\partial M} = -\frac{\partial g}{\partial G}/\frac{\partial g}{\partial M}$. This demonstrates that the relative marginal cost of information has to be equal to the relative marginal benefits it generates. We will provide a possible explicit solution for G in Section 5.

For comparison, we show the outcomes of two policy cases. The first includes optimal policy rules set by a social planner who takes into account the presence of consumption norms. The alternative case includes the standard Pigouvian tax (standard environmental policy) in which norm effects play no role. The results are summarized in Table 3.2. It is clear that policy is quite different between the two cases, in terms of instruments and their settings.

Table 3.2 Policy rules.

Case	Pigouvian tax	Advertising tax	Information provision
(1) Policy under a norm ("first-best")	$-\sum_{i=1}^{n}\left(\frac{\partial u_i}{\partial c_i}+\frac{\partial u_i}{\partial n_i}\cdot\frac{\partial n_i}{\partial c_i}\right)^{-1}\left(\frac{\partial u_i}{\partial P}\right)$	$-\sum_{i=1}^{n}\left(\frac{\partial u_i}{\partial c_i}+\frac{\partial u_i}{\partial n_i}\cdot\frac{\partial n_i}{\partial ci}\right)^{-1}\left(\frac{\partial u_i}{\partial n_i}\cdot\frac{\partial n_i}{\partial \overline{n}}\right)\frac{\partial g}{\partial M}$	$\frac{\partial g}{\partial G} = -\frac{\frac{\partial g}{\partial M}}{\frac{\partial f}{\partial M}}$
(2) Standard policy	$-\sum_{i=1}^{n}\left(\frac{\partial u_i}{\partial c_i}\right)^{-1}\left(\frac{\partial u_i}{\partial P}\right)$	$\tau_M{}^* = 0$	$G^* = 0$

3.5 More explicit policy rules: functional specifications

In order to provide more insight about the various policy rules derived in Section 4 we present now a set of functional specifications. To simplify the analysis, assume that all individuals are identical and have identical preferences. Note that this is not inconsistent with a consumption norm or status effects fostered by advertising. The assumption of an average individual who strives to conform to a single homogenous standard of behaviour is enough to show the effect of disutility through non-compliance or status and potential policy responses (which does not deny

that a population model with heterogeneous consumers could address additional interesting questions).

We present two distinct cases differing in the specification of norm-motivated behavior (see equation 5). A quadratic specification models a consumption norm while a linear specification captures status sensitivity or seeking. The basic issue here is that product differentiation of products and services is often driven to support exclusivity and status symbols.

3.5.1 A model with a quadratic function reflecting a consumption norm

We consider the implications of defining norm-motivated behaviour in terms of a disutility that an individual will suffer when her consumption c departs from $\overline{n}$. We model the measure of deviation from a norm as a quadratic function:

$$n_i = (c - \overline{n})^2 \tag{29}$$

This assumes a symmetric effect of deviation from the norm, i.e. it is equally costly in utility terms whether one is positioned at a certain distance above or below the norm. It is plausible to assume that consumers incur disutility from consuming more than the norm. Schultz et al. (2007) have shown that consumers, who were initially above the average consumption of energy in their neighbourhood, decreased their energy consumption after receiving information that allowed for social comparison regarding consumption.[13] We further assume a logarithmic utility and a linear production function:

$$U_i = \gamma_c \ln c_i - \gamma_n \ln n_i + \gamma_l \ln l_i - \gamma_P P \tag{30}$$

$$f = \alpha_L L + \alpha_P P + \alpha_M M \tag{31}$$

Here γ_c, γ_n, γ_l, γ_P, α_L, α_P and α_M are positive constants. We tried other functions but even the simple Cobb-Douglas utility[14] and production[15] function in our context lead to a nonlinear system that cannot be solved analytically.

The function *g* in equation (6) is specified as follows:

$$g = \frac{aM}{M + G + b} \tag{32}$$

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[13] The specification in equation 29 is consistent with consumers internalizing the social cost of consuming the polluting good. The existence of such norms has been extensively studied for common-pool resource context. Studies here have assessed the factors that hinder the overconsumption of such resources (Ostrom, 1990). Note further that individuals may be influenced by group-specific norms and can change peer groups as a result of which their consumption norm may alter over time (probably go up). This is evidently not covered by our basic model.

[14] A Cobb-Douglas utility form for consumption and leisure leads to $U_i = c_i^{\gamma_1} l_i^{\gamma_2} + \gamma_3 n_i - \gamma_4 P$.

[15] A Cobb-Douglas production function for labor and pollution gives $f_i = A L_i^{\beta} P_i^{(1-\beta)} - M$.

where *a* and *b* are positive constants.[16]

For calculating the social optimum - accounting for norm-related effects - we use the decision rules defined by equations (26) and (28). The social optimum (interior solution) is shown in the first column of Table 3.3. In contrast, suppose that the social planner does not recognize the presence of consumption norms exacerbated by advertising activities, thus that $\hat{\tau}_M = 0$ and $\hat{G} = 0$. Without a tax on advertising, advertisement will be provided by private firms at the maximum level. The solution for the standard policy case, without regulation of advertising (so no advertising tax and no public information provision, i.e. $\tau_M = G = 0$) is shown in the second column of Table 3.3.

[16] This functional specification assures that the conditions for the function *g* as formulated in Section 3.1 (eq. 6) are satisfied. Moreover, *g* takes value zero if *M*=0, approaches zero for large values of *G*, and approaches a positive upper boundary (*a*) for large values of *M*.

Table 3.3 Social optimum and optimum without regulation of advertising.

			Social ("first best") optimum		**Optimum without regulation of advertising**
Consumption	(i)	c^*	$\frac{N\gamma_P\bar{n}^* + \alpha_P(\gamma_c - 2\gamma_n) + \sqrt{N^2\gamma_P{}^2\bar{n}^{*2} + \alpha_P{}^2(\gamma_c - 2\gamma_n)^2 + 2N\gamma_c\gamma_P\alpha_P\bar{n}^* - 4N\gamma_P\alpha_P\bar{n}^*}}{2N\gamma_P}$	$\hat{c}$	$\frac{N\gamma_P\hat{\bar{n}} + \alpha_P(\gamma_c - 2\gamma_n) + \sqrt{N^2\gamma_P{}^2\hat{\bar{n}}^2 + \alpha_P{}^2(\gamma_c - 2\gamma_n)^2 + 2N\gamma_c\gamma_P\alpha_P\hat{\bar{n}} - 4N\gamma_P\alpha_P\hat{\bar{n}}}}{2N\gamma_P}$
Leisure	(ii)	l^*	$\frac{\alpha_P\gamma_l}{N^2\gamma_P\alpha_L}$	$\hat{l}$	$\frac{\gamma_l\hat{c}^2(\bar{M}+b) - \gamma_l a\bar{M}\hat{c}}{(\bar{M}+b)\alpha_L(\gamma_c - 2\gamma_n)\hat{c} - \gamma_c a\bar{M}\alpha_L}$
Consumption norm	(iii)	$\bar{n}^*$	$\frac{a}{1+\alpha_M}$	$\hat{\bar{n}}$	$\frac{a\bar{M}}{\bar{M}+b}$
Norm	(iv)	n^*	$\left(\frac{c^*(1+\alpha_M) - a}{1+\alpha_M}\right)^2$	$\hat{n}$	$\left(\frac{\hat{c}(\bar{M}+b) - a\bar{M}}{\bar{M}+b}\right)^2$
Pollution	(v)	P^*	$\frac{N^2\gamma_P c^* - N\gamma_P b - N^2\alpha_L\gamma_P - \gamma_l\alpha_P}{N\gamma_P\alpha_P}$	$\hat{P}$	$\frac{N}{\alpha_P}\frac{\left[2(\gamma_c - \gamma_n)\alpha_L(\bar{M}+b)\right]\hat{c}^2 - \left[(\gamma_c - 2\gamma_n)\alpha_L{}^2(\bar{M}+b) + 2\alpha_L\gamma_c a\bar{M}\right]\hat{c} + \alpha_L{}^2\gamma_c a\bar{M}}{\alpha_L(\gamma_c - 2\gamma_n)(\bar{M}+b)\hat{c} - \alpha_L\gamma_c a\bar{M}}$
Advertising	(vi)	M^*	$\frac{(1+\alpha_M)2\gamma_n\alpha_P a}{(1+\alpha_M)^2\gamma_P[a - c^*(1+\alpha_M)]}$	$\hat{M}$	$\bar{M}$
Public information	(vii)	G^*	$\frac{2\gamma_n\alpha_P\alpha_M a}{\gamma_P(1+\alpha_M)[a - c^*(1+\alpha_M)]} - b$	$\hat{G}$	0
Pollution tax	(viii)	$\tau_P{}^*$	$\frac{(1+\alpha_M)N\gamma_P c^{*2} - N\gamma_P a c^*}{(1+\alpha_M)(\gamma_c - 2\gamma_n)c^* - \gamma_c a}$	$\hat{\tau}_P$	$\frac{(\bar{M}+b)N\gamma_P\hat{c}^2 - N\gamma_P a\bar{M}\hat{c}}{(\bar{M}+b)(\gamma_c - 2\gamma_n)\hat{c} - \gamma_c a\bar{M}}$
Advertising tax	(ix)	$\tau_M{}^*$	$\frac{N\alpha_M\gamma_P c^*[(1+\alpha_M)c^* - a]}{\alpha_P(1+\alpha_M)(\gamma_c - 2\gamma_n)c^* - \gamma_c\alpha_P a}$	$\hat{\tau}_M$	0

Note: Subscripts * and ^ indicate socially optimal values and values in the optima with and without regulation of advertising, respectively

Let us compare the two solutions in Table 3.3. From row (i) it follows that there are two solutions for c, namely c_1 and c_2. This is due to the quadratic term in the function in equation (29). When N is very large $c_1^* \cong \bar{n}^*$ and $\hat{c}_1 \cong \hat{\bar{n}}$, and $c_2^* \cong 0$ and $\hat{c}_2 \cong 0$. The latter two solutions do not make much sense and are likely to be a minimum solution to the optimization problem. From row (iii) in the table we can see that $\bar{n}^* < (>)\ \hat{\bar{n}}$ if $b < (>)\ \alpha_M \bar{M}$. This condition shows that if $\bar{M}$ is sufficiently large then $\bar{n}^* < \hat{\bar{n}}$. If $\bar{M}$ is limited then $\bar{n}^* > \hat{\bar{n}}$. We consider the first case to be the most general one.

Using the optimal solutions for *c*, we can derive the condition which has to hold so that individual consumption is smaller or larger than a consumption norm. For the social optimum we find that $c_1^* > (<)\ \bar{n}$ if $\gamma_c < (>)\ 2\gamma_n$. In addition we are interested if consumption is higher or smaller in the second-best solution. Using row (iii) it follows that if N and $\bar{M}$ are large, then $c_1^* \cong \bar{n}^* < \hat{\bar{n}}_1 \cong \hat{c}$.

From row (vi) we can see that M^* is positive if $c^* < a/1+\alpha_M$. Moreover, $\hat{M} = \bar{M}$ is larger than M^* as the latter is the interior solution to the first-best optimization problem. In other words, the second-best solution includes more advertising which indirectly increases dissatisfaction due to non-conformity.

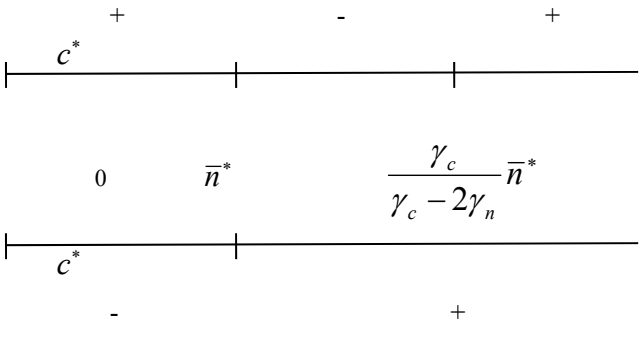
Comparison of G^* and $\hat{G}$ in row (vii) shows that $G^* > \hat{G}$ if $c^* < a/1+\alpha_M$. However, information provision by the government in order to counteract advertising efforts by private firms may not be an optimal strategy for two reasons. First, it distracts funds from more useful applications, i.e. which yield more utility in the end. Second, it increases overall information which can lead to excess information and associated with this confusion among consumers. This effect is, evidently, not captured by the model.

Next, we compare the pollution taxes in row (viii). We find that if $\bar{n}^* < \hat{\bar{n}}$ then $\tau_P^* > \hat{\tau}_P$ as long as $\gamma_P > \gamma_c - 2\gamma_n$ and $\bar{M}$ is large. It follows that the presence of marketing which pushes up consumption norms implies higher taxes on pollution than standard theory would recommend. For an extreme case, where $c = \bar{n}$, we have $\hat{\tau}_p = 0$ because $c = \bar{n}$ in the utility function causes the second term to be infinite[17].

The interpretation of the results in (ix) depends on whether the advertising externality is negative or positive. If $\gamma_c < 2\gamma_n$ and $c^* > \bar{n}^*$ ($c^* < \bar{n}^*$) then $\tau_M^* < 0$ or a tax (subsidy). This condition means that the tax is optimal for high consumption when the norm effect on utility is relative large, compared with the direct utility obtain from consumption (regardless of the

[17] A utility function of the following type would keep the second term finite:
$U_i = \gamma_c \ln c_i - \gamma_n \ln(d + n_i) + \gamma_l \ln l_i - \gamma_P P$ with $d > 0$. We tried to solve the problem for this specification but no analytical solution could be obtained.

norm). If $\gamma_c > 2\gamma_n$ then if $c^* > \overline{n}^*$ and $c^* < \frac{\gamma_c}{\gamma_c - 2\gamma_n}\overline{n}^*$ it follows that $\tau_M{}^* < 0$. If however for these parameter conditions $c^* > \overline{n}^*$ or $c^* > \frac{\gamma_c}{\gamma_c - 2\gamma_n}\overline{n}^*$ then $\tau_M{}^* > 0$, that is, a tax on advertising would be optimal. In case $c^* = \overline{n}^*$ it follows that $\tau_M{}^* = 0$ (boundary condition). Figure 3.1 summarizes these results. It draws the ranges of c-values where a tax or subsidy on advertising is socially optimal. For different conditions different optimal policy settings result.



Condition	Interpretation
$\frac{\gamma_c}{\gamma_c - 2\gamma_n} > 1$	Norm following contributes relatively little to utility
$\gamma_c < 2\gamma_n$	Norm following contributes relatively much to utility

Figure 3.1 Tax (+) or subsidy (-) on advertising is optimal.

3.5.2 A model with a linear function reflecting status sensitivity or seeking

Here we consider an alternative norm function, namely of the form:

$$n_i = \frac{c_i}{\overline{n}} \tag{33}$$

This reflects a non-symmetric effect, that is, being below a norm is unattractive unlike being above it. This means that this function can also be interpreted as representing a status-seeking effect. The purchase of conspicuous (pollutive) products is encouraged as each consumer's level of utility decreases if average consumption increases. Because of the different norm function we have to slightly change the utility function to:

$$U_i = \gamma_c \ln c_i + \gamma_n \ln n_i + \gamma_l \ln l_i - \gamma_P P \tag{34}$$

The other specifications remain the same. The resulting social optimum is as follows (indexes are omitted to keep the presentation simple):

$$c = \frac{\alpha_P(\gamma_c + \gamma_n)}{N\gamma_P} \tag{35}$$

$$l = \frac{\alpha_P \gamma_l}{N^2 \gamma_P \alpha_L} \tag{36}$$

$$n = \frac{\alpha_P (1+\alpha_M)(\gamma_c + \gamma_n)}{aN\gamma_P} \tag{37}$$

$$\bar{n} = \frac{a}{(1+\alpha_M)} \tag{38}$$

$$P = \frac{N(\gamma_c + \gamma_n) + \gamma_l}{N\gamma_P} - \frac{b + \alpha_L N}{\alpha_p} \tag{39}$$

$$G = \frac{\gamma_n \alpha_M \alpha_P}{\gamma_P (1+\alpha_M)} - b \tag{40}$$

$$M = \frac{\gamma_n \alpha_P}{\gamma_P (1+\alpha_M)} \tag{41}$$

Equation (35) shows that pollution is the limiting factor of consumption (and production). If the productivity of pollution (α_P) increases, then optimal consumption also increases. If the unitary external cost of pollution (γ_P) increases, then optimal consumption will decrease (ceteris paribus in both cases).

Table 3.4 summarizes the tax solutions in the two cases, when the social planner either accounts for the status effect in setting the optimal tax rates and when she does not. The optimal pollution tax is equal to $\tau_P = \alpha_P$ which is higher than the pollution tax without status effects (see below), that is if $0 < \gamma_c < 1$. A pollution tax drives up the price of the consumption good and thus lowers the real wage, causing households to work less and consume more leisure. Note that equation (35) shows that if there are more individuals who suffer from the environmental externality then the level of optimal consumption goes down. The marketing tax can be rewritten as $\tau_M = \left(\alpha_M / \alpha_{Pc}\right)\tau_P$ so that $\tau_M / \tau_P = \alpha_M / \alpha_{Pc}$. This shows that the economic rate of substitution equals the technical rate of substitution. The optimal level of information provided by the government to counteract the negative welfare effect of advertising is equal to

$$G = \frac{\gamma_n \alpha_M \alpha_P}{\gamma_P (1+\alpha_M)} - b$$

If the social planner does not account for social interaction effects (case 2), standard environmental policy leads to a Pigouvian tax at the level of $\tau_P = \alpha_P / \gamma_c$, while $\tau_M = 0$ and $G = 0$.

Table 3.4 Explicit solutions for the optimal environmental (Pigouvian) tax, advertising tax, and public information provision.

Case	Pigouvian tax	Advertising tax	Public information provision
(1) Policy under consumption norms	$\tau_P = \alpha_P$	$\tau_M = \alpha_M$	$G = \frac{\gamma_n \alpha_M \alpha_P}{\gamma_P (1+\alpha_M)} - b$
(2) Standard (environmental) policy	$\tau_P = \frac{\alpha_P}{\gamma_c}$	$\hat{\tau}_M = 0$	$G = 0$

3.6 Conclusions

Traditional policy theory based on rational agents assumes that consumer preferences are exogenous and independent between agents. Consistent with this it neglects the impact of advertising by private firms on preferences. Behavioural economics has provided strong evidence, however, that welfare is affected by social context variables, such as norms and status. These provide a suitable basis for commercial advertising to act upon with the aim to promote consumption. We have taken this here as a starting point to study the social welfare effects of advertising and associated public policy in the context of environmental externalities.

The few general economic and policy studies which include advertising have assumed either that preferences are fixed, or that there are no environmental externalities. Combining advertising with fixed (or exogenously changing) preferences does not make much sense. If preferences are assumed to be fixed or unaffected by advertising it is logical that advertising will have a positive effect on social welfare. That is, if it solves problems of lacking information for consumers. We have adopted another starting point, based on the broad literature which has been critical of the social benefits of advertising, namely that advertising creates dissatisfaction with current consumption and creates new wants. This then gives rise to an information-related externality and thus social costs. Such an externality effect of marketing or advertising is particularly clear in the case where private firms affect consumption norms associated with conspicuous goods by engaging in advertising activities. If as a result of this the norm increases, individuals previously complying with it will deviate from it and thus loose utility. This can be regarded as an unintended and therefore external effect. This suggests the need for public regulation of advertising, which goes beyond advertising bans in particular media or for a limited set of goods (such as alcohol and tobacco).

We have developed a model of behavioural economics which allows us to account for consumption norms or status sensitivity in combination with advertising in a policy relevant context of pollution and associated environmental externalities. This combination is motivated by the fact that consumption often involves commercial advertising as well as generates considerable pollution over the life-cycle of the goods involved. We mentioned the examples of cars, holidays and houses. In effect, our approach involves studying optimal environmental policy when consumer preferences are influenced by privately and publicly provided information. The reason is that consumers are motivated to conform to a norm of consumption of polluting goods and services which is affected by commercial advertising as well as public information provision In particular, advertising can magnify negative environmental externalities by stimulating the consumption of very pollutive goods, i.e. it contributes to affluent effluents. In addition, advertising causes dissatisfaction with current consumption and creates new desires, thus lowering the utility of current consumption. This can be considered a double externality problem. Tinbergen's theory of economic policy acknowledges the need for multiple policy instruments in order to impact multiple policy (including externality) problems. In particular he argued that the number of instruments needs to be at least equal to the number of targets (Tinbergen, 1956). Our model includes two types of externalities which then requires at least two policy instruments. The social welfare analysis shows that advertising reduces social welfare and if not regulated will attain a socially excessive level. We find that a tax on advertising can induce firms to internalise the associated social cost of advertising in its private costs, which brings private decisions in line with social interests. The social cost of advertising arises from marketing efforts, which first affect the (consumption) norm, subsequently the consumption choices by all consumers, and ultimately utility.

From our analysis it further follows that the presence of norms implies higher taxes on pollution than standard theory would recommend. That is, since pollution is likely to be higher if there is social interaction (i.e. a consumption norm driven by advertising) that pushes up consumption norms, and thus average consumption and pollution, Pigouvian taxes have to be adjusted as well. A third instrument, information provision by the government or a type of "non-commercial counter-advertising" may offset the negative welfare effect of commercial advertising. Self-regulation as an alternative to government regulation was not considered here as there is little evidence of its effectiveness and as it requires another type of analysis. Our results have been tested for two norm functions, a linear and a quadratic one.

For the first functional specification, which reflected the existence of consumption norms and consumers being conformists (i.e. certain consumers, or for certain goods or services), the results are as follows. The presence of a norm implies higher taxes on pollution than an optimal environmental tax based on a standard theoretical model, depending on whether the advertising externality is negative or positive. The case of the norm effect on utility being

relative large is the most relevant case as here marketing has much impact. In this case, an advertising tax (subsidy) is optimal when equilibrium consumption is above (below) the norm. When the norm effect is relatively small a more complex tax/subsidy scheme is optimal. The details of the optimal regulation of advertising are summarized in Figure 3.1

The second functional specification reflected status seeking by consumers. In this case a more uniform result emerges. Consumers desiring to purchase conspicuous, often very pollutive, products, such as cars, leads to the policy conclusion that the advertising of such goods should be taxed in order to internalize the social cost of these consumption strategies. The optimal pollution tax here is higher than for the case without status effects for certain (likely) parameter values. The reason is that it accounts for the consumption externality created by status seeking and thus provides a stronger incentive to reduce consumption and thus pollution.

Turning to the question of the value and practical implication of the presented research we recognize that no one has dealt with the combination of environmental and advertising externalities as we do. For some our research results about governmental policies may seem too obvious from the statement of the problem – if advertising increases the social norm from consuming a polluting good then advertising needs to be regulated, for example, through a tax. Indeed, negative externalities should be taxed, and positive ones should be subsidized. This is in line with basic policy models in environmental and public economics. However, we would argue that our result is not that trivial, for two reasons. First, we show which particular policy package is needed to restore optimal social welfare. Second, we consider two particular cases giving two sets of (conditional) results.

Concluding, accounting for advertising and associated endogenous consumer preferences leads to a different set of environmental policy instruments and settings than under traditional assumptions. Further research can extend the model to a dynamic context which allows making the long-run effects of preference change instigated by marketing and advertising more explicit. This probably would require a dynamic (possibly evolutionary) approach as the core question here is whether the norms (or behavior) of a small part (niche) of environmentally-conscious and altruistic consumers can diffuse to become common in the entire population of consumers. In addition, different specifications of norm functions and the way these translate into optimal policy rules can be studied. Finally, the specific role of advertising in production and associated constraints and private costs might be elaborated.

Appendix A2.1: Lagrangian for the social welfare maximization

$$\begin{aligned}\mathcal{L} &= \sum_{i=1}^{n} \mu_i u_i(c_i, n_i(c_i, \overline{n}), l_i, P) - \sum_{i=2}^{n} \mu_i u_i^* + \lambda_c \left(f(L, P, M) - \sum_{i=1}^{n} c_i - G \right) \\ &+ \lambda_{\overline{n}} \left(g(G, M) - \overline{n} \right) + \lambda_l \left(\sum_{i=1}^{n} (1 - l_i) - L \right)\end{aligned} \tag{A1.1}$$

Differentiation with respect to each variable yields the first-order conditions ($i = 1,\ldots,n$):

$$\frac{\partial \mathcal{L}}{\partial c_i} = \mu_i \left(\frac{\partial u_i}{\partial ci} + \frac{\partial u_i}{\partial n_i} \cdot \frac{\partial n_i}{\partial c_i} \right) - \lambda_c = 0 \tag{A1.2}$$

$$\frac{\partial \mathcal{L}}{\partial l_i} = \mu_i \left(\frac{\partial u_i}{\partial l_i} \right) - \lambda_l = 0 \tag{A1.3}$$

$$\frac{\partial \mathcal{L}}{\partial \overline{n}} = \sum_{i=1}^{n} \mu_i \left(\frac{\partial u_i}{\partial n_i} \cdot \frac{\partial n_i}{\partial \overline{n}} \right) - \lambda_{\overline{n}} = 0 \tag{A1.4}$$

$$\frac{\partial \mathcal{L}}{\partial P} = \sum_{i=1}^{n} \mu_i \left(\frac{\partial u_i}{\partial P} \right) + \lambda_c \left(\frac{\partial f}{\partial P} \right) = 0 \tag{A1.5}$$

$$\frac{\partial \mathcal{L}}{\partial L} = \lambda_c \left(\frac{\partial f}{\partial L} \right) - \lambda_l = 0 \tag{A1.6}$$

$$\frac{\partial \mathcal{L}}{\partial M} = \lambda_c \left(\frac{\partial f}{\partial M} \right) + \lambda_{\overline{n}} \left(\frac{\partial g}{\partial M} \right) = 0 \tag{A1.7}$$

$$\frac{\partial \mathcal{L}}{\partial G} = \lambda_{\overline{n}} \left(\frac{\partial g}{\partial G} \right) - \lambda_c = 0 \tag{A1.8}$$

Chapter 4.

Reputation and household recycling practices: Field experiments in Costa Rica *

4.1 Introduction

Current solid waste management practice and recycling activities in Costa Rica aims to reduce urban pollution faces many problems. A considerable amount of domestic waste is illegally disposed of, while on average only less than 10% of the city's waste is recycled after separation at the household. The lack of infrastructure for recyclable materials, the absence of separation centers, and limited funding for the creation of proper landfills are some of the main obstacles to a suitable development of source separation and waste reduction. Recently, the government of Costa Rica passed legislation aimed at reducing pollution by modifying how people dispose of their waste and how much they recycle. Suggestions include improving waste management practices through technical innovation, increasing the number of landfill projects and promoting source separation to significantly reduce the volumes going to final disposal (Presol, 2008). Until now there has been little organizational effort to facilitate the waste recycling of private households. So far, only some community-run recycling and education centers have been initiated, including the set-up of information guides for households, the operation of collection trucks and the establishment of centralized separation centers. This may not be sufficient in scale to contribute significantly to environmental protection and conservation. To understand how to encourage participation in recycling activities, the current research investigates the role of public disclosure in promoting such behavior.

Our premise is that efforts to design successful environmental policy instruments and regulations may want to consider the role of pro-social motivations underlying sustainable and unsustainable behaviors. Pro-sociality can be defined as behavior that benefits others at a cost to oneself (Andreoni, 1989; Rabin, 1993; Fehr and Fischbacher, 2003; Bénabou and Tirole, 2006). Recent studies have investigated the important implications of pro-social behavior for environmental conservation, i.e. pro-environmental behavior (Stern, 2000; Biel and Thøgersen, 2007; Hage et al., 2009; Steg and Vlek, 2009). Experimental evidence affirms the significance of pro-social motivation in environmental conservation, such as the sustainable harvest from

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common-pool resources or investments in climate change mitigation (Ostrom et al., 1994; Milinski et al., 2008).

It follows from the empirical and experimental literature that there may be different motives for individuals to behave pro-environmentally. On the one hand, Deci (1972) argues that an individual's intrinsic motivation, a form of impure altruism (Andreoni, 1989), is the main motivator of individual behavior. Related social preferences like fairness or reciprocity are other explanations (Fehr and Schmidt, 1999; Gintis et al., 2003). On the other hand, it is believed that extrinsic motivation based on incentives altering cost-benefit ratios can shape an individual´s motivation to behave pro-environmentally. This is supported by many economic studies which stress the incentive role of prices (taxes, charges, levies, subsidies). Nevertheless, a growing literature predicts that such external incentives can conflict with intrinsic motivation and may partially or wholly crowd out environmental preferences (Frey, 1997; Cardenas et al., 2000; Gneezy and Rustichini, 2000; Heyman and Ariely, 2004; Ariely et al., 2009).

While economic incentives can certainly foster more sustainable behavior, the social, non-monetary aspects of decisions involving the environment are often ignored. Research in behavioral economics and social psychology suggests that social interaction shapes pro-social environmental behavior. Empirical and experimental evidence shows that reputation provides motivation for pro-social acts and cooperation in general. In fact, many people engage in pro-social behavior in order to improve their self-image and their reputation, hoping to feel proud or trying to avoid feelings of shame (Gächter and Fehr, 1999; Rege and Telle, 2004, Semmann et al., 2005; Bénabou and Tirole, 2006). These findings suggest that linking environmentally relevant behavior to reputation and emotions may be an effective strategy to foster sustainable behavior (Stern, 2000). As a result, policy may attempt to appeal to feelings of pride and shame to motivate environmental conservation behavior and policy support (Markowitz and Shariff, 2012).

Shame and pride are common forms of social sanctioning and rewarding to encourage desired behaviors. For example, in education the best and worst students are often disclosed and singled out in front of their entire class community. In Mexico, the worst-performing student needs to wear "orejas de burro" (donkey ears) during class time to signal his/her negative evaluation by the teacher to others while the best student is awarded with a crown to positively stand out from others. Such a social reward and penalty policy is supposed to motivate students to learn and strive for better achievements. Another example from Latin America is that small shopkeepers in Costa Rica publish the name of the largest debtors on a list posted next to their cash counters. This reflects the assumption that feelings of shame and guilt are strong incentives to shape behavior, even when monetary incentives like fines or interest on the debt fail to do so.

There are a number of studies that employ information disclosure to motivate cooperative behavior and investigate its impact on public good provision in general. In the

laboratory, Rege and Telle (2004) use a one-shot public goods game where all subjects' identities were revealed after contribution decisions were made. Contributions increased from 34.4% in the treatment without disclosure and approval possibilities to 68.2% in the approval condition. Similarly, List et al. (2004) confirm the increase of donations to an environmental charity if made public. Lopez et al. (2009) in a field experiment with coastal communities using a standard linear public goods game randomly reveal one member out of the five-person group and find that contributions to the public good increase from 14.6% without random revelation to 20.2%. Barr (2001) obtained similar results in rural communities in Africa. Alpizar and Martinsson (2012) find that donations upon entering a protected area are significantly more frequent for individuals who are members of a group, compared to visitors arriving alone to the park. Moreover, when a third party is present, total donations by individuals who are part of a group are significantly higher.

The objective of this Chapter is to explore non-monetary incentives affecting the decision to engage in recycling activities at the household level, involving costly and time-consuming effort. In particular, we investigate the hypothesis that people can be motivated by feelings of pride, shame or both, as their behavior is disclosed to their neighbors. Moreover, we also explore which of the two mechanisms is more effective in enhancing pro-environmental behavior. We use a modified public goods experiment to study the effect of exposing behavior that falls below a set threshold of acceptable contribution. While in real life, the threshold for adequate behavior is oftentimes endogenous, in our own experiment, the threshold was determined ex-ante and set by the experimenter. This is similar to governments mandating firms to disclose corporate sustainability information on the basis of prior set sustainability benchmarks and guidelines.

In the field experiment, people participated in a series of one-shot threshold public goods games. In a typical threshold public goods game, participants are given a certain endowment that they may either contribute to a public good or keep to make up their personal payment. Only if a group of participants collects a pre-announced target is the public good provided for and its payoff is evenly divided among the group. However, if contributions are insufficient, the public good is not provided for and any contributions are lost. In some variants of the game, the contributions are refunded if the target is not met (Marks and Croson, 1998). To our knowledge, only a few experimental studies have examined the determinants of local public goods provision in developing countries with a threshold involved. For example, De Hoop et al. (2010) shows that people are willing to contribute substantially to a health education program in Peru which is only realized if the cumulative investment surpasses a certain threshold value. The results show that donations are influenced by time preferences where participants with high discount rates contribute less than others. Carlsson et al. (2010) study the impact of social influence on individual willingness to contribute to the funding of a bridge in a

rural village in Vietnam and find significant and substantial effects when reference information on the behavior of others is provided. For example, if the reference level is zero contribution, this reduces average donations by almost 20%.

These previous field experiments focus on typical donations with the possibility of a refund, thus ignoring the fact that much individual pro-environmental behavior, and recycling efforts in the household in particular, is devoted to ends that exclude the possibility of refunding. In our experimental design, we implement a field experiment involving contributions to a real community project under different incentive structures. The situation was framed as a decision on how much effort (time) to dedicate to recycling, since time is likely to be the largest cost associated with sorting solid waste in a household. In case a group of four participants reached a minimum total time dedicated to recycling, the monetary value of that time was then donated to fund an education program in the community aimed at encouraging solid waste management. If the threshold was not met, the value of recycling effort was not refunded, and hence was lost. Our three treatments consisted of one designed to expose groups below the threshold (shame treatment) and a second one aimed at rewarding those above the threshold (pride treatment). Moreover, we compare these results to a treatment with an environmental regulation mandated as minimum contribution to the public good. In this way the impact of external interventions on intrinsic motivation can be examined. We also asked participants to fill out a questionnaire in order to assess the effect of individual characteristics and social context on experimental outcomes.

We find that disclosure of information leads to approximately 20-30% higher investments in conservation, demonstrating that both shame and pride can increase pro-environmental behavior. In addition, we observe that negative information provision in the form of shame and disapproval results in higher average contributions to the public good compared to the pride treatment. We also find that a standard environmental regulation can crowd-in pro-environmental behavior, probably as a result of eliminating the risk of not meeting the threshold. Our insights may point the way towards effective communication strategies to increase recognition of pro-environmental behavior and motivate public support for environmental conservation polices.

The remainder of this chapter is structured as follows. Section 4.2 introduces the experimental design as well as details about the procedure. Section 4.3 presents the organization of the experiment, while results are given in Section 4.4. Section 4.5 draws conclusions and derives policy lessons.

4.2 Experimental design

We apply a threshold public goods game sharing the features of the work of Milinski et al. (2008) to a field context. In our experiment, subjects are assigned to groups of four players and individual endowment is set to 5 points, which is denoted as x_i.[1]

In the experiment we used a random partner matching protocol, thus subjects remained anonymous to the other members in their group during the course of the experiment. Participant *i* can distribute their total endowment available to a public, as well as their private, account. Furthermore, to enhance external validity and to facilitate comprehension, we tried to keep the experiment as close as possible to the participant's daily household behavior. We suggested to participants that they imagine the time used for recycling in their household when allocating points to the public account. Players knew that if the group total allocated to the public account reached or surpassed 12 points, the value of the sum would be donated to a local NGO[2] to fund recycling workshops in the community. If voluntary contributions were insufficient to meet this collective goal, the group contribution was lost and remained with the experimenter. All group members always kept any endowment not invested into the public account.

We ran various pilots with a higher endowment (10 points) but it quickly became apparent that larger endowments lead to excessive nervousness in our subject pool. Moreover, tokens of lower value were also considered and disregarded, as subjects were more comfortable with rounded numbers.

The payoff to player *i* corresponds to $5-x_i$. We constructed a payoff matrix that was shown during the course of the experiment to the participants. All possible combinations of the earnings from contributions for participant *i* can be read from the matrix (see Table 4.1). The exchange rate used for the payment in the experiment was Costa Rican Colones (CRC) 1000 for 1 point.[3]

To measure the level of contributions under different incentives, our participants were divided into two sessions which we here, but not in the experiment, refer to as pride and shame sessions. The sessions proceeded as follows. Our control round (Round 1) is essentially a threshold public goods game, as described above. In Round 2, participants play the same game with one modification; we told all group members prior to their decision that at the end of this round the experimenter will assign a red flag (green flag) to participants who contributed less than 3 points (more than 2 points) in the shame (pride) sessions. Rewarding and punishing by assigning green and red flags, provided public information, i.e. visible to all participants. At the

[1] We ran various pilots with a higher endowment (10 points) but it quickly became apparent that larger endowments lead to excessive nervousness in our subject pool. Moreover, tokens of lower value were also considered and disregarded, as subjects were more comfortable with rounded numbers.
[2] The local NGO is called Terranostra. It is a well-known and active NGO in Costa Rica, with experience in solid waste management.
[3] At the time of the experiment the Dollar-Colones exchange rate was approximately US$1 = 500 Colones.

end of Round 2, the experimenter removed the flags from the tables of the participants and continued with Round 3. In Round 3, besides having the same characteristics as the decisions in Round 1, all individuals faced a uniform environmental regulation in the form of an obligatory contribution of 3 points. Finally, in Round 4, subjects were exposed to the same incentives as in Round 2.

Table 4.1 Example of payoff matrix.

Points in private account	**Your payment**		**Points in public account**	**Your contribution to the recycling program if your group collects at least 12 points**
0	0 Col.		5	5000 Col.
1	1000 Col.		4	4000 Col.
2	2000 Col.		3	3000 Col.
3	3000 Col.		2	2000 Col.
4	4000 Col.		1	1000 Col.
5	5000 Col.		0	0 Col.

One potential concern is that subjects might be affected by the number of red or green flags they observe in Round 2. Note that our combination of random matching and anonymity ensures that subjects cannot learn who is playing with them, which in turn ensures that behavior is not triggered by awareness of selfish or altruistic behavior in one's own group. Still, if a particular session was characterized by a very high or very low occurrence of red or green flags, this might potentially affect coming rounds. We tested whether the coming rounds of sessions with large occurrence of either type of flag differed from sessions with few such flags, and strongly rejected that concern (chi-square test, p-value=0.794 for green flags and p-value=0.420 for red flags). On average, each session had 24 participants divided into six groups, and the minimum acceptable number of groups was four in any session.

We believe our design accurately captures the decision faced by a given household on whether to engage in separation and recycling activities. A common concern during focus groups is the fact that other households and local governments are ill-prepared to do their part of the separation, collection and transportation processes needed for a successful recycling program, thereby making any effort by individual households futile. The threshold (without refund) public good captures the need to reach a minimum level of separation for any recycling program to be sustainable, otherwise all effort by households that do commit is most likely lost. Moreover, the separation of solid waste in any given household, particularly in the absence of deposit-refund schemes, is likely to bring very small, if any, individual benefits, and all benefits are to be enjoyed by a very large collectivity of citizens well beyond the individual household.

The Milinsky et al (2008) design feature of defining a zero marginal per capita return to the public good in the context of climate change fits our context well too. Finally, we chose to disclose individual and not group behavior because at the level of a neighborhood or a small community (represented by groups of subjects in our experiment), the number of factors affecting the final success of a recycling program are many, and responsibility is therefore diluted. In contrast, a green or red dot at the curbside, were garbage is collected separated or not, would be an easy way of identifying individual actions and hence of bringing our treatment into practice.

4.3 Organization of experiment

In Costa Rica the research took place in an urban neighborhood in San Jose where people face many local environmental dilemmas contributing to serious environmental concerns, such as the absence of recycling and water conservation. Our sample is made up of residents of the community of Santa Rosa, which belongs to the municipality of San Jose. The community of Santa Rosa was selected as it was in contact with a local NGO involved in environmental protection and conservation issues and until now no local recycling initiatives have been initiated there. In recruiting people, the same NGO facilitated the organization of invitations (leaflets and posters) and local logistics for each experimental session. The days before experimental workshops were carried out a member of the NGO advertised the workshops, distributed invitations and signed up interested people for the scheduled experiments (see Appendix A4.1 for an example).

When the experimental workshops were advertised, potential participants were informed that their task was to make economic choices and that the amount that they would earn depended on their own decisions. Based on the assumption that some of the people who committed may later not show up at the experiments, we chose to sign up the maximum number of people (35 participants) we would be able to handle altogether in the experiment. Furthermore, we took care that only one member from each household, preferably the head of household activities, which in most cases was a woman, signed up for the workshops. In total, 237 people took part in the field experiment at the local school or community center during April 2011. Apart from this, we conducted various separate pilot studies in the community with a considerable number of participants (113). Table 4.2 summarizes the descriptive statistics of the community data and the sampled participants.

Table 4.2 Descriptive statistics of community data and sampled individuals/households.

	Community	**Sample**
Population	2360	237
No. households	439	237
Women	51%	85%
High school completed	62%	56%
Pride treatment		118
Shame treatment		119

Source: Census data Santa Rosa municipality.

On the day of the experiment, the participants who showed up for their experimental session were asked to provide their identity and were checked against the list of names of people who had already participated. By following this strategy, we avoided double participation and possible multiple participation by members of the same household. Once the sign-up procedure was complete, participants were seated at single tables in the community´s school class or community hall room. The subjects were randomly assigned to their seats with enough space between the desks to guarantee anonymity when making their decisions. From the outset, participants were instructed not to talk to each other and informed that doing so would mean not being permitted to continue and leaving without any payment. They were informed that they were going to take part in a series of decisions in situations that resemble real life situations. We also clarified that our aim was not to teach them how to recycle. Finally, it was made clear that on the basis of their decisions they were capable of earning a considerable amount of money.

Every participant received a decision manual containing four decision sheets for each round of play (see Appendix A4.2 for an example). The decision sheet served as documentation on which participants recorded the number of points distributed between the private and public account. They received oral instructions on the objectives of the experimental decision task with the aid of a PowerPoint presentation. Emphasis was placed on their understanding of the payment function. Various examples of a hypothetical participant dividing his/her endowment between the public and private account were explained in detail in order to enhance subjects' understanding on this important matter. We decided to present a set of examples of possible distribution choices in order to avoid participants being primed on some particular choice. To make sure that everyone understood the decision task before starting, all participants played a practice round that was designed to test their understanding of the experiment and any remaining questions were answered in private.

The procedure during Round 1 was as follows: the subjects needed to decide on how to distribute their endowment between the public and private accounts. They had to indicate their distribution on their decision sheet. The following instructions were read to them in Spanish before making their decision: *Suppose that the 5 tokens you received are equivalent to time and*

effort recycling. Each token has a value of ₡1000.We want you to tell us how many tokens you want to put in your personal account, where you are free to spend them as you please; and how many tokens you want to put in the common fund. Remember that you are part of a group of four persons, and that if the common fund has at least 12 tokens, we will then donate the total amount to Terranostra. Enough time was given to the participants to think about their distribution decisions. Following this, experimenters checked if all participants had made their decision and subjects were advised to turn the page of the decision manual and wait for instructions for the following round. In the information disclosure treatments, a team of assistants verified the value of individual contributions and assigned green or red flags to the concerned players depending on whether the session included a pride or shame treatment. Flags were placed on the table and subjects were asked to look around to get a better impression of the behavior of others. The flags were then removed before the next round started.

Note that during the course of the various rounds, group contributions and individual earnings were not computed, and thus no additional information was provided to them. After all rounds were completed, we asked participants to remain seated and follow a standard random procedure for the selection of the round which was used as a basis for their payment calculation. Similar to a lottery, one participant was asked to randomly draw out of a box containing four numbered balls (1-4) resembling all rounds played. After the end of the experiment and payment selection, the participants were asked to complete a questionnaire aimed at eliciting socio-economic data, motivation in the game, environmental attitudes and social background information (see Appendix A4.3).

Finally, subjects received their earnings from the experiment plus a show-up fee of 2000 CRC ($5). In total, sessions lasted approximately 2 h and subjects earned on average 5000 CRC ($10) in total (including show-up fee). The total sum of money invested in the public account accumulated from all sessions was donated to Terranostra to be used for environmental education in the community after the completion of the study. In total, the sum of $2404 was donated to this local NGO.

4.4 Experimental results

A total of 237 observations were gathered in 12 workshops with a minimum size of 4 groups. In this section, we present an overview of the results for all experimental treatments to explore our main research questions: 1) whether positive information disclosure (pride treatment) is more effective than negative information disclosure (shame treatment) in achieving the high levels of household recycling effort needed to justify implementing a municipal recycling system, and how these reputational incentives perform relative to an environmental regulation, and 2) whether an environmental regulation crowds out recycling efforts, particularly of those initially

committed to solid waste management. For both questions, we use individual contributions and also observe whether a four-player group is successful in reaching the contribution threshold.

As an order test, all sessions included a Round 4, repeating the reputation treatment (either pride or shame) of Round 2, and we cannot reject the null hypothesis of no order effects. In the analysis that follows, the shame (n_s=238) and pride (n_p=236) treatments include data from both Rounds 2 and 4. These subsamples are then compared to Round 1 in all sessions (n_c= 237). Moreover, the regulation treatment in Round 3 is not significantly different from the control (Round 1) in either the session with shame or pride treatments, so again data from all sessions is pooled (n_r=237).

4.4.1 Shame and pride

Table 4.3 summarizes the average level of individual contributions in the control, pride and shame treatments. In addition, this table mentions the success rate of four-player groups (i.e. proportion of groups reaching the collective threshold of 12 points).[4] In the control treatment, the average investment is below 2 and thus the lowest relative to all other treatments. As expected, both treatments led to a general increase in average individual contribution and higher group success rates. In the pride treatment, average individual contributions are significantly higher (by 21 per cent) than in the control (*t*-test, p=0.002). Similarly, the shame treatment results in contributions that are 39 per cent higher than in the control (*t*-test, p=0.000).

Table 4.3 Average individual contributions and group success.

Treatment	N	Individual contribution mean (in points)	Group success (# groups)
Control	237	1.86	14%
Pride	236	2.25	23%
Shame	238	2.58	32%

We also analyze differences in individual contributions between shame and pride treatments. The disclosure of negative information about the subjects' pro-environmental decisions results in significantly higher contributions, compared to the provision of positive information (*t*-test, p=0.012). Figure 4.1 depicts the distribution of individual contributions under the three treatments, clearly showing that the two information disclosure treatments lead to more frequent amounts higher than, or equal to, three.

[4] In some workshops, the number of participants resulted in a few groups of less than four players. Since participants were not aware of whether their group was complete or not, their decisions are still included in the analysis of individual behavior, but dropped from the analysis of group behavior.

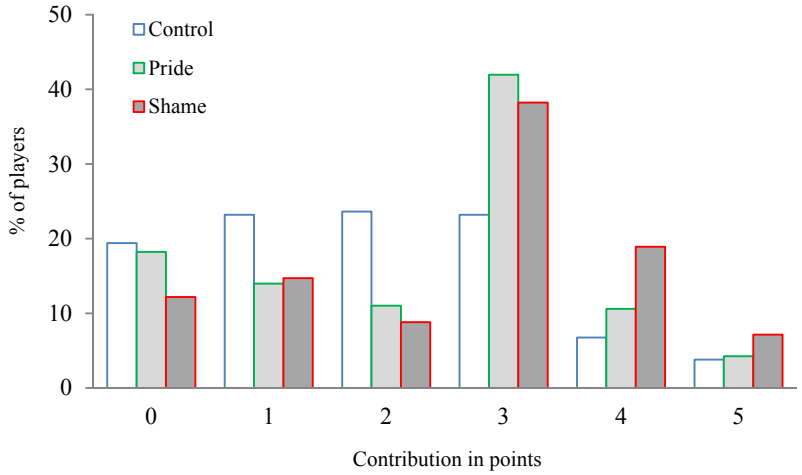


Figure 4.1 Histogram of individual contributions in different treatments.

Regarding group success in reaching the public good threshold, the disclosure of information increases the number of groups that manage to reach the threshold. In the control treatment, only 14% of all groups succeeded in reaching the contribution threshold in the control treatment, versus 23% and 32% in the pride and shame treatments. Using the group as the statistical unit of analysis, we find that only the disclosure of negative information in the shame treatment significantly increases group success, compared to the control (proportion test, p=0.016). The difference for the pride treatment is not statistically significant (proportion test, p=0.215). Although the group success rate in the shame treatment is circa 40% higher than in the pride treatment, this difference is not significant (proportion test, p=0.243). Figure 4.2 presents average group contribution by treatment and success rate.

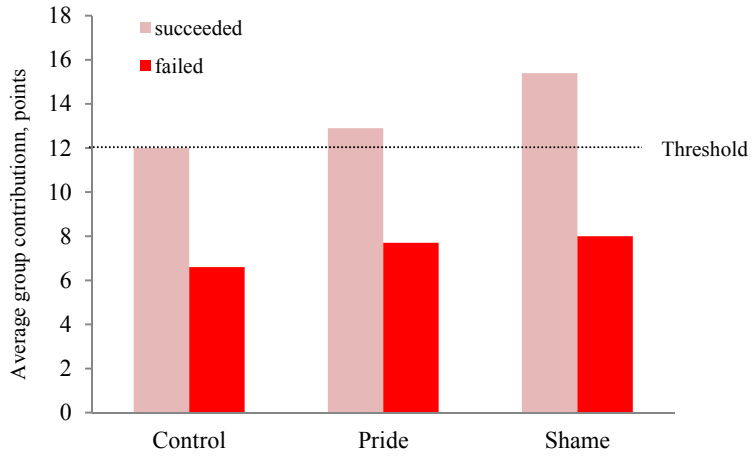


Figure 4.2 Average group contribution by treatment and success rate.

4.4.2 Environmental regulation

We also investigate the average number of points when subjects faced a minimum compulsory contribution of three points. This obviously leads to higher mean contributions equal to 3.69 points (p-values=0.000 in all cases) and a very low standard deviation (std=0.72, compared to 1.35 in the control) indicating individual contributions were clustered around the mean.

In the regulation treatment, the interesting analysis focuses on the change in the subject's decisions when a compulsory contribution is imposed for subjects that have shown a strong pro-environmental inclination by contributing three or more points in the control. We find that most individuals who contributed exactly three points in the control treatment tend to increase their contributions (in total 85.4%), i.e. when faced with the regulation they contribute more than the compulsory three points. Moreover, individuals providing more than three points in the control (altruists) mostly maintain their contributions in the regulation treatment, and only 13% decrease their contributions.

In contrast to our expectations and previous results from field experiments (e.g. Cardenas et al., 2000) we find no evidence of crowding-out when contributions are regulated by a minimum contribution, but rather most players decided to contribute even more than just the mandated three points. There are several possible explanations for this finding. First, information from the exit questionnaire sheds some light on the reasoning used by most subjects. When asked whether recycling should be regulated by law, more than 80% answered positively. Second, it could be that the compulsory contribution when applied to a threshold public good game takes away the uncertainty associated with losing the contributions if your group members fail to reach the threshold. In the contextualization of the experiment, we emphasized the importance of getting everybody involved, since neither the government nor individual household can sustainably implement a solid waste management program on their own. This was again captured by the exit survey, where fear of losing their time and effort recycling hampers a bigger involvement of the community members in the program. Again, the following reactions to a suggested mandatory recycling program reflect such concern: "if it is mandatory, it permits everyone to be aware of their own responsibility", or "I agree, because in this way we can create a standard protocol and it will be clear for everyone what and how to do it".

4.4.3 Individual types

Continuing with the analysis, we classified subject's decisions into three categories depending on their level of contribution. A subject decision is considered *selfish* if he/she invested less than three points. *Limited altruists* are subjects that contributed exactly three points to the public good. We call a subject's decision *altruistic* if the participant invested more than three points.

The shares of subject's decisions classified into the aforementioned categories in all treatments are shown in Table 4.4.

Concerning the distribution of subject choices, we observe that in the control treatment most subjects behave like free-riders, and only a small share of all subjects (11%) can be classified as altruists, i.e. players contributing more than three points. Such results are in line with results from Milinski et al. (2008), which, using a similar experimental design, find that 60% of subjects are selfish.

Table 4.4 Proportion of individual types in the experiment.

Type of subject	**Control**	**Pride**	**Shame**	**Regulation**
	Anonymous condition	**Exposure of altruistic behavior**	**Exposure of selfish behavior**	**Minimum contribution**
selfish	66%	43%	36%	0%
limited altruist	23%	42%	38%	46%
altruist	11%	15%	26%	54%
no. of observations	237	236	236	237

Importantly, the distribution of selfish, limited altruists and altruist decisions is significantly different in the treatments in which decisions are publicly disclosed, when compared to the control (chi-square test; p=0.000 in both tests). Transparency achieves a significant increase in choices that meet the threshold of altruism.

A key difference between the pride and shame treatments is that the former singles out altruistic decisions by rewarding subjects with a green flag if contributions are equal or larger than three, whereas the shame treatments singles out selfish decisions by disclosing subjects contributing less than three. Indeed, we find that the shame treatment results in a significantly lower share of selfish decisions when compared to the control (proportion test, p_s=0.000), and also compared to the pride treatment (proportion test, p=0.09). Unexpectedly though, we find that even the share of altruists is significantly higher in the shame treatment (proportion test, p=0.002), confirming the social strength of disclosing negative information to change subject's decisions.

4.5 The link between game behavior and individual characteristics

Finally, we investigate the determinants of individual contributions when subjects faced either the pride or shame treatment. The descriptive statistical information of all participants which we collected in an exit survey is presented in Table 4.5.

In line with previous research (e.g. Alpizar et al 2008), we model contributions as a two-stage decision in which the decision to donate a positive amount is captured by a logit model, followed by the decision on how much to donate, which is analyzed using a regression model using only subjects with a positive contribution. For the latter, we use a robust regression approach to deal with possible outliers. We also present a third regression that looks at the probability that a given subject contributed three or more, i.e. the public good threshold.

We focus on differences in the two-stage decision due to the pride or shame treatments, which are captured by a dummy variable that is equal to one in the shame treatment and zero in the pride treatment. Furthermore, we include a dummy (*second round dummy*) to capture potential differences in behavior between the first and second time that subjects faced each treatment in a given session, but this dummy variable is always insignificant. Besides controlling for typical socio-economic characteristics including gender, age, household size, employment, and education we also measured a set of behavioral variables such as associational norms and environmental knowledge and behavior.

Table 4.5 Individual characteristics of participants and definition of variables.

Variable	**Description**	**Mean**	**Sd**
Socio-economic variables			
female	1 = female	0.85	0.35
age	age in years	38.12	15.58
household size	number of household members	4.24	1.68
employment	1 = one member of the household is fully employed	0.65	0.47
education	1 = education less than completed secondary school	0.55	0.49
Behavioral variables			
social norm	1 = more than 50% of their social group is recycling	0.25	0.43
natural capital	1 = player knows how to recycle	0.80	0.39
institutional capital	1 = player knows the legal regulations wrt recycling	0.25	0.43
responsibility	1 = player is responsible for recycling in own household	0.41	0.49
need regulation	1 = player thinks that recycling should be regulated by law	0.84	0.35
legal norm	1 = player thinks that the local government expects recycling	0.91	0.28
warm glow	1 = player appreciates social approval for recycling	0.77	0.42
environmental impact	1(very small) to 5 (very large)	4.37	1.02
governance	1(very good) to 5 (very bad)	2.65	1.27
recycling	1 = the player's household is recycling	0.69	0.46

Table 4.6 shows the three regression results. We find that subjects in the *shame* treatment significantly contributed higher amounts and were more likely to contribute positive amounts

overall. This confirms our statistical analysis in Section 4.5 on the differences between our main treatments, and is in accordance with experimental evidence on the superiority of costly punishment (in our case disclosing a negative value judgment on their behavior) over reward mechanism for maintaining cooperation in public goods games (e.g. Sefton et al., 2007; Rand et al., 2009). Disregarding the numerous design differences in previous studies and ours, it seems that punishment strategies, costly or not, are better than rewards in achieving higher contributions. We also find that *age* seems to be an observable determinant of contribution choice. Thus, older participants in this setting were relatively more likely to contribute more to the public good.

An interesting result is that those who belong in real life to social groups in which a majority of people recycle (*social norm)* tend to contribute significantly more. Here, our simple approach to measure social interaction by categorizing individuals according to their number of pro-environmental friends highlights an actual relationship between social context and contribution behavior. This is in-line with survey based evidence on social networks and their important function for natural resource management (Bodin et al., 2006). Similarly, others highlight the motivational function of the pro-environmental behavior of others on one's own individual practices (e.g. Nolan et al., 2008).

In the case of *responsibility* (a dummy variable that equals 'one' if the participant is the person responsible for recycling in the household), we find it had an unexpected negative effect on contributions: those who are responsible for recycling practices contribute less. Similarly, even if non-significant, *recycling* (a dummy that equals one if the subject's household carries out recycling activities) has a negative sign too. One possible explanation for this is that these subjects might think they are putting enough effort into recycling activities in their real life, and hence refrain from doing so in the experiment.

Other socio-economic variables such as gender, household size and education are all far from significant in any of the models. Employed subjects tend to significantly contribute more, but employment does not in itself determine whether the subjects choose to donate or not.

Table 4.6 Determinants of contributions.

	Model 1		Model 2		Model 3	
	Robust regression of conditional (>0) contributions		**Logit regression Prob (>0)**		**Logit regression Prob (≥3))**	
	Coef.	P-value	Coef.	P-value	Coef.	P-value
Game variables						
shame	0.32	0.026*	0.74	0.055*	0.59	0.021*
second round dummy	-0.04	0.749	-0.42	0.242	-0.09	0.687
Socio-economic variables						
female	0.14	0.464	0.05	0.921	0.02	0.939
age	0.02	0***	0.02	0.12	0.03	0.002**
household size	-0.01	0.769	-0.08	0.441	-0.07	0.343
employment	0.35	0.039*	0.11	0.793	0.40	0.179
education	-0.12	0.449	-0.77	0.052	-0.39	0.152
Behavioral variables						
social norm	0.22	0.213	1.72	0.032*	0.75	0.029*
natural capital	0.39	0.098	0.26	0.627	0.48	0.237
institutional capital	0.26	0.181	-0.82	0.15	0.14	0.695
responsibility	-0.34	0.028*	-0.51	0.203	-0.49	0.07
need regulation	-0.21	0.371	0.55	0.367	-0.10	0.799
legal norm	-0.41	0.127	0.35	0.555	-0.62	0.189
warm glow	0.002	0.99	-0.16	0.704	-0.20	0.511
environmental impact	0.11	0.157	-0.05	0.786	0.15	0.269
governance	0.06	0.268	-0.31	0.036*	-0.09	0.371
recycling	-0.49	0.008	0.38	0.425	-0.61	0.064
r2			0.14		0.08	
number of observations	276		317		317	

Note: * p<0.05, ** p<0.01, *** p<0.001

4.6 Conclusions

This Chapter reports data from a field experiment that investigates the effect of public disclosure on pro-environmental action, and specifically on household solid waste management efforts. By using a modified threshold public goods game based on the design developed by Milinski et al. (2008), we assess the degree of interaction between positive and negative information provision with social preferences and intrinsic motivation that underlie existent environmental practices. We implement four different treatments, namely: disclosure of

negative information enforced through feelings of shame; disclosure of positive information driven by social esteem and pride; and, environmental regulation, in addition to a treatment without any intervention. Our experimental design goes beyond previous field and lab experiments by presenting a test on the relative effectiveness of positive and negative information disclosure in the same setting, while to our knowledge others have focused on introducing only one of the two interventions (e.g. Maier-Rigaud et al., 2010; Lopez et al., 2009) or used disclosure experiments with approval and disapproval mechanisms operating at the same time (e.g. Rege and Telle, 2004; Martinsson and Villegas-Palacio, 2010).

We find evidence indicating that pro-environmental actions can be encouraged by more transparency. Our results indicate that each of our treatments significantly increase contributions to the public good compared to the treatment without intervention. We find that the reputational effects induced by shame and pride led to approximately 20-30 % higher contributions to the public good when compared with a treatment without disclosure, while, notably, negative information provision, i.e. singling out free-riders, outperforms the pride treatment, i.e. singling out those who contribute a lot with respect to higher individual contribution and higher probability of group success.

When we introduce a compulsory contribution equal to the threshold, we find surprisingly that the proportion of subjects contributing more than the regulated minimum contribution, or even their whole endowment, significantly increases compared to all other treatments. These results suggest that the environmental regulation acted as a coordination device for cooperation; that taking away all uncertainty regarding reaching the threshold leads to many participants putting in an extra effort. Another important and related explanation is that, particularly for threshold public goods such as solid waste management, a regulation might be favored as it acts as an important baseline and reference level for individual effort.

Our field experiment provides a practical application of the effect of disclosure-based policies on pro-environmental behavior. Our findings show that the image value of pro-environmental behavior seems to significantly increase with the disclosure of negative information. This suggests that scarce public funds may rather be allocated to discouraging antisocial behavior (singling out free-riders) than to awarding pro-social behaviors (singling out altruists), as the latter may undermine intrinsic motivation. One mechanism that can be applied in the context of solid waste management in developing countries is the disclosure of recycling performance metrics of individual households through the labeling of garbage cans by the local authorities responsible for waste collection. Postings in the local press or placards in stores to single out those households with worse recycling performance may be another approach.

Finally, the importance of leveling the playing field by making sure that nobody's effort goes to waste was found, both in the experiment and in the accompanying exit survey, to be a key element in motivating pro-environmental behavior. Surely a compulsory effort in household

solid waste management is highly unlikely, but authorities should spare no effort in ensuring that a solid waste management campaign is not perceived to be weakened if not all households participate. By showing strong commitment to the campaign authorities can motivate significant effort from individual households.

Appendix A4.1 Invitation letter

INVITACIÓN

Estimados vecinos,

La Universidad CATIE, en colaboración con la Municipalidad de Sto. Domingo desean invitarlo a participar en un taller sobre **desechos sólidos** en los hogares de Costa Rica, en el cual esperamos aprender de su experiencia con el manejo de desechos de su hogar.

En este taller usted tendrá la oportunidad de participar en una encuesta que refleja la realidad del manejo de desechos en el hogar. Por su participación en la encuesta usted recibirá una bonificación en efectivo que dependerá de sus respuestas.

Además como una cortesía el CATIE hará un pago inicial de 2000 colones adicionales a lo que usted reciba en la dinámica, y dará un refrigerio.

El taller tiene una duración de 1 hora y media y se realizará:

Fecha: _____

Hora: _____

Lugar: _____

EfD

CATIE

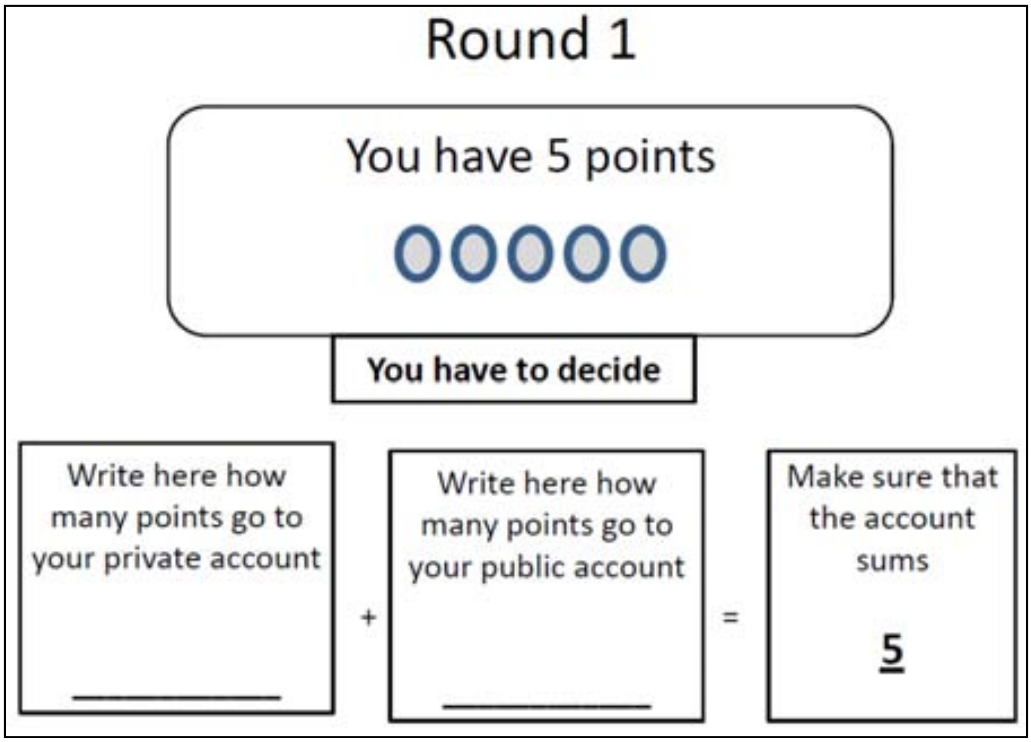
Por favor confirmar su participación llenando la siguiente información:

Nombre: _____

Teléfono: _____

Comunidad: _____

Appendix A4.2 Sample decision sheet (translation from Spanish)



Appendix A4.3 Selected questions from exit questionnaire (translation from Spanish)

Question	Answer scale
Behavioral variables	
(1) Of all of your social group (family, neighbors, friends), how many of them are recycling?	Everyone A Majority About Half Some None
(2) Do you know the legal regulations and laws regulating waste separation in your community and country?	Yes/No
(3) Do you know how to separate waste correctly? Please describe.	
(4) In your household, who is responsible for waste separation and handling?	Myself Others
(5) Do you think recycling should be regulated by law?	Yes/No
(6) Do you appreciate social approval for doing recycling?	Yes/No
(7) How large or small do you estimate the negative consequences (e.g. environmental hazards, health, well-being of your family) of missing waste sorting in your municipality?	Very small Small Medium Large Very large
(1) (8) How would you best describe your municipality's effort of waste collection and processing?	Very good Good Medium Bad Very bad
(9) In your household, are you recycling?	Yes/No
Socio-economic variables	
(10) Gender	Male Female
(11) Household size	#
(12) Profession	
(13) Education	Without education Primary incomplete Primary complete Secondary complete University incomplete University complete Other

Note: No scales are provided for the open ended questions 3 and 12. The responses of question 3 were coded into 1 if player has sufficient knowledge on how recycling works and 0 otherwise.

Chapter 5.

Bounded rationality and social interaction in negotiating a climate agreement *

5.1 Introduction

Climate change can be regarded as a large-scale social dilemma, because it involves a global public good, namely the atmosphere. An effective climate policy aimed at reducing greenhouse gas emissions requires a collective effort by the most important emitters of greenhouse gases. This is difficult to achieve because cooperators - countries reducing emissions - pay the cost of mitigation, while any benefits are shared between cooperators and free-riders alike. A basic problem here is that cooperation is needed among a very large group of unrelated individuals, in effect the entire human population. The issue is further complicated by the multilevel nature of institutions: voters and politicians at national level, and national representatives (negotiators) at an international level.

Two related prominent features of an international climate agreement are temporal and spatial asymmetries of, and uncertainty about, the benefits and costs of mitigation, even under full cooperation (Barrett, 2001; Barrett, 2007). Cooperation means certain costs now but uncertain future benefits, accruing partly to later generations (temporal asymmetry). Moreover, the prospects of benefitting from a stable climate vary widely from country to country (spatial asymmetry). For example, developing countries will generally benefit to a greater extent than developed countries due to the fact that the damage curve is steeper for such countries. As opposed, developed countries carry a main, historical responsibility for the climate problem but are likely to suffer less from it in the future. Associated with this, the costs of an agreement will mainly fall onto a subset of negotiating countries (major emitters), and are more certain than any long-term benefits.

Most economic analyses apply standard game theory to international climate negotiations in order to study the participation decision of negotiators when bargaining over emission reductions.[1] This theory is based on the core assumptions of rational agents driven by net benefit maximization, stable preferences and perfect information (see, for example, Carraro

* This chapter also appears as: Gsottbauer, E., and van den Bergh, J.C.J.M (2012) Bounded rationality and social interaction in negotiating a climate agreement. *International Environmental Agreements: Politics, Law and Economics*, forthcoming.

[1] For an overview of theories of multilateral environmental agreements, including behavioral approaches, see van den Bergh and Castells (2004).

and Siniscalco, 1993, Barrett, 1994; Finus, 2001; Heitzig et al., 2011). This leads to the prediction of free-riding as the dominant strategy. An incomplete agreement or unilateral action are then second-best outcomes. Yet, in both these cases capital flight of dirty industries and thus carbon leakage are likely, with the consequence that emissions reduction will be limited (Babiker, 2001; Paltsev, 2001; Kuik and Gerlagh, 2003).

The assumption of rational agents and self-regard in current analyses of climate agreements is not in line with reality as this approach neglects many important aspects of human behavior. In this respect, much can be learned from behavioral economics which has identified the factors that influence cooperation and generally economic decision-making (Simon, 1955; Kahneman and Tversky, 1974, 1979; Ostrom, 1990; Boyd and Richerson, 1992; Fischbacher et al, 2001; Fehr and Gächter, 2002; Nowak and Sigmund, 2005). Recently, some studies have examined the importance of alternative models of individual behavior for environmental issues (Shogren and Taylor, 2008; Gsottbauer and van den Bergh, 2010). The context of climate negotiations has, so far, hardly been examined. Exceptions are Lange (2006), Gowdy (2008), and Brekke and Johansson-Stenman (2008), who all focus on fairness and discounting.

This Chapter will take a broader view and suggest that, in trying to understand negotiations for an international climate agreement, one needs to take into account a range of aspects of bounded rationality and other-regarding preferences. Our aim is to show how insights will alter, or which new questions will appear, if rationality and isolated individuals are replaced by bounded rationality and other-regarding preferences. This can be seen to provide for a microfoundation of certain political and institutional group processes underlying negotiations. In general, one may expect that with bounded rationality and social preferences the net benefit of cooperation are perceived as lower or higher than with perfect rationality and self-interest. This in turn will affect the willingness to cooperate. Of course, with this approach we do not claim to capture the complete set of factors and constraints determining the outcome of climate negotiations. But we are able to offers some new insights as well as suggestions for making negotiations more successful.

The remainder of this Chapter is structured as follows. Section 5.2 highlights the relevance of bounded rationality and limited self-interest for climate negotiations, distinguishing between behaviors of citizens, civil servants, politicians, negotiators and experts, both at individual and collective levels. Section 5.3 provides a basis for later sections by briefly reviewing the role of communication, punishment and reward in negotiations for an international agreement, as assessed with theoretical and experimental studies. Section 5.4 examines the impact of particular social preferences, including fairness, altruism, spite and parochialism, on striking a climate agreement. Section 5.5 identifies several decision biases, namely loss aversion, framing, risk perception, myopia, cognitive dissonance, and overconfidence, and discusses their implications for climate negotiations. Finally, Section 5.6

draws conclusions and suggests possible strategies to foster cooperation in negotiations for a climate agreement.

5.2 Rationality and negotiations: from voter to negotiator

Negotiations about global public goods involve many actors at different levels, namely citizens and politicians at a national level, and negotiators (politicians or professional negotiators) at an international level. The latter implement certain negotiation strategies, which are guided by national politicians, who in turn need support from voters. In addition, interest groups are influential in political decision-making, as acknowledged in public choice theory (Buchanan, 1984; Mueller, 1989). Each of these actors show bounded rationality and other-regarding behavior, though possibly not to the same extent. For example, many political decisions in the areas of economics and environment show considerable myopia.

At each level of climate negotiations and preparation, information is filtered and decisions are taken by individuals (be it civil servants, politicians, advisors, lobbyists, etc.), which means that the outcomes of negotiations are directly connected to their behavioral features and preferences. Indeed, the latter are crucial for understanding both individual and group processes underlying climate negotiations, where groups may range from teams through regions to countries. Country behavior, for example, may look a bit like the sum (although not exactly, given majority rules in a democracy) of individual decisions, but this does not mean that individual behavioral characteristics are completely lost at "higher" or "representative levels". Understanding the role of nonstandard preferences as one determinant of global climate policy can provide insights about strategies to get out of the current impasse in climate negotiations.

Herbert Simon already argued that politicians are boundedly rational. In particular, when decisions are more complex, political choices generally deviate from perfect rationality. For example, politicians operate under stress and time constraints causing selective attention and oftentimes make decisions based on imperfect information. These limitations lead them to make mistakes so that their choices are better described by "satisficing", i.e. making a choice that is "good enough" rather than maximizing some social welfare function (Simon, 1985). In line with this, limits on human rationality have been identified as playing a key role in political decision-making, such as political failures in cooperation giving rise to wars and overconfidence contributing to the profoundness of the current economic crisis (van Evera, 1999; Johnson, 2004; Shefrin, 2010). This research suggests that behavior by politicians, negotiators, and experts involves many deviations from rationality and selfishness.

Politicians often make use of decision heuristics (Miller, 2009), suffer from unrealistic forecasts based on optimistic judgment (Kahneman and Lovallo, 1993), and tend to be myopic

as they are driven by electoral cycles and short-term economic interests (Congleton, 1992). Myopia is a phenomenon which is often discussed with respect to political decision-making. It means that temporal incentives or preferences of politicians – mainly driven by considerations of reelection – do not match societal interests or the social discount rate. The latter implies taking seriously into account outcomes far in the future. This affects political decision making about climate policy as this involves near term costs and long run benefits. Myopia in effect means neglecting the long term costs of climate change, even though these are the reason to worry about it in the first place.

Not only individuals but also groups and large organizations, such as national governments, are involved in climate negotiations. Many economists (e.g., Williamson, 1981; Colinsk, 1996; McFadden, 1999) agree that bounded rationality is important in understanding decision processes in all kinds of organizations. Jones (1999) observes that in complex environments neither individuals nor groups respond perfectly. Nelson and Winter (1982) introduced the famous concept of routines that determine the practices and processes of many organizations, both in business and political contexts. Moreover, prospect theory has been applied to the study of international relations to explain that decision-making biases and heuristics can favor international conflicts rather than cooperation (Johnson and Tierney, 2003; Kahneman and Renshon, 2006).

Are agents at certain levels more rational than at others? For example, are negotiators or politicians more rational than individual citizens? Assuming that politicians and their representatives in negotiations base their decisions on a wide range of expert opinions, political decisions might be believed to be of a higher quality, better informed and hence more rational than non-political decisions. According to Tetlock (2005), however, professionals are prone to the same biases as non-professionals. He provides empirical evidence asserting disappointing accuracy and forecasting skills of many policy experts. Similarly, Fischhoff et al. (1982) explain that even if experts are knowledgeable, this does not guarantee they can avoid mistakes in intuitive judgments. The misinterpretation of risks is a prime example of a commonly made mistake. As many individual decision biases undermine the objectivity of decision making, Fahr and Irlenbusch (2008) suggest groups of experts or committees as better decision makers. In fact, their experimental results show that groups behave more rationally than individuals. This has important implications for the design of decision-making processes in negotiations or organizations, such as the IPCC. Here, a negotiation committee might be more successful in avoiding common decision mistakes than a single decision leader.

Table 5.1 Actors directly or indirectly connected to climate negotiation.

Actors	Associated groups and organizations
Citizens	Business managers, employees, consumers
Politicians	Political parties, ministries, parliament, government
Civil servants	Negotiators, climate officials, policy makers
Experts/ scientists	Advisory councils (IPCC, UNFCC), energy councils, environmental councils, economic councils, external consultants
Stakeholders / interest groups	Employer organizations (emitters), trade unions, environmental NGOs, consumer organizations

Table 5.1 lists the various mentioned actors and their collective decision-making counterparts. Voter and political interests are connected, as elections lead politicians to compete for votes and consider interests and desires of potential voters. Politicians are also influenced by lobbyists and interest groups. Negotiators and "climate officials" (a term often used in the media to denote civil servants involved in negotiations) possess the characteristics of civil servants which strongly represent national interests. A public choice perspective is that civil servants want to protect their own interests, in particular securing their employment. Climate and economic experts evaluate the status of climate change and its economic impacts under different policy scenarios, which serve as the basis for climate negotiations. Interest groups provide information to policy processes, such as emitters giving detailed advice about available abatement technologies and their costs. Nevertheless, they may seek to influence policy outcomes in their own favor.

In summary, the application of behavioral economics to the analysis of climate negotiations captures certain essential aspects of the real world. As we will see later, this approach allows an explicit treatment of issues such as fairness and framing, which play a very strong role in ongoing negotiations. One may argue that not every step in the negotiation process can be explained by a single behavioral model. For example, Underdal (1998) presents various frameworks (one being the rational actor model) to account for the variance observed in cooperation in, and compliance with, environmental agreements. In addition, some strategic games may explain certain choices. On the other hand, it is likely that long-run negotiation solutions bear a relation to bounded rationality and social preferences, simply because perfect rationality, irrationality, and individual isolation are exceptional or not tolerated in the negotiation process.

5.3 Communication and incentives to induce global cooperation

This section will draw attention to the importance of communication and incentives in climate negotiations. It aims to provide a set of insights from studies that have theoretically and

experimentally examined the effectiveness of various types of incentives and information provision in realizing a climate treaty. We will here not yet be explicitly dealing with bounded rationality and other-regarding preferences. However, as we will see in later sections, communication, punishment and reward will affect negotiations differently when bounded rationality and social interaction play a role. So this section can be seen to provide a basis for analyses in later sections.

The reduction of carbon emissions and the mitigation of climate change can be considered a global public goods game. Milinski et al. (2008) presented the first experimental study on the emergence of cooperation in a climate change game. Groups of six students where equipped with a starting capital of €40. Players could contribute to a climate account (i.e. the public good) in order to reach climate protection. Instead of dividing the climate account among the six group members, as in standard public goods games, it was used to encourage people to reduce their carbon emissions. In particular, the collected money was suggested to sponsor newspaper ads on climate change action. Contributions by players can thus be classified as purely altruistic acts, since they solely benefit others (future generations or the environment) at a cost to oneself.

In order to make his public goods game resemble more closely the dilemma caused by climate change, Milinski and his team also introduced uncertainty about the provision of the public good. If the students of one group failed to establish sufficient cooperation over the course of several rounds, they faced the risk of not only losing money invested in the public good, but also their personal income. This can be interpreted as an extreme climate disaster. If all players together invested at least €12 per round, this prevented dangerous climate change. Milinski shows that many groups failed to establish cooperation and missed out on the benefits of a stable climate, reflected by individual, personal gains.

This experiment suggests that successful international cooperation on the reduction of greenhouse gas (GHG) emissions will not emerge in the absence of adequate incentives for cooperation. Barrett and Stavins (2003) note that the current Kyoto Protocol indeed provides very poor incentives for participation and should therefore be restructured in order to overcome the free-riding problem. That is, a treaty must offer clear net benefits to all participating countries. Moreover, such benefits and associated strategies need to be communicated very well.

5.3.1 Communication

Experimental studies of common-pool resources[2] and public goods document that communication, i.e. the ability of players to discuss strategies in advance or during the game,

[2] In contrast to public goods games where subjects contribute money or effort, in common-pool resource dilemmas players exploit a resource. In game-theoretic terms both games represent a social dilemma.

increases cooperation (see, for example, Ostrom et al., 1992). The reason is that communication reduces uncertainty about others' strategies and thus about the net benefit of cooperation. Public information about other players' behavior can further trigger conformist tendencies, i.e. cause individuals to cooperate when others cooperate. Such behavior can be described as conditional cooperation (Fischbacher et al., 2001). Of course, the tendency to copy the most frequent behavior in the population does not always maximize social welfare. The most extreme example is that individuals may start to free ride when interacting with other free-riders, with the likely effect that cooperation breaks down (Carpenter, 2004).

The aforementioned climate game of Milinski has been adjusted by Tavoni et al. (2011) to allow for communication in the form of announcing intended contributions by players. This improved cooperation. It indicates that transparency with respect to countries' abatement strategies, such as commitments to emission reductions, can be useful in order to reach successful outcomes. One such mechanism was implemented during the climate talks in Copenhagen: countries were able to make voluntary pledges on minimum carbon reductions which were then publicized. But merely cooperative countries participated in this.

5.3.2 Punishment and reward

Several laboratory and field studies have emphasized the widespread willingness to punish non-cooperative group members (free-riders). Monetary punishment like a fine reduces payoffs to free-riders but also represents a cost to the participant imposing the sanction. This in turn can lead to high contributions to public goods where players may contribute up to 90% of their starting capital (Fehr and Gächter, 2002). An effective monetary punishment to enforce climate agreements could be severe trade restrictions imposed on non-complying countries (Barrett and McIlveen, 2009).

Besides punishment, positive incentives like a monetary reward can be effective in fostering and maintaining cooperation. The reason is that rewards increase the net benefit of cooperation by a fixed amount in the form of a monetary reward, subsidy or bonus (Falkinger et al., 2000). Rewards may be based on revenues from a global carbon tax, or involve compensation payments by countries that gain most from a climate treaty to countries losing out on it. Concerning the latter, transfers from developed to developing countries might induce participation of the latter (Barrett and Stavins, 2003).

Punishment and reward may also be non-monetary. For example, punishment can take the form of social disapproval, ostracism or even gossip (Rege and Telle, 2004; Maier-Rigaud et al., 2010; Sommerfeld et al., 2007). Such non-pecuniary punishment encourages cooperation by activating reputational concerns which reduces the benefits of free-riding (Rockenbach and Milinski, 2006; Hilbe and Sigmund, 2010). Experimental research further shows that potential utility from positive social reputation, a non-monetary reward, resembles a type of "currency"

increasing the benefits of cooperation (Milinski et al., 2002). Milinski et al. (2006) demonstrated that players' investment in climate protection increases substantially if players can make their investment public, thus gaining social reputation which functions as a reward.

In actual climate negotiations, non-monetary punishment in the form of disclosing a country's inaction may affect its reputation and possibly bring negotiations forward.[3] However, the fact that the US did not want to ratify Kyoto is public information as climate negotiations and action on climate change are topics widely covered and discussed by the media. So far, public condemnation of the US by many NGOs, media and even other countries (which ratified Kyoto) has not stimulated them to change their bargaining attitudes. This may in fact be seen as a kind of a puzzle, which we will address in the decision bias "cognitive dissonance" in Section 5.5. Possibly, reputational incentives may play a more important role in contract compliance, i.e. once countries are committed to an agreement. For example, in the Kyoto protocol, non-compliance damages a negotiating party's reputation and may negatively affect its options to benefit from other, future international treaties, such as on foreign direct investment or technology transfers (Nentjes and Klaassen, 2004).

Research on which one of the two (monetary) incentives is more effective is inconclusive. As opposed to punishment, rewards lead to increased contributions and payoffs only under repeated interactions (Rand et al., 2009). Sefton et al. (2007) contrast reward and punishment in a public goods experiment and find punishment to be a more effective mechanism for sustaining contributions than reward. Hilbe and Sigmund (2010) show that if reward and punishment incentives are available, cooperators more quickly dominate the population. The latter is consistent with evidence on successful international environmental agreements. Barrett and Toman (2010) argue that the success of the Montreal Protocol[4] (in terms of cost and environmental effectiveness) is based on the fact that it provided a combination of monetary reward and punishment opportunities. As a reward, it offered side payments to compensate developing countries for the additional cost of phasing out ozone depleting substances. It further included trade restrictions (punishment) directed at non-participating countries.[5]

[3] Reputation systems in general are used to facilitate interaction of negotiating parties, such as buyers and sellers in e-commerce, such as on e-bay.

[4] The Montreal Protocol is an international environmental agreement on the protection of the ozone layer through the phasing-out of ozone damaging gases.

[5] There are a number of other reasons why the Montreal Protocol was successfully negotiated fairly quickly: a strong connection between ozone depletion and health, notably the risk of cancer; readily available substitutes for damaging gases; and a relatively small sector of the economy which facilitated a transition. Therefore, a comparison between the Montreal and Kyoto Protocols cannot offer strong conclusions about the effectiveness of incentives to participate.

Table 5.2 Mechanisms to stimulate participation in a climate agreement and their impact on perceived net benefits (monetary and non-monetary) of cooperation in an international climate agreement.

Mechanisms	Description	Net benefit of cooperation
Communication	Decreases uncertainty about benefit	+
Punishment	Decreases benefit from free riding	+
Reward	Increase benefit from cooperation	+
Punishment & Reward	Increase benefit from cooperation	++

Note: "+" increases net benefit "++" increases net benefit very much.

Table 5.2 summarizes our findings on the different types of mechanisms to stimulate participation in a climate agreement and their impact on the net benefits of international cooperation to reduce global warming. All of the incentives have a positive impact on the net benefit and subsequently on the likelihood of cooperation. In particular, the combination of punishment and reward is very effective.

5.4 Social preferences and climate change negotiations

Here we focus on how other-regarding preferences and heterogeneity of actors and interests can influence the negotiation process. For example, negotiations are often characterized by reaching mutual benefits among participating parties. Such a preference for fair outcomes may be, in part, explained by actors holding social preferences. This means participating parties are not only motivated by their self-interest, but also care about the benefits of others. This is consistent with evidence from many economic experiments which shows that social preferences are important in bargaining situations (Charness and Dufwenberg, 2006).

Besides fairness, other social preferences that play a role in decision-making are altruism, spite or envy, and parochialism (Fehr and Fischbacher, 2002). In game-theoretic terms these signify that players can value the payoff of others either positively or negatively. In short, altruistic agents value others' payoffs positively, while spiteful agents put a negative value on others' payoffs. Parochialism or in-group bias means that agents value solely the payoffs of group members positively (in-group favoritism), whilst valuing those of outsiders negatively (out-group hostility). As we will see, the presence of some social preferences may move negotiations forward, while that of others may limit cooperation among countries.

5.4.1 Fairness

A preference for fairness is also known as inequity aversion (Fehr and Schmidt, 1999). Heterogeneity with respect to wealth or endowment in public goods games indicates that fairness matters more in asymmetric situations, such as negotiations between unequal partners. Experimental research generally finds a negative effect of wealth inequality in public goods games, where fairness concerns and inequity-aversion can explain low levels of cooperation in unequal situations (Baland and Platteau, 1999; Cardenas, 2002).

In the context of climate change, countries differ in many respects, such as wealth, size, economic development, vulnerability, historical responsibility, and projected emissions. This is reflected in an unequal distribution of cost and benefits, which affects climate negotiations. For example, Reuben and Riedl (2009) show that players with different benefits from a public good will contribute perfectly proportionally to the ratio of their marginal benefit, which indicates that players are highly motivated by a fair contribution norm. Translating this to climate negotiations means that countries with a low net benefit, like large emitters (high cost, low long-term benefit), may contribute less than others if fairness concerns matter.

What are the likely consequences of fairness perceptions among negotiating countries? Negotiations are dominated by multiple types of fairness. Particular aspects of negotiations such as the distribution of benefits and costs – outcome fairness - and negotiation procedures and context – process or procedural fairness – are two of them (Albin, 1993). How to distribute mitigation costs among the participating countries, i.e. a burden-sharing system, is one of the key issues in current negotiations. Perceptions of fair burden-sharing may differ across countries. Table 5.3 offers a summary of the most prominent proposals for burden-sharing rules in climate negotiations and corresponding equity principles.[6]

To guide negotiations, it is important to think about a fair negotiation process and implications for voting procedures, participation in committees and access to information. Cooperative outcomes may be less likely under certain procedural rules that affect fairness. An example is that only some countries participate in early negotiation behind closed doors, as happened in the post-Kyoto negotiations. Most of the climate negotiations take place behind closed doors and oftentimes only involve a handful of countries. In past climate talks, such negotiations have led to much dissatisfaction among other nations that were excluded from parts of the negotiation process.

[6] Rose and Kverndokk (1999) provide an overview of equity criteria to evaluate the distributional consequences of climate policy.

Table 5.3 Burden-sharing rules and different equity principles.

Burden-sharing rule	Description	Equity principle
Polluter Pays	Abatement in proportion to (historical or current) emissions level	Countries with high emissions reduce more than countries with low emissions
Ability to Pay	Abatement in proportion to GDP	Countries with high GDP reduce more than countries with low GDP
Population size	Abatement in proportion to population	Countries with large populations reduce more than countries with small populations
Land area	Abatement in proportion to land area	Countries with large territories reduce more than countries with small territories

The few experimental studies examining fairness of climate negotiations underpin the importance of fairness principles for successful negotiation outcomes. An experiment by Tavoni et al. (2011) shows that an unequal distribution of endowments of participants in a climate game negatively affects cooperation levels. They designed their experiment in a way that the wealth inequality is correlated with countries' historical responsibilities, that is, their cumulative carbon emissions. They suggest that communication can improve acceptance of such responsibilities and reduce the negative effect of inequality, which makes cooperation more likely. Dannenberg et al. (2010) study equity preferences of climate negotiators and find that they dislike unequal negotiation outcomes. Another finding is that negotiators from different countries do not differ with respect to their degree of inequity aversion. As different fairness principles imply particular burden-sharing rules, first trying to agreeing on fundamental fairness principles may increase the likelihood of arriving at an agreement on burden-sharing rules. Possibly, pre-negotiate on a common fairness principle may contribute to stronger reputation and shame effects.

5.4.2 Altruism

Decision makers are altruistic if they act to benefit others at a cost to themselves. Experimental research reveals that altruism favors cooperative behavior and the provision of public goods. Altruistic behavior is motivated by a variety of motives. For example, Andreoni (1990) suggests the existence of both pure and impure forms of altruism. The latter denotes the behavior of individuals that contribute to public goods because they derive utility from the act of giving, also referred to as 'a warm glow'. Moreover, altruism is facilitated by social interaction. Rege and Telle (2004) show that if one's behavior in a public goods experiment is publicized, altruistic contributions increase. This is also referred to as a type of reputational altruism. Other reasons for altruistic actions are kinship, i.e. family relations (Hamilton, 1962), and reciprocity (Trivers, 1971). Another finding is that altruism decreases if it becomes too costly (Fehr and Fischbacher, 2003).

With respect to climate negotiations the question arises whether politicians are likely to exhibit altruism. Against the common assumption in public choice theory that decisions by stakeholders in a political context (voters, civil servants, politicians, interest groups) are based on self-interest, altruism in political judgment is common. Fowler (2006) shows that high levels of voter participation in elections can be explained by voters being sufficiently altruistic. Other empirical studies present a more pessimistic view of altruism in political contexts. Younas (2008) shows motivations for giving development aid are dominated by economic considerations. Donor countries seem to be very much motivated by trade benefits and thus self-interest.

Can altruism explain cooperation in an international climate agreement? Milinski's (2002, 2006, and 2008) experimental research shows that altruism motivates investment in the climate account. Players in his game behave altruistically when they observe that all players contribute. However, altruism is limited and groups generally fail to reach the contribution target necessary to avoid a climate disaster. Milinski also shows that altruistic contributions can be increased if made public. This can be explained by the presence of reputational altruism, a type of impure altruism. Another motivation for contributions may be reciprocal altruism, a strategy based on repeated interaction. This suggests that reciprocity among countries may be important for large-scale cooperation. Such reciprocity may be fostered by linking climate agreements to trade and technology (R&D) agreements (Folmer et al., 1993).

There may be little willingness to cooperate among negotiating parties because of limited solidarity across generations, despite connections between parents, children and, grandchildren in overlapping generations (Howarth and Norgaard, 1993). Moreover, any investment in emissions reduction will mainly benefit future generation in developing countries, while the cost of cooperation is mainly for developed countries. The question is what type of institutions can promote the extension of the relevant reference group to other countries and future generations? One possible approach would be the inclusion of different age-groups, including very young people, in climate negotiations, so as to represent the different generations associated with climate change and policy.

5.4.3 Envy

Envy or spite is a type of negative social preference where individuals desire to decrease others' welfare. Elster (2007) acknowledges the phenomenon of envy in economic and political decision-making, which is relevant to consumption, working environment and cooperation in negotiations. He asserts that envy is provoked in others by unequal allocation of enviable goods. He refers to Veblen's concept of conspicuous consumption, which is a type of consumption intended to provoke envy through the display of costly goods.

Findings from experiments show that spiteful individuals are willing to give up benefits from cooperation to reduce the benefits of, or increase the cost to, the bargaining partner with the ultimate goal to improve their own payoff (Saijo and Nakamura, 1995; Fehr et al., 2008). Their net (non-monetary) payoff will increase then. However, this also lowers the net benefit from cooperation. Experimental research has further found that spitefulness can lead to punishment not only of free-riders, but also of cooperative group members. Such punishment is solely motivated by concerns for relative positions or status, i.e. the punisher makes herself relatively better off rather than improving social welfare (Falk et al., 2005).

To what kind of actions may envy give rise in climate negotiations? The first critical aspect is the asymmetry between notably developing and developed countries in terms of historical responsibilities (cumulative emissions), income level, wealth, etc. Since envy is triggered by comparison and unequal allocations and payoffs, negotiations between developed and developing countries can be expected to be influenced by feelings of envy. In this respect, envy and equity are intertwined concepts. Already Varian (1974) described a fair division as equitable and "envy-free". For the context of climate change, this can be seen as relevant to the case of developing countries. For example, current proposals on burden-sharing are seen as unfair and inequitable by these countries, but these perceptions may at the same time be influenced by envy of those that are better off. This means that the evaluation of the burden-sharing is based on relative rather than absolute economic outcomes (Roberts and Parks, 2007). In line with this is the claim of developing nations that the rich countries have to abate more (also proportionally) because they have more ability to pay. However, although in practice it is difficult to tell fairness and envy concerns apart, the existence of both suggests that the many inequalities and asymmetries among the negotiating countries may be an impediment to reaching an agreement.

5.4.4 Parochialism

Parochialism describes individual and group behavior employing individual categorizations and distinctions, such as similarity, common fate, or physical proximity and its likely consequences. Parochialism means in-group bias, behavior that favors one's own group, restrict benefits to its members, and foster loyalty to the group (Tajfel and Turner, 1979). Parochialism also includes hostile behavior, such as strong punishment towards outsiders or out-group members (Bowles and Choi, 2003; Choi and Bowles, 2007). This behavioral pattern manifests itself in political parties, interest groups like trade unions, religious and ethnic groups, football matches, and even in interactions between citizens of different nations (Brewer, 1999; Bowles and Gintis, 2004).

Evidence from public goods experiments shows that people behave more cooperatively towards their in-group than towards their out-group (Koopmans and Rebers, 2009). Cooperation is stimulated by the fact that members similar to oneself benefit from it. In line with this,

countries sharing similar characteristics may adopt similar negotiation positions. For climate negotiations such in-group favoritism or solidarity might explain why some negotiating parties are only in favor of certain emission allocations (burden-sharing rules) that benefit not only themselves but also their in-group members or countries which are considered as being culturally proximate. Parochialism might also contribute to inaction or protective strategies when countries which have to reduce emissions a lot feel that the benefits go mostly to nations which do not belong to their in-group, i.e. which are culturally distant. In particular, parochialism may lead to smaller coalitions, like a coalition of large emitters (notably developed countries) instead of a coalition including all countries.

Table 5.4 summarizes the role of social preferences in climate negotiation processes and their impact on the perceived net benefit of cooperation. A negotiator motivated by altruism is generally more cooperative. Fairness or inequity aversion offers some explanation as to why countries still have not agreed on emission reduction commitments. So far, equity concerns and envy due to unequal allocations may have discouraged cooperation. Parochialism neither has made large-scale cooperation easier.

Table 5.4 Impact of social preferences on perceived net benefits of cooperation in an international climate agreement.

Social preference	**Description**	**Perceived net benefit of cooperation**
Altruism	Preference to increase the payoff of others	++
Fairness	Preference for equitable payoffs	+
Spite/Envy	Preference to decrease the payoff of others	– –
Parochialism	Preference to increase the payoff of similar nations (in-group bias) and to decrease the payoff of outsiders	–

Note: signs denote changes relative to a situation with rational, self-regarding agents:"+" increases net benefit; "++" increases net benefit very much; "-" decreases net benefit; "--" decreases net benefit very much

5.5 Uncertainty, decision biases and climate negotiations

Decisions relevant to climate change negotiations are surrounded by uncertainty. For example, there are scientific uncertainties about how GHG concentrations will precisely affect future global temperatures, sea level, ecosystems, and the economy. The IPCC even classifies uncertainty (from virtually certain with > 99% probability to exceptionally unlikely with < 1% probability) in order to establish a consistent and transparent terminology of the likelihood of future outcomes. Experimental evidence documents that decision-making under uncertainty often violates full rationality assumptions, referred to as cognitive or decision biases. The IPCC (2001) acknowledges the existence of such biases in decision-making, noting that experts may show myopia or overconfidence when making judgments about the likelihood of climatic

events. Therefore, the analysis presented in the IPCC assessment reports gives more weight to methods less prone to subjective judgments by experts.

Many decision biases have been documented (Kahneman and Tversky, 1979; Suedfeld and Tetlock, 1991; McFadden, 1999). Below we discuss what we regard as the most relevant ones for the case of climate negotiations. Additional ones which may receive attention in future research (as space is too limited here) are: anchoring (a decision relying heavily on one feature or piece of information); primacy effect (tendency to give more weight to more recent events); projection bias (prediction of future events resembles current situation); and biases related to reference points, such as status-quo bias (a tendency to place a higher value on the current state) and the endowment effect (a tendency to place a higher value on something we own). In the following we focus on a selection of decision anomalies that may be important to climate negotiations.

5.5.1 Prospect theory and framing

An important theory to explain people's judgment and decisions under conditions of uncertainty is Prospect theory. It accounts for many inconsistencies and decision biases which may limit cooperation. Examples are loss aversion and framing (Kahneman and Tversky, 1979). As opposed to expected utility theory based on rational assumptions which only considers absolute wealth when it comes to the evaluation of uncertain outcomes, Prospect theory models individual attitudes to risk with a value function. It allows for different weights on gains and losses where the function is concave for gains and convex for losses, and steeper for losses than for gains. This means that the disutility associated with a loss is larger than the utility associated with an equivalent gain. As a consequence, people are risk-seeking for losses and show risk aversive preferences for gains. This is also referred to as loss aversion. Moreover, loss aversion combined with another behavioral tendency, the certainty effect, i.e. certain outcomes being overweighed relative to uncertain ones, leads to the following predictions: individuals prefer a deterministic gain over a probable one (risk aversion), and a higher probable loss over a certain one (risk-seeking).

This previous insights hold only if probabilities are high. In a later contribution, Tversky and Kahneman (1992) find if probabilities are low (10% or smaller) individuals are risk-averse for losses and risk-seeking for gains. This additional insight of Prospect Theory is based on the probability weighting function. Botzen and van den Bergh (2009) note that probability weighting is especially important for climate change because most of the large climate risks are expected to have low probabilities. Further, the interaction between probability weighting and valuing monetary outcomes has nontrivial consequences for insurance demand. Table 5.5 summarizes the insights from probability weighting for climate change framing.

Table 5.5 Framing and probability weighting.

Framing about climate change	**Probability**	
	HIGH	LOW
GAIN	Risk-averse	Risk-seeking
LOSS	Risk-seeking	Risk-averse

Describing a problem as a gain or a loss elicits different risk attitudes. Negative frames, interpreted as losses, lead to riskier choices while positive frames generally stimulate risk-aversion. Table 5.6 summarizes the various insights from Prospect and Advanced Prospect theory for climate change framing. Such reversal of preferences between negative and positive frames is also referred to as the reflection effect. Frames are important if not crucial for the success of negotiations as framing may influence risk perceptions and preferences for climate policy. For example, research on the communication of climate risks confirms that positive frames produce stronger behavioral intentions to act on climate change than negative, loss frames (Spence and Pidgeon, 2010; Spence et al., 2011: Morton et al., 2011). On the other hand, negative events, information and experiences generally can count on more attention than positive ones, both from media and the public. For example, bad news and negative information (e.g. high unemployment and inflation rates, natural disasters, traffic accidents) receives more attention in the media than good news, which is referred to as bad news bias (Baumeister et al., 2001; Soroka, 2006). This asymmetry is also reflected in macroeconomic dynamics where consumption tends to drop relatively more in the case of an economic downturn than in times of economic prosperity (Bowman et al., 1999). For climate change, the relatively large attention effect of negative information is illustrated by the success of Al Gore's documentary "An Inconvenient Truth". The attention effect for different climate frames is shown in the bottom row of Table 5.6. The frame bias and bad news bias taken together defy a definite conclusion about which frame is more effective in fostering a climate agreement.

Table 5.6 Prospect theory applied to frames of climate change and policy.

	Negative frame		**Positive frame**		
	Bush original	Gore	Nordhaus	Stern	Bush reframed
Deterministic	High short term cost of *climate agreement* dominant	Moderate economic costs of *climate agreement*	Net benefits (=avoided cost) of *climate agreement*	High net benefits of *climate agreement*	High net benefits (income minus climate damages) of *no climate agreement*
Gamble[a]	Almost certainly there is no climate change and thus damage costs are highly improbable *(no climate agreement)*	Highly probable damage cost of climate change, serious risk of extreme events (*if no climate agreement*)	Unlikely net benefits in terms of(welfare minus climate damages *(if no climate agreement)*	Extremely uncertain net benefits of climate change, very risky strategy *(if no climate agreement)*	Uncertain net benefits of *climate agreement* because climate change uncertain
Risk attitude	Risk-seeking, which leads to a decision in favor of the gamble	Risk-aversion, which leads to a decision in favor of the deterministic alternative	Risk aversion, which leads to a decision in favor of the deterministic alternative	Risk aversion, which leads to a decision in favor of the deterministic alternative	Risk aversion, which leads to a decision in favor of the deterministic alternative
Choice outcome	No climate agreement	Climate agreement (stringent regulation)	Climate agreement (stringent regulation)	Climate agreement (stringent regulation)	No climate agreement
Attention effect	Large	Large	Medium to large	Large	Not relevant

Note: a) The table mostly corresponds to the typical pattern of Prospect Theory for sufficiently high probabilities for losses or gains which implies risk-seeking for losses and risk-aversion for gains. In the Gore frame, however, the response pattern reverses because of very small probabilities (extreme events): here risk-averse behavior for losses with low probabilities is the result.

It is not immediately clear what are the basic negative and positive frames in the context of climate agreement and policy. After deliberation, we came up with five frames linked to well-known advocates of (no) climate policy, involving politicians and scientists.[7] With regard to the negative frame one can use as an orientation either climate change or climate policy, leading to opposite views, as expressed clearly by Al Gore and the Bush administration, respectively. With regard to the positive frame climate policy has been the focus, as reflected – in different ways – in the well known economic studies by Nordhaus and Stern (Nordhaus 1992, 2008; Stern, 2006).[8] In order to include a positive frame with "no climate policy" (or climate change), we reframe the original Bush position. As a result, one then arrives at five frames in total, as shown

[7] A reviewer suggested that "symbolic politics" is somewhat related (Sears, 2001). It stresses the influence of political symbols on political decisions. Examples are political language, the opposition between right and left wing, religious connotations and family values. Such symbols often elicit emotional rather than rational responses, which in fact gives support to our focus on bounded rationality here.

[8] One might also mention here Cline (2007) who can be seen as close to Stern, both in approach and conclusions.

in Table 6. Note that although we could also reframe the other positions, this would not increase diversity of outcomes in the positive and negative (row "choice outcome"). The Stern Review stressed the negative impact of climate change on GDP, suggesting that under an extreme scenario damage costs might reach up to a 20 % loss of GDP. This explains why Stern, like Gore, attracted much attention (see the bottom row of the table).

It is relevant to understand the dominant climate frames and how the discourse on these can influence the likelihood of a climate change agreement. The original Bush position stresses the high and certain cost of stringent climate policy, and uncertainty about climate change (a "gamble") translating into equally uncertain economic, health and welfare losses. Risk-seeking behavior with regard to the uncertain loss then supports the choice of no climate policy and no climate agreement. Gore's famous documentary "An Inconvenient Truth" stresses the high costs and damages of inaction (no climate agreement), whereas it regards the cost – in terms of GDP – of an agreement uncertain but moderate. Here, risk-seeking for the loss prospect implies support for a climate agreement. A positive frame derives from Nordhaus (e.g., 1992; 2008) who highlights the certain net benefits (or costs) of an agreement in terms of reduced GDP growth and compares these with uncertain but moderate losses or even net benefits in case of no agreement, i.e. economic growth minus damage costs. This results in risk aversion and a decision in favor of a climate agreement. Another frame relates to Stern (2006) and suggests that the damage costs of climate change outweigh the cost of safe climate policy. In this case the certain net benefits are much larger than the cost of an agreement. Stern's risky prospect highlights very uncertain net benefits under no agreement. Risk-aversion in this case leads to a decision in favor of a climate agreement. A third frame results from reframing the original Bush position. This highlights the high net benefits, i.e. economic growth minus climate damages, in the case of no agreement. The risky strategy is described by uncertain net benefits in case of an agreement due to the very unlikely impacts of climate change. Risk-aversion for this positive prospect then leads to no agreement. The above analysis suggests that a simple reframing of climate change into a positive prospect may not be sufficient to reach an agreement.

Climate change frames can serve to inform voters. But they can also be strategically used by negotiators to influence risk perceptions and bargaining outcomes in their interests. Through strategic framing, it is possible for politicians or policy makers to select aspects of climate risks that will magnify or diminish the perceived risk by people (whatever stakeholder). Nevertheless, little is known on such strategic framing and its effectiveness.

5.5.2 Risk perception biases

An important difficulty in decision-making is correct risk assessment of climate and environmental risks. A bias in risk perception, i.e. a discrepancy between an individual's

perceived probability and the actual risk, may affect risk estimates and in turn the attitudes toward climate change policies and a climate agreement. Bounded rationality is an important determinant of individual risk perception in the context of climate change risks (see Botzen et al. (2010) assessing climate change flood risk perceptions).

Examples of systematic biases on the perception of risk are the overestimation of low probabilities and underestimation of large risks as well as substantial differences in risk estimates if information is available or not. This means the accessibility of the problem and information about it matters, which is known as the availability heuristic (Viscusi, 1989; Viscusi and Zeckhauser, 2006). Another mental shortcut for probability judgment is the affect heuristic, i.e. (positive and negative) feelings about (climate) hazards. In line with this the affective-laden representation of risk through images and media reports can influence risk perception and policy preferences (Slovic et al., 2002). For example, Leiserowitz (2006) finds that negative affect is a stronger predictor of climate change risk perception than traditional socio-economic variables.

Other cognitive biases that particularly influence individual decisions to take precautionary and adaptive measures to mitigate their risk against climate hazards such as flood or droughts are omission bias for negative events, i.e. a tendency of favors inaction and optimism bias, i.e. individuals ignoring negative events (Grothman and Patt, 2005; Patt and Schröter, 2008). This reflects that individuals tend to underestimate their personal risk of negative impacts (such as from climate change) and think they are less likely to be affected than other people. As a consequence, their perceived risk is much lower than the actual risk and so they are less willing to engage in risk-reducing behavior.

What are the consequences of incorrect public risk perceptions about climate change for an international climate agreement? It is likely that biased perceptions of the likelihood of climate change and its impacts will affect one´s willingness to support climate policy and participate in an international climate agreement. In this sense, Leiserowitz (2005) states that distorted risk perception constrains political action due to missing public support for a climate treaty, regulations or taxes. The fact that many Americans only see a moderate risk associated with climate change is likely to contribute to the US not ratifying the Kyoto Protocol.

5.5.3 Myopia

Myopia refers to an individual's tendency to prefer immediate benefits and to delay costs. This means, myopic decision makers have high discount rates which can lead them to the postponement of important investments in the presence (Loewenstein and Prelec, 1992; O'Donoghue and Rabin 1999; Frederick et al., 2002). Myopia is equally relevant to intertemporal choice problems like investment in climate change mitigation. Since the cost of mitigation is immediate and benefits come later in time, myopia results in little climate protection generally. For example, Hausman (1979) demonstrates households could realize

future energy savings through the purchase of more energy-efficient products, but refrain from doing as future benefits are extremely discounted and thus undervalued relative to immediate costs. In order to overcome such intertemporal failures, Metcalf (1994) suggest energy policy taking the form of a subsidy on the initial investment which counteract the effect of high discount rates.

Political decisions may be particularly prone to myopia due to the short time horizons of politicians, reinforced by four-year election cycles. Congleton (1992) calls this political myopia, which he argues can lead to environmental degradation as many politicians refuse to act on long-term issues such as climate change. This exemplifies the intergenerational trade-off politicians are faced with when making decisions that will likely affect future generations. Discount rates applied to political problems such as climate change may thus be inappropriately high. Experimental research shows that if this trade-off is amplified by uncertainty about the benefit to a future generation, this leads to more self-interested behavior rather than intergenerational altruism (Wade-Benzoni et al., 2008). The question is how to ameliorate myopia and align the discount rates of politicians with the socially optimal discount rate. The literature on behavioral economics suggests setting deadlines and peer commitment through public announcement of specific goals (e.g., Ashraf et al., 2006; Bryan et al., 2010). For the context of climate change commitment devices can take the form of public announcement of emissions reduction.

What are the likely consequences of myopic decision-making for climate negotiations? In this respect, Bosetti et al. (2009) assess the role of immediate versus delayed (myopic) participation of developing countries in an international climate agreement. Their analysis shows that the global economic costs of a delayed participation of large emitters (e.g., India and Brasil) are substantial. In particular, they find that the policy costs double in the case of delayed participation compared to a case of full and immediate participation of all countries.

5.5.4 Cognitive dissonance

Cognitive dissonance denotes a mental conflict in which people are biased to think of their choices as correct, and incur disutility if they encounter any inconsistency with their beliefs. This leads also to a tendency to search for information that confirms ones expectation and disregard dissonant information (Festinger, 1957). The selective use of information that confirms one's belief and expectations (confirmation bias) is related to a moderate risk perception of climate change. For example, some individuals tend to ignore new information on climatic patterns and tend to trust in their initial beliefs (Patt and Schröter, 2007). This means people skeptical about climate change will seek information confirming their initial belief, rather than including new, particularly contradicting evidence which may alter their belief.

In order to overcome cognitive dissonance about climate change, these people tend to deny or ignore the facts about climate change and its impacts, or claim that climate change is caused by non-anthropogenic factors (Stoll-Kleemann et al., 2001). In the US, climate change action is highly controversial and has provoked climate change denial, endorsed by (certain) scientists, industrial leaders and conservative politicians. In this context Dunlap and McCright (2011, p. 144) refer to a "U.S. climate change denial machine". Their observations suggest that particular conservative politicians, mostly white men, dominate among those who deny human-induced climate change (McCright and Dunlap, 2011). This is consistent with the findings that conservatives accept higher technological risks and threats, such as related to nuclear energy and weapons, than others (Kahan et al., 2007). The authors explain this denial by arguing that conservatives are strongly inclined to justify the current social and economic system and therefore dislike any opinions that seek to undermine it, even more so if they involve potential economic losses to their current state.

5.5.5 Overconfidence

Evidence generated by economists and psychologist indicates that overconfidence leads individuals to overestimate their own capability, performance and skills, and control over events as well as to misjudge how they perform in comparison with others (better than average effect). The overconfidence bias affects investors who are likely to trade more than rational ones, managers deciding about risky acquisitions, and politicians approving prestigious public projects, and negotiators unwilling to make concession (Bazerman and Neale, 1993; Doukas and Petmezas, 2007; Glaser and Weber, 2007; Kahneman and Renshon, 2007). Overconfidence has been argued to have played an important role in international crises with overconfident politicians, such as wars, as well as in the current financial crisis with overconfident investment bankers (Johnson, 2004; Shefrin, 2010).

With respect to climate negotiations, overconfidence may also pertain to the estimated capacity of humans and their economy to accept climate damages or to adapt to climate change. In order to counteract the source of overconfidence, Kahneman and Lovallo (1993) suggest that the introduction of more objective forecasting, and the consideration of views and feedbacks from outside advisers can help to arrive at a more accurate view on future outcomes. For climate negotiations, better considerations of the insights generated by the IPCC and climate and economic experts may improve decision-making.

Table 5.7 illustrates the influence of all mentioned biases on the perceived net benefit of cooperation. Overall, decision biases in judgments under conditions of uncertainty have a negative impact on an international climate agreement.

Table 5.7 Impact of decision biases on perceived net benefits of cooperation in an international climate agreement.

Decision bias	Description	Perceived net benefit of cooperation
Loss aversion	Preference for avoiding losses leads to risk-seeking behavior	– –
Framing	Negative and positive casting of a problem leads to risk-seeking and risk aversion	–/+
Risk perception	Inconsistency between perceived probability and actual risk	–
Myopia	Preference for immediate rewards and delayed costs	– –
Cognitive dissonance	Discrepancy between current belief and new information	–
Overconfidence	Overestimation of own capabilities	–

Note: signs denote changes relative to a situation with rational, self-regarding agents:
"-" decrease net benefit; "--" decrease net benefit very much.

5.6 Conclusions

This Chapter has examined the impact of bounded rationality and social preferences on the perceived benefits of cooperation in climate negotiations. So far, most research on international negotiations has assumed rational actors rather than actors exhibiting some form of bounded rationality and other-regarding behavior. In this Chapter, we have highlighted the case of decision makers systematically deviating from rational choices in the context of climate negotiations. Some particular strategies may limit cooperation while others may increase the likelihood of an agreement.

There is no doubt that countries will need to participate in a climate agreement in order to reduce global GHG emissions effectively. So far, countries have little incentive to do so (Barrett, 2005). Findings from laboratory experiments support the positive impact of incentives like communication, punishment, and reward. These mechanisms are successful in inducing countries to join a climate coalition as they increase the (perceived) net benefits of cooperation, which have to be sufficiently high to induce large-scale cooperation. This Chapter has emphasized that a treaty must offer clear net benefits even when participants are characterized by bounded rationality and other-regarding preferences. However, the latter means that benefits will be differently perceived than under perfect rationality and self-regarding behavior.

We argued that social preferences can affect climate negotiations. Empirical and experimental research show that consideration of payoffs for other countries influences climate negotiators in their evaluation of burden-sharing rules. Relevant social preferences are altruism, fairness, envy and parochialism. Altruism leads to the prediction that individuals and groups refrain from free-riding and instead cooperate for the common good. The multiple asymmetries

between countries suggest that fairness (or inequity aversion) and envy, which oftentimes are difficult to tell apart, are likely to play a role in negotiations. This means that unequal allocations of emission reductions may destroy cooperation. Parochialism, a preference for cooperation with similar countries, may exert a negative effect on climate negotiations, leading to treaties that are limited to a subset of similar countries. This can be used constructively in the sense of forming a starting point for a more ambitious agreement extended with other countries. Another suggestion is to include different generations in the climate negotiation process so as to stimulate expressions of altruism from current to future generations.

Decision biases matter as well for negotiating a climate agreement. Behavioral economics has identified various anomalies that lead to making decision errors, as compared to rational choice. Prospect theory influence decision processes in climate negotiations through the differential evaluation of gains and losses and risk-seeking behavior for losses. Moreover, it is likely that an agreement will be influenced by myopic behavior by politicians, leading to little attention for problems with a long-term horizon, such as climate change. All decision biases that were indentified here have a potentially negative influence on cooperation and should, if possible, be ameliorated.

Reframing of climate change and policy needs more attention. Two effects are important here, namely attracting attention which is characterized by negative news bias, and asymmetric risk attitudes to gains and losses (i.e. the reflection effect in Prospect theory). With regard to the latter, the framing can focus on climate change impacts or on climate policy impacts. We find that for one negative frame (Gore) and two positive frames (Nordhaus and Stern) the choice outcome according to Prospect theory is a climate agreement. For one negative (Bush) and one positive (Bush hypothetical) no support for a climate agreement is obtained. The two effects taken together suggest that the best frame to adopt is Gore. Another strategy is to use both positive and negative frames simultaneously (as is the reality), although this may create confusion among voters and politicians, unless they are perceived as complementary, i.e. in terms of problem identification and solutions. An argument for positively framing information is that people believe that there is a solution to the climate problem and are thus more willing to act. But first they need to be convinced that there is a problem to be solved, for which the negative frame may be needed. This points at complementarity. Therefore, if one really intends to do everything to make an international climate agreement likely, then perfecting frames and more generally communication strategies seems worthwhile.

Given all these behavioral effects, an obvious question is whether we need the help of psychologists to guide negotiations for an effective international climate agreement? More fundamentally, do we need to accept bounded rationality and social preferences, or should we try to change them and make people more rational? Is this a realistic goal? Psychologists can perhaps answer what is possible and impossible in this sense. We suggest that incentives for

cooperation need to be restructured to fit the various alternative models of human behavior discussed here. For example, even if financial incentives exist, they might not be sufficient to induce large-scale cooperation. A future climate treaty may include the possibility of status or reputational benefits of cooperation. This assumes that the relative rather than absolute benefits of emissions reduction will influence participation by countries. Reputational concerns may gain importance through increased transparency created by the media and internet (e.g., through disclosure portals) which can increase the long-run cost (including reputation effect) of a country not ratifying a climate treaty.

This chapter has provided a starting point for identifying the impact of bounded rationality and social preferences on the outcomes of climate negotiation processes. Future research could try to identify the preferences of current negotiators and assess the empirical magnitude of the various types of bounded rationality and social interaction. To achieve this, research is needed to characterize utility functions of important stakeholders in negotiations and the role of climate variables in these. The outcome of such research might serve as an input to experiments that test particular behavioral features, like prospect theory or inequality aversion, in combination with alternative framings of climate change. In addition, connecting our approach to relevant variables from political science approaches to studying negotiations, such as ideology, power and discourse, may be worthwhile. This all can hopefully contribute to a better insight about effective incentives and strategies to accomplish a global climate treaty.

Chapter 6.

Experimental analysis of climate negotiations under abrupt and gradual damage scenarios [*]

6.1 Introduction

Striking an international agreement to limit global emissions of greenhouse gasses has turned out to be extremely difficult. Theoretical economic studies have defined the conditions for such an agreement to be feasible and effective (Carraro, 1997; Barrett, 2005, 2007; Aldy and Stavins, 2007). However, the behavioral roots of agreement negotiation have received little attention so far (Gsottbauer and van den Bergh, 2012). This holds in particular for behavioral responses to uncertainty in combination with gradual or abrupt climate change.

The incentives for countries to participate in an international climate agreement depend on a divers set of factors including varying national wealth, infrastructure, technology, and abatement costs curves (Sandalow and Bowles, 2001; Barrett, 2002). The most important economic driver of participation may be the expected economic impacts of climate change (Barrett, 2007). Empirical assessments of these show a wide variation (van den Bergh and Botzen, 2013), ranging from conservative estimates (Nordhaus and Boyer, 2000; Tol, 2005) to high estimates (Stern, 2007). There is a lot of discussion about the right costs estimates if extreme damage scenarios are considered (Weitzman, 2009).

The impact of uncertainty about climate change on climate treaty formation has been considered in a number of game-theoretic studies. The general finding of these is that more precise information and learning about the extent of possible climate damages reduces the incentives to cooperate (e.g., Ulph and Maddison, 1997; Kolstad and Ulph, 2008; Dellink and Finus, 2012). In addition, there is a growing literature showing that actual experience with climate change impacts can predict action on climate change issues (e.g., Weber, 2010; Spence et al., 2011). Next, a few behavioral experiments have been undertaken to clarify how uncertainty about climate tipping points affects individual cooperation for a climate treaty (Milinski et al., 2007; Barrett and Dannenberg, 2012). Studies in this vein have further explored the influence of inequality in wealth and "carbon debt" on cooperation levels (Tavoni et al., 2011), as well as differences in cooperation between low and high vulnerable individuals (Hasson et al., 2010).

[*] José María Ortiz kindly provided technical assistance in preparing and conducting the experiment.

This study presents an experiment about the effect on climate negotiations of uncertainty combined with alternative scenarios of climate change. This is motivated by the discussion about which type of information communication about climate change impacts is more effective in fostering an international agreement (e.g., Lorenzoni et al., 2005; Leiserowitz, 2006; Moser and Dilling, 2007; Hulme, 2009). The problem of reaching an international agreement is modelled as a public goods game, where we adapt the experiment by Milinski et al. (2008). Four players can contribute to the public good by investing money in a climate account aimed at saving the climate. If the sum of contributions of the players in a group does not reach a preset threshold until period 10, all group members lose their remaining wealth with a probability of 50%. Not reaching the required threshold therefore poses a considerable climate change risk for all group members and might be interpreted as a tipping point. To examine potential responses to different types of climate change, the experiment involves two treatments, namely abrupt and gradual climate change, which are then compared to a control treatment. To explain individual strategies we measure participants' cognitive abilities and degree of rationality.

The remainder of this chaper is structured as follows. Section 6.2 describes the experimental design. Section 6.3 presents and interprets the experimental results. Section 6.4 concludes.

6.2 Experimental design

We recruited 132 participants and let them participate in a climate change public goods game. Players are randomly assigned to groups of 4 without knowing the identity of their fellow group members. They play for ten periods, and receive an endowment of 4 points per period. They have to decide how many points (0, 2, 4) to invest in climate protection. Every group needs to reach a threshold of 80 points ultimately in period 10 to avoid a climate change risk, which leads to a loss of all individual wealth with a probability of 50%. If group investments in climate protection are equal or higher than this threshold, total group investment is used to purchase actual emission rights.[1] Players received detailed instructions and started every period with full information about the current status of their own wealth, the investment level of their group, and investment decisions by other group members. Before payment subjects filled out a short questionnaire (see Appendix, section A6.4 and A6.5, for sample characteristics and a statistical analysis of the questionnaire responses). All sessions were played with five to six groups consisting of four players (see Appendix, section A6.1, experimental procedure)

[1] The purchase of emission rights is a way to offset CO_2 emissions and contribute to climate change mitigation. CeroCO_2, an organization in Spain, is our partner for the compensation of CO_2. 80 points in the climate account translate to 32€ or an equivalent of 4 tons of CO_2.

We ran three treatments of this game (Table 6.1) which differed in terms of (information provided on) climate change impacts and associated real damage cost that subjects incur. We modelled abrupt and gradual disaster under uncertainty and compare them to a control situation without climate damages. In the control condition, players participate in ten periods of the climate game just described. In the treatment with climate disaster, players suffer negative wealth shocks corresponding to damages from natural disasters. In the abrupt climate change condition, after five preliminary rounds of play, players loose half of their accumulated private wealth. This corresponds to a scenario of sudden natural disaster such as a flooding or hurricane. Players in the game were caught by surprise as is common for such types of climate extremes. The experimental instructions described possible impacts of severe climate change until period 10, while not indicating actual risk, timing and extent of associated damages. This corresponds to a situation with high uncertainty about the possible impacts of climate change.

In the gradual climate change treatment, damages costs occur every period and are a function of actual contribution behavior. Damages are specified as a percentage loss of private wealth with a minimum of 10%. They occur until the group reaches the preset threshold. Damages are a function of cumulative group contribution and increase the further this is removed from the ideal or linear contribution path that ends in it being equal to the threshold in period 10. This relationship between contributions, damages and private wealth was explained to the participants, along with the treatment-specific damage function. The three treatments allow testing whether the type of climate change scenario matters for decisions about participating in an international climate agreement. Sections A6.2 and A6.3 in the Appendix present more details and instructions of the experiment.

Table 6.1 Climate change damage treatments.

Treatment	**Knowledge**	**Damages**	**Damage function until period 10**	**Damage after period 10**
Control	Certainty	No	No	Individual wealth loss with 50% chance if threshold 80 is not reached
Abrupt	Extreme uncertainty	Exogenous	Half of private wealth lost in round 5	Id.
Gradual	Limited uncertainty	Endogenous	Depends on cumulative group contribution, according to equation (1) in the Appendix A6.2	Id.

6.3 Results

In this section, we first analyze whether the different climate change treatments have an influence on the level of cooperation in the public goods game. We then explore the behavioral factors behind the treatment effects, concentrating on the influence of cognitive ability and degree of rationality.

6.3.1 Behavior under abrupt and gradual climate disaster

Table 6.2 presents summary statistics of the experiment, including average group and individual contributions, the proportion of free riders, and the average frequency of successful groups, i.e. ones that reach the threshold and thus avoid dangerous climate change. Figure 6.1 shows cumulative group contribution over periods. They are the highest in the public goods game with gradual climate change and the control case. Under abrupt climate change subjects contributed on average 8.3% less (p=0.64, Wilcoxon-Mann-Whitney test). In other words, (information about) abrupt climate change appears to undermine voluntary cooperation. Moreover, the high variance in the results of this treatment indicates more polarization and extreme strategies than under the other two treatments. Under abrupt climate change failing groups (i.e. not reaching the threshold) contributed on average only 47.67±26.39 (mean ± standard deviation), while failing groups under the control and gradual climate change treatments contributed 77.00±1.41 and 76.00±2.83, respectively. The latter two indicate a clearer willingness to reach the threshold. A pairwise comparison confirms the statistical difference between the abrupt treatment on the one hand and the control and gradual treatments on the other (p=0.05, n=8; p=0.07, n=8; Wilcoxon-Mann-Whitney test).

Table 6.2 Summary statistics.

Treatment	Cumulative individual contribution	Cumulative group contribution	Frequency of "free riders"	Successful groups (%)	# groups	N
Control	20.14 (3.82)	80.55 (2.21)	29.6	81.8	11	44
Abrupt	16.79 (8.72)	67.17 (27.28)	52.1	50.0	12	48
Gradual	20.10 (4.83)	80.40 (2.80)	37.5	80.0	10	40

Note: Average values by treatment; standard deviations in parentheses. "Free riders" contribute less than 20 points (less than half of their endowment) over 10 periods.

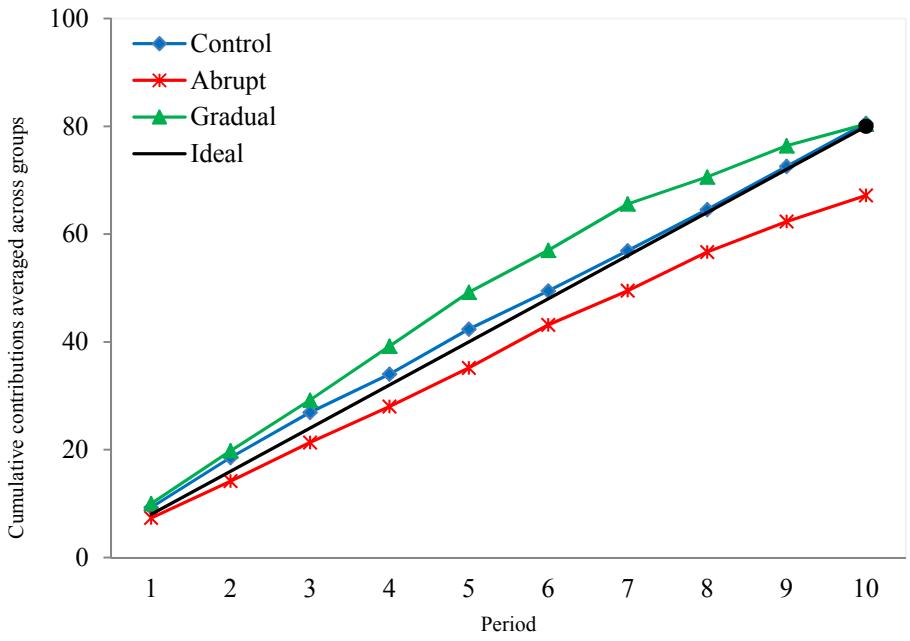


Figure 6.1 Average cumulative group contribution to climate protection in the control (blue), abrupt (red) and gradual (green) treatments compared with the "ideal" path (i.e. linear path to threshold in ten periods) (black).

As shown in Figure 6.2, the frequency of successful groups is remarkably similar between the control and gradual climate change treatment (82% vs. 80%). In contrast, we found that abrupt climate change tends to reduce the prospect of meeting the threshold (50% success rate) (p=0.001, one-sided Fisher's exact test compared to the control success rate). Thus, group performance becomes particularly worrisome in case of very uncertain, severe and sudden climate change impacts.

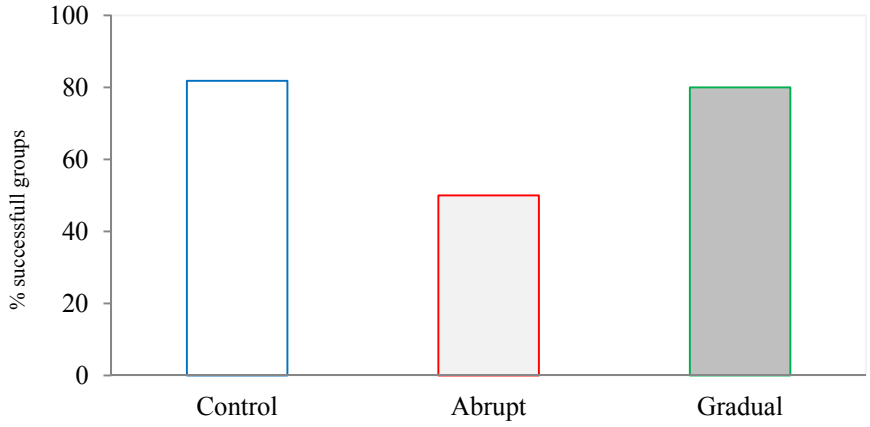


Figure 6.2 Group success in avoiding climate change across treatment conditions. The differences in percentages of successful groups in the control and gradual versus the abrupt treatments are significant (p=0.001, one-sided Fisher's exact test).

We explain better group performance in control and gradual climate change as a consequence of greater certainty about climate change. The strategies in both these treatments are characterized by a greater willingness to contribute in the first rounds than in the abrupt treatment: groups contributing at least 32 points in the first four rounds which follows the linear path to the threshold of 80 points over 10 periods, are more likely to reach this threshold. In the gradual climate change treatment, most groups (90%) actually follow a stringent climate control strategy. In the control treatment more than half of all groups (64%) adopt an ambitious contribution strategy which might be interpreted as supporting a stringent climate policy. On the other hand, only 42% of groups in the abrupt treatment are willing to commit early on. These contribution patterns indicate that groups in the control and gradual climate change treatment on average adopt a foresight strategy, realizing that early commitment and contribution can minimize their climate change risk and damages. Such forward-looking behavior positively affects the probability of successful climate protection, resulting even in some groups under the gradual change treatment reaching the emission target before period 10 (namely, 3 out of the 8 successful groups). Figure 6.3 displays the difference in early climate control strategies among the three treatments.

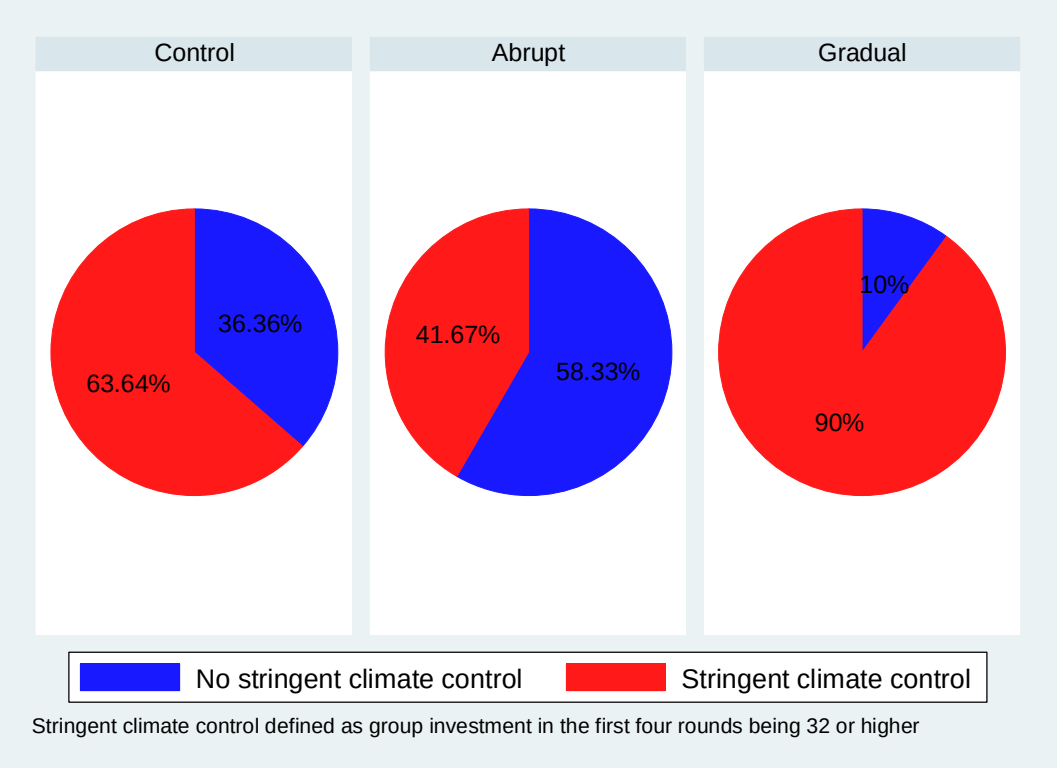


Figure 6.3 Percentage of groups choosing a stringent climate control strategy (contributing much), corresponding to group contribution being 32 or higher in the first four rounds of the game. The difference between the control and gradual versus the abrupt condition is statistically significant (one-sided Fisher's exact probability test p=0.185 (control); p=0.026 (abrupt) for each treatment).

Certainty about climate change causes on average higher contribution. We classify subjects into three categories of contribution behavior: free riders contribute less than 20 points over 10 rounds, fair and constant types 20 points, and altruists more than 20 points. On average 30%, 38% and 52% of subjects in the control, gradual and abrupt climate change treatment provided less than their constant contribution leading to the threshold over 10 rounds (i.e. free riders). The rest were fair and altruistic individuals (p=0.08, n=132, χ^2=5.02). The highest level of free riders was realized in the abrupt climate change treatment and consistent with this it shows the lowest level of total contribution. In fact, we find 22% more selfish subjects in the abrupt change treatment than in control (p=0.028, n=92, χ^2=4.81) and 12% more selfish subjects in the abrupt than gradual change treatment (p=0.171, n=88 χ^2=1.87). See Figure 6.4 Free riders provided an average round contribution of 1.0 in abrupt, 1.6 in the control and 1.5 in the gradual treatment (p=0.001, df= 2, F=2.68). Table 6.3 presents the results from a probit estimation, confirming the increasing presence of free riders in the abrupt climate change treatment.[2]

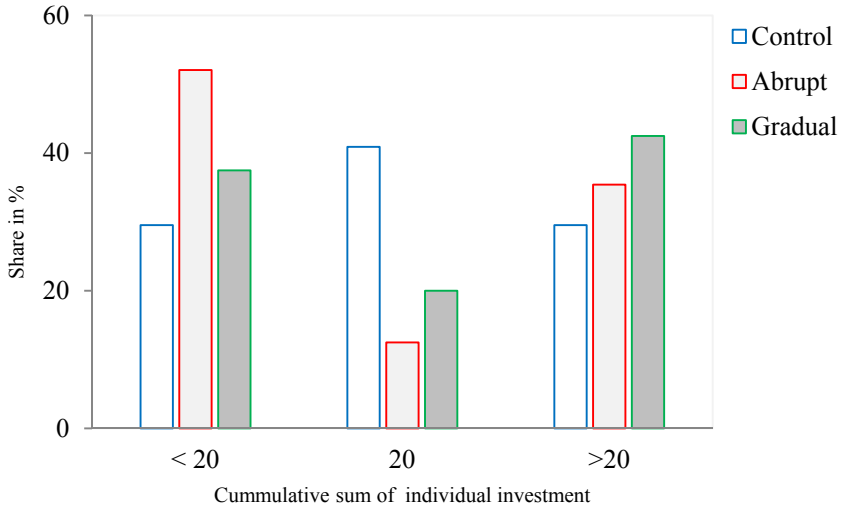


Figure 6.4 Contribution strategies of subjects for each treatment. For selfish strategies, i.e. cumulatively contributing less than 20 points over ten periods, we report the percentage increase in selfish behavior. There are 22% more selfish subjects in the abrupt than in the control treatment (p=0.028, n=92, χ^2=4.81); and 12% more selfish subjects in the abrupt than in the gradual treatment (p=0.171, n=88 χ^2=1.87).

[2] See also the Appendix, section A6, which presents the results of a series of linear regressions on cumulative individual contribution and Probit regressions on free riding behavior across treatments, including all variables generated by the questionnaire.

Table 6.3 Probit regression of free riding behavior.

Dependent variable: cum. individual contribution below 20		
Treatment dummies	Coef.	P-value
(Reference: Control)		
Abrupt climate change	0.590	0.029*
Gradual climate change	0.219	0.251
No. observations	132	

Note: Robust standard errors are clustered at the group level. Significance: * p<0.05.

While the dynamics of individual contribution strategies do not differ much between control and abrupt climate change during the first half of the session (rounds 0-5) (p=0.08, n=92, $\chi 2$=4.99), we found that decisions after the disaster (period 5) in abrupt climate change shifted markedly to defection (rounds 6-10) compared with the control treatment (p=0.001, n=92, $\chi 2$=14.85) (see Figure 6.5). In the gradual climate change treatment, altruistic behavior is concentrated in the first half of the session. This is mirrored by less frequent selfish behavior in the first rounds (0-5), and more frequent in rounds 6-10. This shift illustrates the foresight behavior of subjects in this treatment, characterized by contributing much early on and decreasing contributions later on. Contribution strategies in rounds 0-5 and rounds 6-10 are significantly different from strategies chosen in the control treatment (rounds 0-5: p=0.001, n=84, $\chi 2$=13.17; rounds 6-10: p=0.002, n=84, $\chi 2$=12.85). Comparing the sequence of contribution strategies between abrupt and gradual climate change, only the first half are significantly different (p=0.001, n=88, χ^2=14.63) while rounds 6-10 do not differ (p=0.137, n=88, χ^2=3.97).

Average individual contributions (rounds 6-10) are 9.95±2.71 and 8.00±5.32 under control and abrupt climate change, respectively. Contributions are the lowest under gradual climate change (7.80±3.25). The variance of individual contribution is the highest in the abrupt climate treatment indicating that individual performance in the latter varied widely as abrupt climate change induces more extreme contribution strategies. In fact, subjects not reaching the threshold with their group invested 19.25±5.12 under the control treatment while subjects not reaching the target under the abrupt treatment only invested 11.92±8.58. The former indicates a clear preference in reaching the threshold, while the latter indicates a significantly lower willingness to invest in climate protection (p=0.04, Wilcoxon-Mann-Whitney test).

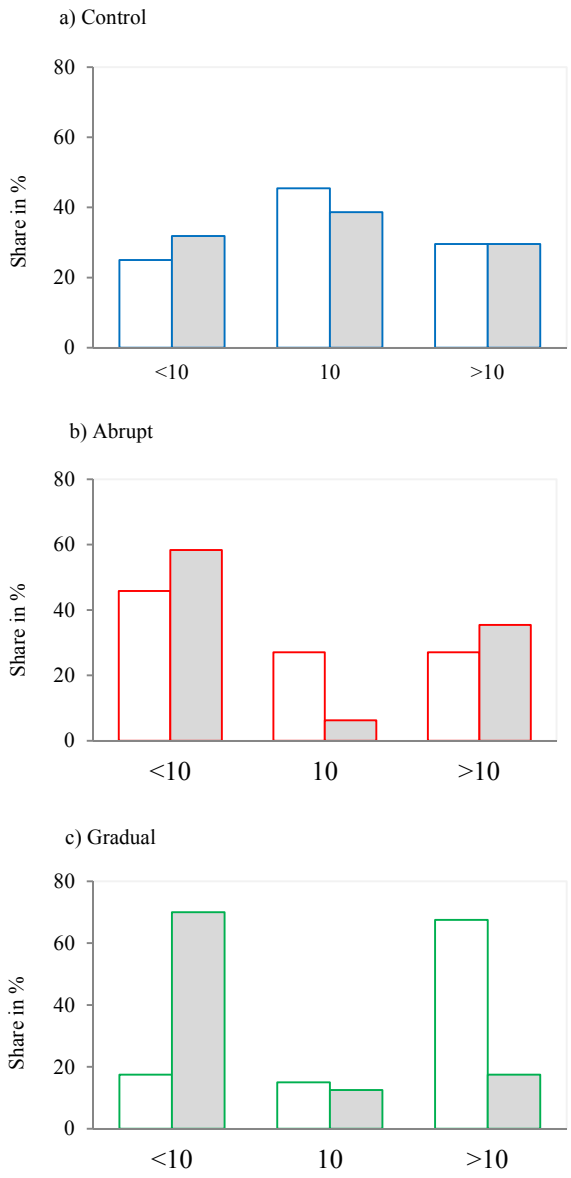


Figure 6.5 Dynamics of individual contribution strategies comparing first half (rounds 0-5, white column) and second half (rounds 6-10, grey column) of the game.

6.3.2 Predicting cooperation on the basis of a rationality measure

A relevant question is what influences individual contribution behavior. We correlate contribution behavior of our subjects with the variable cognitive ability (CRT)[3] as a proxy for rationality.[4] Table 6.4 shows that the average CRT score of selfish subjects (<20 points) across treatments is larger than the average CRT score of fair (20 points) and altruistic players (>20 points) (p=0.369, df= 2, F=1.10).

[3] Subjects were presented the three-item cognitive reflection test (CRT) which was developed by Frederick (2005). The CRT score corresponds to the sum of the correct answers to this test. A high score reflects high cognitive ability or degree of rationality of individual decision makers. See the Appendix, section 4, for sample statistics and questionnaire.

[4] See also section 5 for additional empirical analysis on all survey items.

Table 6.4 Average CRT score for categorized strategies.

Strategy	Average CRT score	N
Selfish	1.21	53
Fair	1.13	32
Altruistic	0.91	47

Note: n=132.

We also classify subjects according to the number of correctly answered questions into a "low CRT category" (0-1 correct answer) and a "high CRT category (2-3 correct answers). Of all participants, 65% (n=86) fall into the low and 35% (n=46) in the high category. Table 6.5 summarizes average cumulative individual contributions by subjects with high and low CRT scores across treatments. The result indicates that rationality and analytical thinking has a significant impact on the behavior of participants with high CRT scores in the abrupt climate change condition; the contribution of this subgroup is actually lower (p=0.07, Wilcoxon rank sum test). Moreover, total payoffs, the values of the private account after 10 periods, are quite different between players within the gradual treatment (Wilcoxon rank sum test, p=0.057). In particular, participants with high CRT scores ended up with a higher payoff (private account value) at the end of the game (Table 6.6). This is explained by the already discussed dynamics of strategies shown in Figure 6.5.

Table 6.5 Average individual contributions by subjects with low and high CRT scores (0-1 and 2-3 correct answers in the CRT test, respectively).

	Control	Abrupt	Gradual
Low CRT	20.23	18.32	20.14
High CRT	20.00	14.00	20.00

Table 6.6 Individual payoff (final value private account) levels for subjects with low and high CRT scores.

	Control	Abrupt	Gradual
Low CRT	19.77	16.39	13.08
High CRT	20.00	19.82	15.88

Next, we explore whether rationality has a significant influence on strategic behavior and the breakdown of cooperation in post-disaster decision making (rounds 6-10) in the abrupt climate change treatment. We begin by examining if individuals with low and high levels of cognitive ability differ in their contribution strategy. In the abrupt climate change treatment free riders (with individual contribution below 20) have a significantly higher CRT score (on average 1.44) than others (on average 0.78) on the cognitive reflection test (p=0.03, Wilcoxon-Mann-Whitney

test).[5] These results suggest that rationality and analytical thinking result in lower contributions. Next, we classify subjects based on two distinct investment strategies for round 6-10 (post-disaster behavior): "climate surrenders" (individual contribution in round 6-10 lower than 10); and "climate fighters" (contribution in round 6-10 equal or higher than 10). The results show that the proportion of climate surrenders is higher in the high CRT group (2-3 correct answer) than in the low CRT group (0-1 correct answer) (p=0.059, one-sided Fisher's exact probability test, p=0.055). See Figure 6.6.

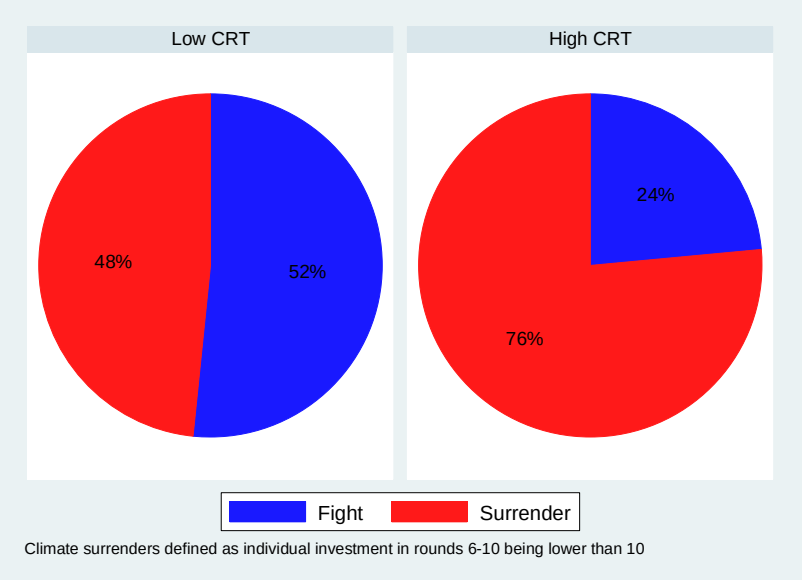


Figure 6.6 Cognitive ability and strategic behavior in round 6-10 in the abrupt climate change treatment.

6.4 Discussion and conclusions

In this chapter we have analyzed contribution strategies under various climate change impact treatments, which can be interpreted as negotiations for a climate agreement. Three important insights are: contributions decrease significantly when participants face much uncertainty about potentially high damages; experiencing – within the context of the experiment – impacts of gradual climate change leads to a greater willingness to contribute to climate protection; experiencing the impact of abrupt climate change– within the context of the experiment – does not much stimulate contributions to protect the climate. In view of these findings, public risk communication campaigns may highlight the evidence about gradual climate change in order to increase support for a climate agreement. If risk communication to the public is focused on emphasizing uncertain climate disasters and rare extreme events, climate treaty making is likely to fail.

[5] Free riders in the gradual climate change treatment have a lower CRT score than altruists (average score 0.8 vs. 1.04, no statistical difference). In the control treatment the scores are basically equal between these two groups.

In addition, we find that people with high levels of cognitive ability and rationality are less willing to contribute to climate protection in a context of much uncertainty about, or abrupt, climate change. One explanation is, as has been found in previous research (Dohmen et al., 2010), that higher cognitive ability leads to more willingness to take risks. Of course, cognitive ability also will affect one's understanding of the complexity and implications of climate change, and the uptake of information about this. Therefore, further experimental research might investigate the effectiveness of heterogeneous information provision about climate change to citizens with particular cognitive features and degrees of rationality.

Appendix

A6.1 Experimental procedure

The experiments were held in the experimental economics laboratory at Universitat Autònoma de Barcelona (Spain). In total, 132 participants were recruited from the student population of the university, using recruitment software OSREE (Greiner, 2004). Experiments were programmed and run on z-tree software (Fischbacher, 2007). After arrival to the computer laboratories, each participant drew a card to be randomly assigned to a group of four players. At no time during the experiment participants knew the identity of their fellow group members. After everyone was seated, the instructions for the experiment were distributed and read aloud by the experimenter. Participants were asked to answer a few questions to ensure their understanding of the instructions. When all subjects had correctly answered the questions, the computerized experiment was started. The experiment lasted approximately one hour. Before payment subjects filled out a short questionnaire. Average earnings equaled €10.80 including a standard show-up fee of €5.

A6.2 Description of the experiment

The basic game implemented in the experiment is a collective risk experiment (Milinski et al., 2008) that is played by a group of 4 anonymous players for ten consecutive periods. Each period of an experiment is divided into two stages. First, participants receive a period endowment of 4 points (see Fig. A6.1) and have to simultaneously decide how many points (0, 2, 4) to contribute to a climate account for climate protection. Points not invested are added to the respective player's private account. This is followed by a result stage, which lasts 30 seconds and which displays information about the current status of the player's individual private account, group climate account level, and about contribution decisions by other group members (see Fig. A6.2). If the sum of investments per group in the climate account is equal or higher than a 80 point threshold at the end of exactly ten periods, then the equivalent monetary value of the climate account is used to invest in emission rights.[6] The payoff of a player is then given by the final value of his/her respective private account. If the sum of investments per group is lower than the threshold, each group member loses his/her remaining wealth with a probability of 50%, which simulates a high risk of climate change. Overall, individual investment increases the sum of group investment and thus the likelihood that climate change will not occur but decreases

[6] CeroCO_2, a organization in Spain, is our partner for the compensation of CO_2. The compensation of CO_2 emissions is based on the monetary value of the total climate account. This money is used to buy its equivalent value in CO_2 tons. At the time of the experiment the cost of a ton has stabilized around 8€. For example, 80 points in the climate account translate to 32€ and an equivalent of 4 tons of CO_2.

individual wealth, creating a tension between individual and group interests. See all variables of the experiment in Table A6.1.

To capture the idea of climate damage scenarios, three treatments are used. In the control treatment subjects simply play the game just described. In the treatments with climate damage costs during the game, participants incur damage costs after their period contribution (See as example Fig. A6.3 for an example of the abrupt climate change treatment and Fig. A6.4 for the gradual climate change treatment). The climate disaster treatments differ with the respect to timing and extent of the damage. The first treatment simulates abrupt climate change referred to as "abrupt". Before starting, participants are instructed that climate change may lead to damages in the course of the experiment. Yet, the risk and extent of climate damages are unknown. Ultimately, participants incur high damage costs which simulate the consequences of exogenous shocks like natural disasters after a few initial contribution periods. Participants suffer damages stage exactly after round 5 loosing 50% of his/her accumulated private wealth. Participants in the game are caught by surprise as is common many natural disasters such as an unexpected flooding or hurricane.

In the second climate change treatment damage costs are gradual and endogenous, that is participants' contributions strategies may accelerate or decelerate climate change. We refer to this as "gradual climate change" treatment. Damages here depend essentially on two factors. First, damages D_j as percentage loss of private wealth occur until the group reaches the contribution threshold. Furthermore, damages are fixed at a minimum of a 10% loss. Climate damage as a function of total group contributions CA_j increases the more group contribution falls short of an ideal linear contribution path to the threshold, i.e. 8 points per period *t*. The following damage function was used then to calculate the percentage damage per period. The function was also explained to the participants and included in the instructions.

$$\text{Damage}\left(D_j\right) = \begin{cases} 0.10 + \left\lfloor \frac{t*8 - CA_j}{t*8} \right\rfloor + 0.90 & \text{if climate balance} < 80 \\ 0 & \text{if climate balance} \geq 80 \end{cases} \quad (1)$$

A6.3 Experimental instructions for the control treatment

Welcome to the experiment!

You are about to participate in an experiment on decision-making. Your decisions are anonymous. You will earn EURO 5 for participating in the experiment. You are assigned to play in a group of four participants and the amount of money you can earn additionally will depend on your own decisions and on the decisions of other participants of your group. To make this experiment a success, please do not talk to the other participants or draw any attention to you. Should you have any questions please signal us.

Payment

During the experiment, we will not speak in terms of EUROS, but instead in points. Your entire earnings from the experiment will be calculated in points. At the end of the experiment, the total amount of points you have earned will be converted to Euros at the following rate:

1 point = 0.40 Euros or 2.5 points = 1 Euro

When the experiment is finished your earnings from the experiment and the 5 Euro show-up fee will be paid in cash to you.

Duration

The experiment will last approximately 60 minutes and consists of 10 rounds. At the end you need to fill in a short questionnaire.

Climate Change

Now we will introduce you to the experiment. It involves a game simulating climate change. Global climate change is seen as a serious environmental problem faced by mankind. Greenhouse gas emissions, especially carbon dioxide (CO_2), are responsible for the largest contribution to climate change. This originates from burning of fossil fuels like coal, oil or natural gas in industrial processes, electricity production, and the combustion in engines of cars and lorries. CO_2 is a global pollutant, i.e. each quantity unit of CO_2 emitted has the same effect on the climate regardless of the location where the emission occurs.

Rules of Play

You are a member of a group of four. Nobody except for the experimenters will know who is in which group. During the course of the experiment you will be playing exactly 10 climate rounds.

At the beginning of each of the 10 rounds, each player receives an income equal to 4 points. In each of the 10 rounds you can invest into the attempt to protect the climate and to evade

dangerous climate change. In each climate round of the game all four players will be asked simultaneously: **How many points do you want to invest to protect the climate?** Possible answers: 0, 2 or 4 points. When all players have made their choice, the computer will credit all invested amounts to an account for climate protection (climate account). The points not invested will be credited to the player's private account. All decisions will be displayed on the computer screen.

At the end of the game (after exactly 10 rounds) 80 Points need to be contributed to the climate account to evade dangerous climate change.

- If this is the case, all players will be paid out the amount remaining on their private accounts in cash. Please note that 1 point corresponds to 0.40 Euro cents. In addition, to ensure that the 80 points required have been actually invested to prevent climate change, we will purchase CO_2 emission credits by its equivalent monetary value (sum climate account x 40 cents). The purchase of emission rights is a way to offset CO_2 emissions and contribute to climate change mitigation. There are a variety of forms of compensation, including tree planting, investment in renewable energy project, energy conservation and methane capture. *Cero* CO_2, an organization promoted by two NGOs in Spain (Accionatur and ECODES) is our nonprofit partner for the compensation of CO_2.
- If the group does not reach 80 points, the danger of climate change will occur with a probability of 50% (in 5 of 10 cases), which will result in significant economic losses. Specifically this means that each group member will lose all points of his private account with a probability of 50%. In this case the points invested in the Climate Account will also be lost. Probability of loss = 0.5 if climate account balance <80
  0 if climate account balance ≥ 80

Structure of the experiment

The experiment consists of 10 rounds. Every round consists of the following:

1. CONTRIBUTION

First there is a contribution stage: Here every group member can invest 0, 2, or 4 Points in climate protection.

2. DISPLAY

Then all decisions will be displayed simultaneously (display stage). The decisions of your fellow group members, your investment decisions, the climate account balance and the balance of your private account will be shown on the screen. The display stage lasts 30 seconds. If you want to exit this stage earlier, press the Continue button to carry on with the experiment.

Results and questionnaire

All group members will be informed about their earnings on the result display showing the climate account balance, your private account balance, and your total payoff in €. Please write your total payoff on the payment receipt. Then you will be asked to fill in a short questionnaire.

Example and test

To ensure that everyone understands how the decisions transform into earnings an example and test questions follow. (The numbers of points used in the test example are simply for its illustrative purpose. In the experiment, this will depend on the actual decisions of the participants.)

Example

Suppose that in the 10 rounds you have invested a total of 24 points in the climate account. This means you have a total of 16 points, equivalent to 16 x 40 cents = 6.40 Euros, which remain in your private account. Your group collected in total 82 points. This means that 82 x 40 cents = 32.80 Euros will be used to purchase emission certificates. In total we will pay you 11.40 Euros at the end of the experiment (16 x 40 cents plus 5 Euros participation fee).

Test

Please answer the following test questions:

(1) Which total amount of points does each player (of a group of 4) need to invest into climate protection, on average per round, to evade climate change (please tick the correct box)?

□ 0 □ 2□ 4

(2) Please assume that your group has invested Points 38 into the climate account at the end of Round 6. How much need the group invest in the climate account in the next four rounds in total to evade climate change (please tick the correct box)?

□ 12 □ 22 □ 42

(3) Please assume that the necessary amount of Points 80 has not been earned. With which probability will you lose the remaining amount on your private account (please tick the according box)?

□ 10% □ 50% □ 90%

If you have answered all control questions, please signal us. My colleagues will come to your desk and check your answers.

Summary

- You have to choose, in each round, how many points to contribute for climate protection: 0, 2 or 4 points.
- If at the end of the 10 rounds group's contribution amounts to at least 80 points, you will earn the points left in your private account
- If your group fails to reach the target of 80 points, with 50% probability, you will earn the points you have left your private account or you will lose everything.

Should you have any questions, please ask us. If there are no remaining questions, the game starts now. Good Luck!

A6.4 Questionnaire and sample characteristics

Table A6.2 summarizes sample characteristics based on analysing data from the questionnaire that was administered at the end of the experiment. See Table A6.3 for questions and response scales. In total, 132 subjects (51% female) participated in the experiment. Only a small fraction of students has a background in economics (14%). About half of the participants use a car (47%). Several questions asked opinions about climate change. Many participants report a quite high personal risk perception of climate change with a mean of 3.13 on a scale from 1 to 4. The perception of scientific consensus is moderately high, with a mean of 2.78. The support of using price instruments for climate change mitigation is very high (3.45). One-fifth of the sample is skeptical about climate change changing having an impact on extreme weather events in Spain (reported mean 3.31). We examined views on which policy strategy participants would favor to eliminate the risk of climate change. Of the participants, 28% believe that policy should rely on technological change (we refer to these respondents as technological optimists) and 72% that it should focus on behavioral change. 47.7 percent were willing to sacrifice at least 10% or more of their income (on average 12.1% of their income) to fight climate change.

We also asked for attitudes to measure willingness to take risk and individual impatience. Subjects indicated their willingness to take risk on a 11-point scale with zero indicating complete unwillingness, and ten indicating complete willingness to take risk. The question on individual time preferences uses the same scale.[7] The modal response to the general risk question is 4.35, which is considerably below the value of 6 which is consistent with risk taking behavior. The mean for impatience is 5.55.

Participants also answered a set of decision questions to assess relevant behavioral biases including risk and loss aversion, myopia, gambler's and base rate fallacy regarding probabilistic logic. Of all participants, 47% can be classified as being risk averse, 80% as prone to loss aversion and 70% as myopic. In order to evaluate participants' probability judgment we asked them to estimate the probability of a coin toss being tails after a random sequence of a mix of more tail than head tosses. The correct answer is 50%, but the gambler's fallacy leads respondents to an estimate of more than 50%. We find that only 4% of all subjects are affected by the gambler's fallacy. Furthermore, when forming estimates based on conditional probabilities, people often ignore probabilities and focus on irrelevant information instead. This is referred to as base rate fallacy. To evaluate the frequency of this bias in our sample we assessed individual judgment about weather forecasts, corresponding to a decision problem first run in an experiment by Dohmen et al. (2009). The share of respondents who exhibit such base rate fallacy in our sample is 40%.

[7] The risk and time questions we use have been experimentally validated to be a reliable manner to measure preferences over risk and time (Dohmen et al. 2005).

The questionnaire elicited a measure of cognitive ability or degree of rationality in decision-making. Participants were presented the three-item cognitive reflection test (CRT), which was developed by Frederick (2005). The answers of respondents fall into two categories: (1) impulsive or irrational when relying on an intuitive but incorrect answer and (2) reflective or rational when providing the correct answer. In our sample, subjects answered on average 1.08 of the three CRT questions correctly.

A6.5 Empirical analysis subjects characteristics, climate change opinions, preference measures and cognitive ability

We first examine whether climate change opinions are correlated with each other and investigate whether characteristics of participants (background, gender and car usage) correlate with climate change opinions. The results presented in Table A6.4 show a moderate positive relationship of male participants with scientific consensus (r=0.27, p=0.00), and a somehow weaker positive one with climate change risk perception (r=0.21, p=0.02). Further, a moderate negative relationship between male and climate skepticism indicates the stronger belief of male participants about the impact of climate change on the risk of extreme events (r=-0.26, p=0.00).[8] We find a moderate negative relationship between technological optimists (i.e. participants favoring a policy strategy that relies on technological change) and car users in our sample (r=-0.19, p=0.03). Student's background in economics is not related to any indicators of climate change opinions.

We also a performed correlation analysis between preference measures (risk and time), and behavioral biases (risk aversion, loss aversion, myopia, gambler and base rate fallacy) and on climate change opinions (scientific consensus, risk perception, price instruments, skepticism, technological optimist, willingness to sacrifice income). We observe that only risk aversion significantly correlates with climate change risk perception (r=0.18, p=0.04) and find a weak negative relationship between willingness to sacrifice income and loss aversion (r=-0.18, p=0.04). No other of the preference and decision biases measures is correlated with climate change opinions and therefore we do not report these results here.

We next examine whether the measure of cognitive ability or degree of rationality is correlated with student characteristics, climate change opinions, risk and time preferences and behavioral decision biases (see Table A6.5). One significant factor affecting CRT scores, i.e. the number of correct answers to the three-item CRT test, is a background in economics. In addition, men were significantly more likely to have higher CRT scores than women (r=0.37,

[8] Remember, the answer scale ranges from 1=strongly agree with the fact that global warming has increased extreme weather events in Spain, which corresponds to no scepticism and 4=strongly disagree with the fact that global warming increased extreme events in Spain, which corresponds to much scepticism.

p=0.00). In particular, a high degree of rationality, reflected by a high CRT score, has a moderately positive effect on beliefs about the existence of scientific consensus (r=0.18, p=0.04). Moreover, a strong negative relationship between cognitive ability and climate skepticism appeared, meaning that rational people were less likely to associate climate change with more frequent extreme events (r=-0.33, p=0.00). There was also a negative relationship between the willingness to sacrifice income and rational decision making (r=-0.22, p=0.01). Looking at loss and risk aversion, respondents who had a high CRT score were more likely to be loss averse (r=0.38, p=0.00) but less likely to be risk averse (r=-0.23, p=0.01). There was no correlation between rationality and the gambler and base rate fallacy.

We show the results of a probit regression in Table A6.6. It confirms the previous correlation results. The dependent variable indicates the individual CRT score. The regression analysis suggests that economics and male students answer more CRT questions correctly than others. In addition, we find that more rational participants are more likely to believe in the link between climate change and extreme events. Time preferences are positively related to cognitive ability, indicating that more rational subjects are also more impatient. Moreover, more rational subjects appear as being more loss averse.

Finally, we examine the relationship between game behavior and all survey items (Table A6.7). We find moderately negative relationships of male and economics students with cumulative total contributions (r=-0.19, p=0.03; r=-0.21, p=0.02). Climate change risk perception significantly correlates with average contribution behavior (r=0.21, p=0.01). We further find a moderately positive relationship between contributions and willingness to sacrifice income for climate protection. None of the preferences measures and decision biases have a significant effect on contribution behavior or the probability to adopt a free riding strategy (contribution less than 20) in the game.

A6.6 Regression results of game behavior and survey items

We show the results of a series of regressions in tables A6.8 and A6.9. We use an OLS regression to study the dependent variable cumulative individual contributions (Table A6.8) and a probit regression for free riding behavior (Table A6.8). The models include treatment dummies, participants' characteristics, climate change opinions, risk and time preferences, decision biases and a dummy for low cognitive ability based on the CRT three item test.

To analyze the characteristics of those subjects willing to protect the climate in all three treatments, Table A6.9 presents the regression results analyzing each treatment separately.

Table A6.1. Variables generated by the experiment.

Variable	Value	Description
i	4	Players per group
j	10	Periods
W	4	Starting capital for each period; 20 points total wealth
CA_j		designates the climate account after period j, where j=1, ..., 10
	≥ 80	Climate account level (points); probability of losing all points in the account equals zero. This represents a successful climate protection.
	< 80	Climate account level (points); the probability of losing all points in the account equals 50%.
I_{ijk}	$\in\{0,2,4\}$	Denotes contributions to the climate account (points) for player i in period j, where i=1, ..., 4; j=1, ..., 10; k=1, …, 33
D_{ijk}	%	Denotes climate damages (in % of private wealth) of player i in period j for group k

Note: 1 point = 0.40 Euros

Table A6.2 Sample statistics (N=132).

Variable (scale)	Average	SD
Student characteristics		
Economics student (0-1)	0.14	0.35
Male (0-1)	0.49	0.50
Car use (0-1)	0.47	0.50
Opinions about climate change		
Scientific consensus (1-4)	2.78	0.89
Risk perception (1-4)	3.13	0.77
Price instruments (1-4)	3.45	0.70
Skepticism (1-4)	3.31	0.82
Technological optimist (0-1)	0.28	0.45
Willingness to sacrifice income (0-100)	12.06	18.20
Preferences		
Risk preference (0-10)	4.35	2.73
Time preference (0-10)	5.55	2.75
Behavioral decision biases		
Risk averse (0-1)	0.47	0.50
Loss averse (0-1)	0.80	0.40
Myopia (0-1)	0.70	0.46
Gambler's fallacy (0-1)	0.04	0.19
Base rate fallacy (0-1)	0.40	0.49
Correct CRT answers (0-3)	1.08	1.05

Table A6.3 Questionnaire (translation from Spanish).

Question	Answer scale
Student characteristics	
(1)Background	1= Natural sciences 2= Humanities 3= Engineering 4= Economics 5= Other social sciences 99= Missing
(2)Gender	1= Male 2= Female
(3)Do you regularly use a car?	1= Yes 2= No
Opinions about climate change	
(4)Do you think there is a scientific consensus with respect to climate change?	1= No, not at all 4= Yes, absolutely
(5) How serious of a threat is climate change to you or your family?	1= No threat 4= Very serious threat
(6)Do you favor or oppose national and international measures that aim to reduce greenhouse gas emissions even if this results in extra energy costs and an increase in the prices of consumer goods?	1= Absolutely against 4= Absolutely in favor
(7)What percentage of your own current and future income would you be willing to give up to eliminate any risk of climate change and its consequences?	% (scale: 0-100)
(8)How strongly do you agree or disagree with the following statement? Global warming and climate change are affecting the weather and increased frequency of extreme climate events in Spain.	1= Strongly agree 4= Strongly disagree
Cognitive ability	
(9) A bat and a ball together cost 110 cents. The bat costs 100 cents more than the ball. How much does the ball cost?	1= Right (5 cent) 2= Wrong
(10) If it takes 5 machines 5 minutes to make 5 widgets, how long would it take 100 machines to make 100 widgets?	1= Right (5 min) 2= Wrong
(11) In a lake there is a patch of lily pads. Every day, the patch doubles in size. If it takes 48 days for the patch to cover the entire lake, how long would it take for the patch to cover half of the lake?	1= Right (47 days) 2= Wrong
Preferences	
(12) Are you generally willing to take risks, or do you try to avoid taking risks?	0= Risk aversion 10= Fully prepared to take risks;
(13) Are you generally an impatient person, or someone who always shows great patience?	0= Very impatient 10= Very patient;
Behavioral decision biases	
(14) Imagine you are tossing a fair coin. After eight tosses you observe the following result: tails - tails - tails - heads - tails - heads - heads - heads. What is the probability, in percentage, that the next toss is tails?	1= Right 2= Wrong
(15) Suppose you are presented with a choice between a sure outcome €50 and a gamble offering even chances at €0 or €100 outcomes (double or nothing). Which option would you prefer?	1= Sure amount 2= Gamble 3= Indifferent
(16) Please choose which hypothetical payment you prefer: 1. A payment of €10 now 2. A payment of €11 in one month	1= Impatient 2= Patient
(17) Please consider the following hypothetical lottery. A lottery with 50% chance to lose €25 and 50% chance to win a minimum amount. Please state the minimum amount €X for which you would be willing to accept the lottery.	€
(18) Imagine you are on vacation in an area where the weather is mostly sunny and you ask yourself how tomorrow's weather will be. Suppose that, in the area you are in, on average 90 out of 100 days are sunny, while it rains on 10 out of 100 days. The weather forecast for tomorrow predicts rain. On average, the weather forecast is correct on 80 out of 100 days. What do you think is the probability, in percent, that it is going to rain tomorrow?	1= Bayesian (range 20-40) 2= Pure base rate (range 0-20) 3= Base rate neglect (80) 4= Others (ranges 40-80; 80-100)

Note: In the questionnaire the cognitive ability questions were randomly mixed, that is the three questions did not appear together.

Table A6.4 Correlation between student characteristics and climate change opinions.

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
Characteristics									
1 Economics	1.00								
2 Male	-0.04	1.00							
3 Car use	0.07	0.08	1.00						
Climate change opinion									
4 Scientific consensus	0.12	0.27***	-0.04	1.00					
5 Risk perception	-0.07	-0.21*	-0.06	0.19*	1.00				
6 Price instruments	-0.06	0.02	-0.03	0.10	0.23*	1.00			
7 Technological optimist	0.00	0.09	-0.19*	0.04	-0.13	-0.01	1.00		
8 Skepticism	-0.02	-0.26***	-0.07	-0.04	0.34	0.26*	-0.11	1.00	
9 Sacrifice income	-0,03	-0,16	-0,12	-0,05	0,12	-0,03	0,12	-0,08	1.00

Note: * p < 0.05; *** p < 0.001.

Table A6.5 Correlation between CRT score and survey items.

	CRT score
1 CRT score	1.00
Characteristics	
2 Economics	0.18*
3 Male	0.37*
4 Car use	0.16
Climate change opinion	
5 Scientific consensus	0.18*
6 Risk perception	-0.16
7 Price instruments	-0.11
8 Skepticism	-0.33***
9 Technological optimist	0.08
10 Sacrifice income	-0.22*
Preferences	
11 Risk preference	0.12
12 Time preference	0.03
Behavioral decision biases	
13 Risk aversion	-0.23*
14 Loss aversion	0.38***
15 Myopia	-0.15
16 Gambler fallacy	-0.02
17 Base rate fallacy	0.11

Note: * p < 0.05; *** p < 0.001.

Table A6.6 Regression results: CRT score.

DV: number of correct CRT questions	
	Marginal effect
Characteristics	
Economics	1.32**
Male	0.49*
Car use	0.22
Climate change opinion	
Scientific consensus	-0.03
Risk perception	0.05
Price instrument	-0.03
Technological optimist	0.27
Skepticism	-0.54*
Sacrifice income	-0.01
Preferences	
Risk preference	0.02
Time preference	0.11*
Behavioral decision biases	
Risk aversion	-0.34
Loss aversion	1.07***
Myopia	0.25
Gamblers fallacy	-0.41
Base rate fallacy	0.36
r2	0.30
Number of observations	131

Note: Probit with robust standard errors.
* p < 0.05; ** p<0.01; *** p < 0.001. n=131.

Table A6.7 Correlation of game behavior and survey items

	1	2
Game behavior		
1 Free Rider	1.00	
2 Cum. individual contribution	-0.75*	1.00
Characteristics		
3 Economics	0.08	-0.19*
4 Male	0.15	-0.21*
5 Car use	0,10	-0,09
Climate change opinion		
6 Scientific consensus	0.05	-0.07
7 Risk perception	-0.10	0.21*
8 Price instruments	-0.15	0.14
9 Technological optimist	0.14	-0.11
10 Skepticism	-0.05	0.05
11 Sacrifice income	-0.11	0.18*
Preferences		
12 Risk preference	0.05	-0.06
13 Time preference	-0.13	0.07
Behavioral decision biases		
14 Risk aversion	-0.10	0.11
15 Loss aversion	0.07	-0.16
16 Myopia	-0.10	0.17
17 Gambler fallacy	0.16	-0.14
18 Base rate fallacy	-0.01	-0.03
19 CRT score	0.10	-0.15

Note: * $p<0.05$. n=132.

Table A6.8 Predictors of contributions.

	Model 1	Model 2
	OLS regression of cum. individual contribution	**Probit regression of contribution <20**
Treatments (Reference: Control)		
Abrupt climate change	-4.027*	0.711*
Gradual climate change	-0.236	0.236
Characteristics		
Economics	-3.059	0.318
Male	-1.324	0.307
Car use	-1.095	0.256
Climate change opinion		
Scientific consensus	-0.941	0.161
Risk perception	2.428**	-0.246
Price instrument	0.779	-0.239
Technological optimist	-1.602	0.361
Skepticism	-0.894	0.097
Sacrifice income	0.0359	-0.003
Preferences		
Risk preference	-0.0987	0.022
Time preference	0.223	-0.079
Behavioral decision biases		
Risk aversion	0.119	-0.076
Loss aversion	0.147	-0.222
Myopia	2.619*	-0.381
Gamblers fallacy	-4.350	1.222*
Base rate fallacy	-0.213	-0.103
CRT Low	-0.543	0.037
r2		
Number of observations	131	131

Note: All regressions with robust standard errors (clustered at group level).
* p<0.05, ** p<0.01, *** p<0.001. n=131.

Table A6.9 Regression results by treatment.

	Control		Abrupt		Gradual	
	1	**2**	**1**	**2**	**1**	**2**
Characteristics						
Economics	2.483	-0.471	-3.694	-0.479	-3.793	1.530*
Male	-0.0702	0.895	1.784	-2.107**	-4.031	1.438*
Car use	1.657	-0.223	-2.773	-0.269	4.175	-3.142
Climate change opinion						
Scientific consensus	-1.324	0.927*	-0.983	-0.0211	-0.222	0.671
Risk perception	1.578	-1.468***	7.466**	-2.853***	0.0728	0.883
Price instrument	-0.236	0.179	-1.456	0.698	0.704	-0.584
Technological optimist	0.687	-1.039	-3.526	1.641	-3.477	3.231*
Skepticism	-1.496	0.800*	-2.509	0.529	-0.349	0.193
Sacrifice income	0.0145	-0.0122	0.0549	-0.092	-0.0259	0.0749*
Preferences						
Risk preference	-0.0772	-0.0585	-0.364	0.263**	-0.347	0.0657
Time preference	0.411	-0.0993	0.288	0.0103	0,577	-0.511
Behavioral decision biases						
Risk aversion	-3.683	1.539*	-0.376	1.813*	3.212	-4.27
Loss aversion	2.298	-1.831**	0.659	-0.545	0.227	0.435
Myopia	1.159	-0.406	3.489	-1.858	-0.825	2.046
Gambler fallacy	-3.272	2.844**	-7.696*	0	0	0
Base rate fallacy	-2.934	1.769*	-0.0828	-0.3	-1.416	0.62
CRT low	0.498	-0.553	4.738	-3.418***	-1.346	1.688*
N	43	43	48	45	40	40

Note: Models (1) report the results of OLS regressions using cumulative individual contribution as the dependent variable. Models (2) report the results of Probit regressions using free riding, i.e. individual cumulative contribution below 20 points as the dependent variable. All regressions with robust standard errors (clustered at group level). * p<0.05, ** p<0.01, *** p<0.001.

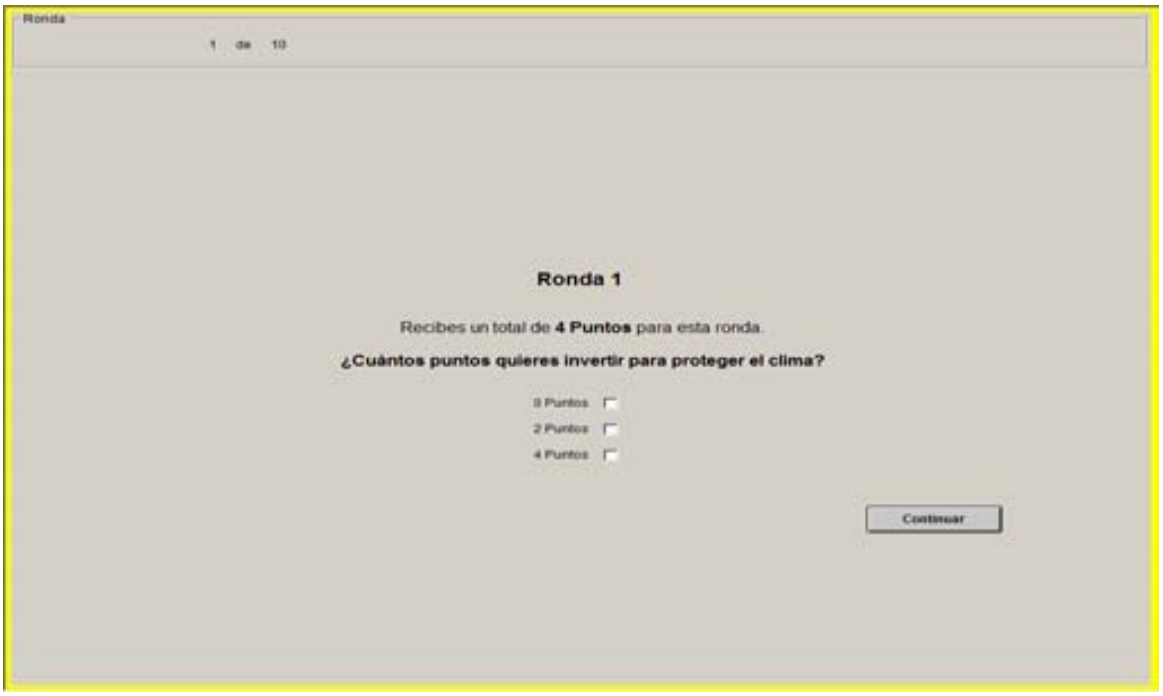


Figure A6.1. A player's decision screen in the contribution stage (equal for all periods).

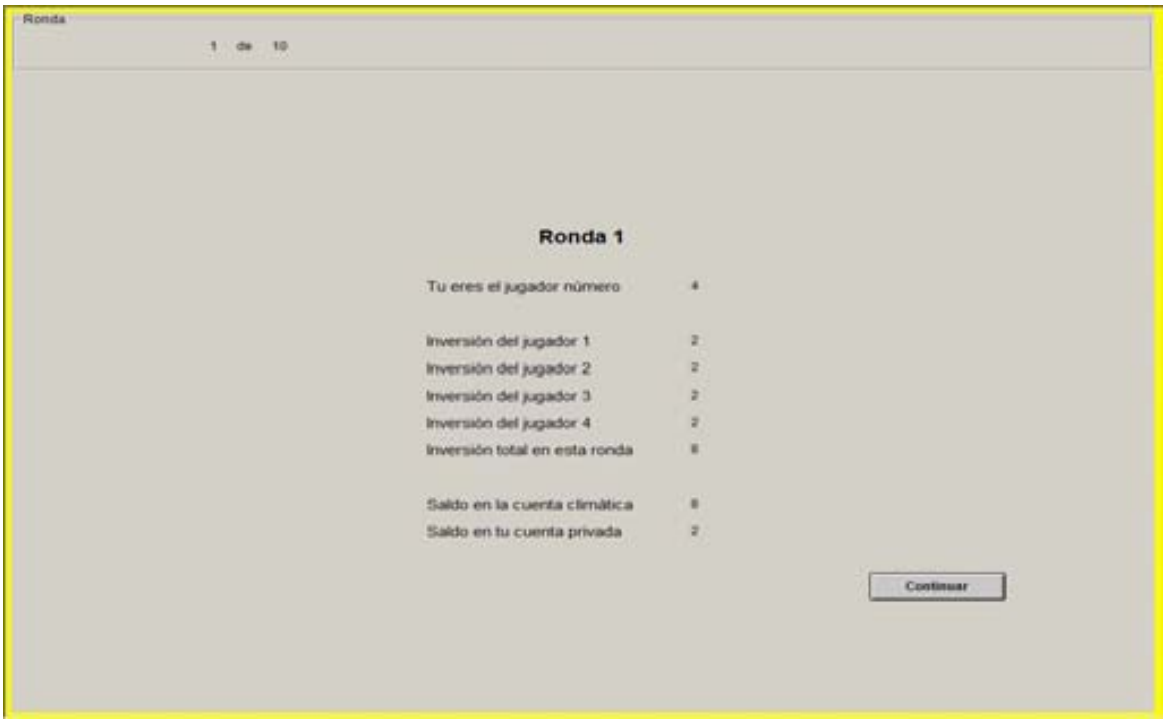


Figure A6.2. A player's information screen in the result stage

Figure A6.3. A player's information screen in the damage stage, corresponding to abrupt climate change in period 5.

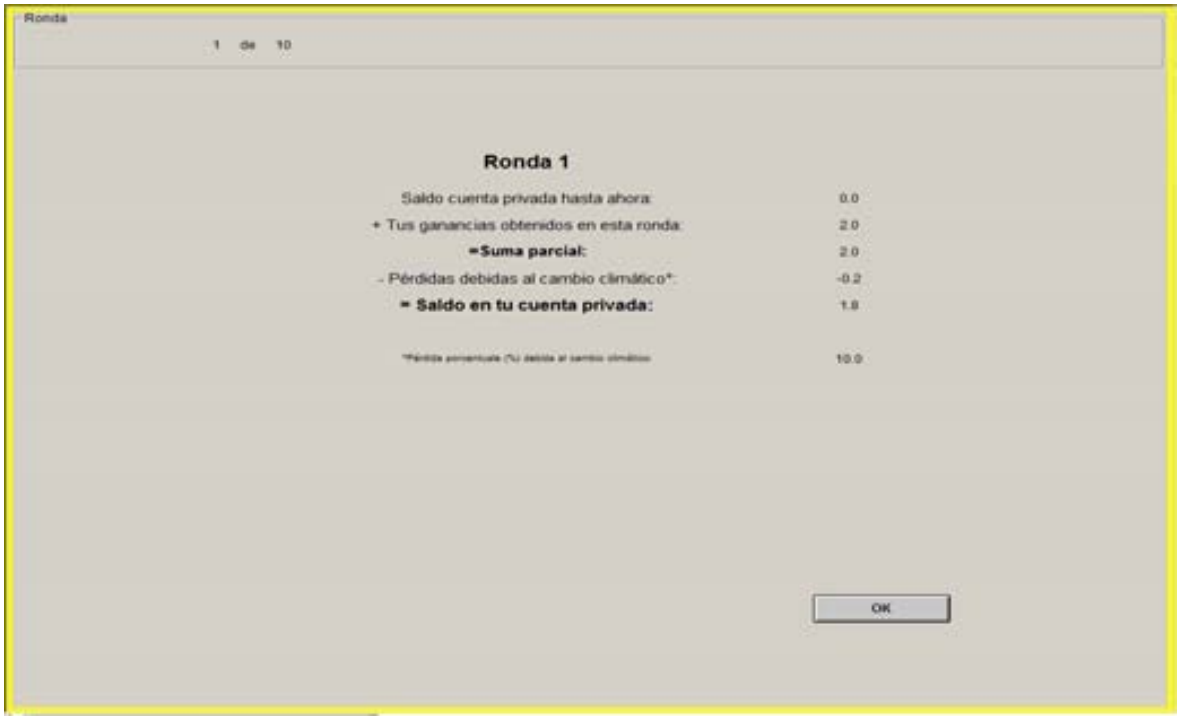


Figure A6.4. A player's information screen in the damage stage corresponding to gradual climate change.

Chapter 7.

Conclusions

In this thesis the implications of alternative models of individual behavior for environmental policy have been studied. This involved looking at specific behavioral principles based on psychological insights, developing a formal model, a conceptual analysis, and two economic experiments, with the aim to study behavioral responses, social welfare and policy implications. The thesis includes five chapters, each starting with a relevant environmental problem and a related fact about individual behavior or decision-making.

In order to provide a good understanding of the relevance of behavioral economics for environmental policy theory and a basis for the other chapters, *Chapter 2* reviewed the application of bounded rationality and other-regarding preferences to environmental issues. It classified non-standard preferences into four types, namely social preferences, preferences over uncertain consequences, preferences over time, and preferences influenced by judgment errors. Environmental policy insights based on these different behavioral categories relate to environmental valuation, sustainable consumption, climate change and policy design. This involved addressing a variety of issues, such as the effectiveness and efficiency of environmental regulation including economic (market-based) instruments, the role of problem framing in improving the social acceptance and thus political feasibility of policy, and the role of adaptation (in well-being terms) to changed circumstances like higher (energy) prices. It was found that a range of instruments of environmental policy are useful in addition to traditionally advised instruments. Some examples are as follows: non-monetary incentive systems complementing price instruments; self-regulation (informal rules) stressing reciprocity and repeated interactions; deliberation, education and information campaigns reducing search and information costs; taxation to discourage pollutive consumption habits and purchase of typical status goods with high environmental impact; and changing defaults in choices offered to consumers so as to favor sustainability. Furthermore, climate policy strategies might include: risk communication that accounts for inappropriate judgment biases affecting assessment of climate risks; natural hazard insurance encouraging correct loss estimates and insurance purchase; coping with myopia and time inconsistency by adequate design of long-term, binding climate agreement and policy; and taxation of carbon dioxide emissions, not just because these are efficient (the argument from mainstream environmental economics) but also because individuals are capable of adapting in happiness terms to such a change, meaning that they will restore their original life satisfaction level. Note, finally, that this chapter includes a long section

on future research avenues regarding the intersection of behavioral and environmental economics.

In *Chapter 3* a theoretical model was developed to study optimal environmental policy when consumer preferences are socially interdependent and sensitive to advertising. A behavioral-economic model was constructed by combining a general equilibrium model with consumers' utility function representing social preference and being sensitive to advertising The former aspect means that preferences are dependent on what other agents consume, while the latter reflects the impact of commercial advertising by private firms on individual consumption decisions and welfare. In other words, welfare is affected by social interaction through social norms and status, which provide a suitable basis for commercial advertising to act upon with the aim to promote (over)consumption in society. A novelty of the model is that it combined environmental and advertising (or consumption) externalities. Two model versions with different functional specifications of individual utility capture norms and status aspects, which allowed deriving particular optimal policies. The first, linear specification illustrates status sensitivity and is relevant for studying conspicuous consumption subject to advertising. The second, quadratic specification describes imitation and conformity of consumption choices. For both cases the results indicate that a set of policy instruments is required in order to optimally control the environmental and advertising externality. First, standard Pigovian taxes need adaptation. In particular, optimal pollution taxes are higher than for the case without social interaction effects. That is, since pollution is likely to be higher if there is social interaction, Pigovian taxes have to be adjusted as well. Second, the policy conclusion is that advertising of conspicuous, pollutive goods should be taxed in order to stimulate firms to internalize the associated social cost of these consumption strategies in their decision-making about advertising. This will then assure a socially optimal level of advertising. The reason is that it accounts for the consumption externality created by status seeking and thus provides an indirect incentive for consumers, because of less advertising, to reduce consumption and thus pollution. Furthermore, information provision by the government as a third, complementary policy instrument can internalize the negative welfare effect of advertising. These results not only contribute to more realism in environmental policy theory but also extend environmental policy with new instruments.

Chapter 4 studied whether non-monetary incentives can motivate pro-environmental behavior in the context of recycling. An obvious policy response to encourage individuals to recycle is to provide economic incentives. However, this is problematic as it is difficult to monitoring and control compliance, and consumers or firms may illegally dump or burn waste. So the question is relevant to what extent intrinsic motivations can stimulate a desirable degree of recycling. A framed field experiment involving one-shot public goods games was conducted in Costa Rica. The sample included heads of households from San Jose. The experiment

allowed contributions to a public good under peer approval and disapproval. To our knowledge these two mechanisms have never been studied together in one experiment. The experiment also assessed how these incentives perform relative to a regulatory solution and how this in turn affects environmental policy design. A total of four treatments were considered: social approval, social disapproval, environmental regulation and, for comparison a situation without an incentive. A compelling feature of this experiment is that its structure closely replicated actual experiences with household recycling of participants. The three key results are as follows: First, approval and disapproval mechanisms are both effective in increasing contributions to the public good. Second, social disapproval can be more effective than social approval as it eliminates extremely selfish contributions. Third, standard regulatory solutions, particularly if they are very ambitious, can promote more and higher contributions than approval and disapproval do. In fact, contributions were maximized applying an obligatory contribution rule in the experiment. The chapter concludes with practical policy suggestions following from these results. Examples are information campaigns on environmental issues focusing attention on negative information provision in the form of disapproval, and the disclosure of environmental performance metrics through postings in the local press to single out the subpopulations who perform worse on these indicators.

In *Chapter 5* the impact of bounded rationality and social preferences on the perceived benefits of cooperation in negotiations for a climate agreement was analyzed. The framework proposed builds on a synthesis of theoretical and experimental insights from the literature on behavioral economics, social psychology and game theoretic analyses. First a categorization was presented of decision-making in climate negotiations at both individual and collective levels. This compromises different actors, namely citizens, politicians, experts, and (professional) negotiators. Next, behavioral characteristics were broadly classified into bounded rationality and social preferences in order to study their impact on the perceived net benefit of cooperation on climate policy. The findings indicate a relationship between a variety of preferences measures – equity, status, reputation, parochialism, framing and risk- and cooperation on climate policy. Five types of insights were derived for the case of negotiations for a climate agreement. First, the multiple asymmetries between countries leading to unequal allocations of emission budgets can impede cooperation due to fairness considerations demanding equitable outcomes. Second, not only absolute but also relative national reduction targets, that is, compared with other countries, influence the setting of collective emission reductions. This is consistent with preferences for relative rather than absolute welfare. Third, disclosure and improved transparency of negotiation strategies can increase the (reputation) cost of free riding behavior, resulting in more cooperative solutions. Fourth, in-group favoritism is likely to lead to coalitions of smaller size, but these may be ambitious and sufficiently stable to address carbon reductions. Fifth, sensitivity of risk preferences to different framings of climate

change can influence public risk perception and support for climate policy. While frames of climate change impact (which are negative or loss frame) can count on much attention, climate policy frames (which are positive or gain frame) are likely to stimulate more willingness to mitigate climate risks. A well-informed framing of climate change in communication along these lines can help to arrive at an effective international climate agreement.

Chapter 6 experimentally analyzes how cooperative behavior in meeting an emission reduction target is influenced by climate change disasters and its uncertainty. A laboratory experiment was conducted based on a modified version of the public goods game in which subjects are confronted with realistic climate change impacts and economic damage costs. This allows testing if particular patterns of climate change damage promote or rather impede cooperation in climate policy. Two models of climate change reflecting uncertain abrupt and gradual climate change disasters were considered and compared to a case with full certainty and no impacts. The results show that contributions decrease significantly in case of severe and unanticipated abrupt climate disasters. Although a climate disaster leads to large economic losses early in the game, thus leaving time for participants to coordinate on contribution efforts in order to reach the emission target, it does not sufficiently increase cooperation to secure climate protection. On the contrary, we find that gradual climate change is able to considerably raise individual contribution efforts. This translates frequently into an effective level of individual voluntary contribution for climate protection. The experiment also reveals that the degree of individual rationality is an important predictor of contribution decisions. In fact, individuals with a higher degree of rationality act more selfishly, while intuitive, boundedly rational decision makers are more willing to cooperate. These results have important implications for risk communication, indicating that disseminating evidence of gradual climate change and its impact can promote action on climate change.

This thesis has studied alternative models of individual behavior and discussed their implications for environmental policy. It looked at a range of features of bounded rationality and social preferences. These were examined by formulating conceptual and formal models as well as by undertaking economic experiments. Ultimately, this thesis has shown that studying the psychological underpinnings of economic behavior provides many new insights for the design of effective environmental policy and agreements.

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