Working Paper in Economics No. 687

Prices versus Standards and Firm Behavior: Evidence from an Artefactual Field Experiment

Magnus Hennlock, Åsa Löfgren, Conny Wollbrant

Department of Economics, January 2017

ISSN 1403-2473 (Print)
ISSN 1403-2465 (Online)

UNIVERSITY OF GOTHENBURG
SCHOOL OF BUSINESS, ECONOMICS AND LAW

Prices versus Standards and Firm Behavior

Evidence from an Artefactual Field Experiment

Magnus Hennlock, Åsa Löfgren, Conny Wollbrant*

Abstract

We conduct an artefactual field experiment in which 164 managers and senior advisors recruited from Swedish industry were presented with a task of maximizing net revenue from abatement investments under three different but equally stringent environmental policy regimes. We find that investment decisions are strongly influenced by type of policy instrument. Economic instruments and performance standards cause different attentional and judgment biases that are inconsistent with standard economic theory. Inconsistencies are larger with economic policy instruments (tax and subsidy) than with performance standards even though subjects' attention to cost minimization was greater with economic instruments than under performance standards.

Key words: artefactual field experiment, bounded rationality, attentional bias, investment inefficiencies, firm, regulation, policy.

JEL-codes: C93, H32, L20.

* Hennlock, Policy and Economy, IVL Swedish Environmental Research Institute, P.O. Box 530 21 S-400 14 Gothenburg, Sweden, tel. +46 31 708 65 08, e-mail: Magnus.Hennlock@ivl.se. Löfgren, Department of Economics, University of Gothenburg, P.O. Box 640, S-405 30 Gothenburg, Sweden, tel: +46 31 786 1375, fax: +46 31 786 1043, e-mail: Asa.Lofgren@economics.gu.se. Wollbrant, Department of Economics, University of Gothenburg, P. O. Box 640, S-405 30 Gothenburg, Sweden, tel: +46 31 786 2615, fax: +46 31 786 1043, e-mail: Conny.Wollbrant@economics.gu.se. The authors are grateful to Professor O.Johansson-Stenman, Department of Economics, University of Gothenburg, Professor M. Dufwenberg, Department of Economics, University of Arizona, Senior Fellow D. Burtraw and K. McCormack at the Resources for the Future, Washington D.C. for valuable comments and advices on earlier drafts of the article. Also, the authors have benefited from helpful comments by participants at the Workshop on Behavioural and Experimental Economics May 2016 at the University of Gothenburg, at the National Conference in Economics at the University of Gothenburg in September 2016, and at the 11th Nordic Conference on Behavioral and Experimental Economics in September 2016 in Olso. In addition the authors appreciate financial support from the Mistra INDIGO research program (the Swedish Foundation for Strategic Environmental Research). Research assistance by Maria Lindblad and Haben Tekie at the Swedish Environmental Research Institute is gratefully acknowledged.

According to standard economic theory, a profit-maximizing, or cost-minimizing, firm should equate the values of marginal product and marginal cost. In the presence of an environmental economic policy, such as the Pigovian emissions tax, this implies choosing the emissions level at which the firm's marginal abatement cost of reducing its emissions is equal to the emissions tax level. This result, which guarantees cost-efficient emissions reductions, is a cornerstone in the mainstream economics literature arguing for the use of economic policy instruments (such as taxes, subsidies, or tradable permits) rather than standards.[1]

Still, despite its powerful theoretical prediction, empirical evidence suggests that under some circumstances, decisions in response to policy deviate from standard theory (for an overview, see, e.g., Sorrell, Mallett and Nye 2011). A prominent example of such deviation from theory is the "energy efficiency gap," which refers to empirical observations that realized energy efficiency investments seem to diverge from the cost-minimizing level. Allcott and Greenstone (2012) provide a comprehensive review of the existence of the energy efficiency gap and suggest that that there is substantial heterogeneity in investment inefficiencies across different types of agents. They further outline a number of causes of these investment inefficiencies, such as imperfect information and behavioral constraints (e.g., inattention to information), though most of the discussion is framed within a consumer perspective. When it comes to firm behavior, according to standard economic theory, competition should force firms with investment inefficiencies out of business in the long run. In terms of productivity, the probability of a firm exiting the market is higher the lower its productivity. Yet, there are well documented and persistent empirical differences in productivity even within narrowly defined businesses and industries (for an overview, see Syverson 2011). Explaining empirical productivity differences has attracted strong interest from economists, and one factor that has received attention is the potential importance of management. For instance, Bloom et al. (2013) show that under certain circumstances, informational constraints and restrictions on competitive pressure can allow "badly run" firms to stay in business.

Our study contributes to this field of research by conducting an artefactual field experiment on firm behavior in response to policy interventions (see Harrison and List 2004 for a taxonomy of experimental approaches). The overall purpose is to test whether heterogeneity in investment inefficiencies could arise as a result of the type of policy instrument implemented as well as complex choice situations in which managers and senior advisors ("the firm") may be subject

[1] Note that a regulator with perfect information about the firms' abatement costs could achieve the cost-efficient allocation by setting firm-specific performance standards based on individual marginal cost functions.

to bounded rationality or rely on norms or simplified choice rules that conflict with standard theory. The research builds on empirical evidence of behavioral anomalies and recent literature that emphasizes the need to consider behavioral economics and bounded rationality in the design and analysis of environmental policy (see, e.g., Shogren 2002; Shogren and Taylor 2008; Gowdy 2008; Gsottbauer and van den Bergh 2010; Pollitt and Shaorshadze 2011; Carlsson and Johansson-Stenman 2012; Gsottbauer 2013).

The aim of the experimental design is to test whether differences in firm managers' responses and attention to information result from equally stringent policy instruments and to analyze which choice rules managers and advisors adhere to in complex investment choice situations (including the choice rule that would correspond to standard economic theory). We recruited 164 firm managers and senior advisors from Swedish industry and randomly assigned each of them to one of three policy instrument treatments—tax, subsidy, or performance standards—all with equal stringency in terms of social efficiency. We asked them to choose the abatement investment level that would maximize the net revenue of a hypothetical firm (with an identical cost structure in all treatments).

The experiment was designed such that subjects were presented with both redundant and relevant numerical information for making the investment choice. However, to mimic real-world complex decision making, the provided information did not allow subjects to base the choice merely on numerical calculations. Instead, they needed to rely on non-numerical information to choose an investment alternative maximizing net revenue. For instance, in the tax treatment, the set of information variables was arranged so that only one investment alternative had a marginal cost equating the tax level. Hence, this alternative corresponded to the optimality condition according to standard economic theory.

The rationale for assigning subjects to different treatments with equally stringent policies is that the policies inherently rely on different types of information variables (price versus performance). Economic instruments and performance standards could therefore draw the attention of firm managers to different types of information. The theoretical and experimental behavioral economics literature has revealed several judgment biases that arise in situations where one information attribute is more salient to decision makers than others. For example, the dissociation between monetary assessments and predicted utility is one well-known judgment anomaly (see, e.g., Thaler 1985; Hsee et al. 2003; Amir, Ariely, and Carmon 2008). Evidence also suggests that monetary assessments tend to make decision makers focus more on

information variables related to transactions (for instance, prices, costs, and market norms) and less on other variables related to the pleasure or utility of owning or consuming the good.

Amir, Ariely, and Carmon (2008) suggest that this can be explained by focalism, meaning that different assessment tasks are informed by different types of information and features of the evaluated stimuli. They find experimental support for this conjecture by testing the impact of different types of information on subjects' value assessments. By drawing subjects' attention to either a monetary variable (production cost) or other attribute variables, they find a disparity between the subjects' willingness to pay and the predicted utility. Schkade and Kahneman (1998) show that decision makers' evaluations of changes are affected by the information emphasized. Finally, preference reversals may occur when choices become more informed by the most prominent attribute of the evaluated options; this is known as the prominence effect (Tversky, Sattath, and Slovic 1988).[2]

In addition, the psychology literature suggests that decision makers may fail to engage in cost-benefit analyses and instead rely on decision-by-rules mechanisms learned through experience or social exchange (Simonson 1989; Prelec and Herrnstein 1991; Shafir, Simonson, and Tversky 1993). Amir and Ariely (2007) show in an experiment that the need for monetary assessments may invoke previously learned rules, resulting in inconsistency between monetary-based judgments and judgments based on other factors such as effort and pleasure. Further, Sunstein (2004) argues that the context of the decision may activate the switch from maximizing preferences to instead applying a certain choice rule.

There are still very few examples of studies specifically on firm behavior in the behavioral and experimental economics literature. Ellison (2006) and Spiegler (2011) discuss bounded rationality in the decision-making process within industrial organization. Camerer and Malmendier (2007) consider the possibility that top managers make mistakes that markets do not fully correct. They argue that managers are most likely to face judgment biases when (i) a certain type of decision is not made frequently and does not deliver clear feedback, (ii) the manager does not specialize in making the specific type of decision, and (iii) the manager is protected from market pressure and competition. All three cases are examples of what may occur when the feedback signals from the market are imperfect or infrequent. To explain deviations from profit maximization in firms, Armstrong and Huck (2010) and Cyert and March

[2] A preference reversal occurs when a subject prefers one alternative in one response mode (e.g., choice) but exhibits the opposite preference order in another response mode (e.g., a rating over an attribute).

(1963) refer to *satisficing*, a concept developed by Simon (1955). Satisficing as an example of bounded rationality suggests that a decision maker generally does not go through and compare all universally possible investment choices, but rather chooses the first option that he or she deems satisfying.[3] Alternatively, firm managers may rely on rules of thumb, such as imitating strategies of well-performing rivals or changing strategies only when profits fall below some acceptable threshold rather than performing explicit calculations of optimal strategies (Armstrong and Huck 2010).

In the context of the current study, our results show that the investment decisions of firm managers and senior advisors are strongly and significantly influenced by type of policy instrument. Moreover, treatments induce significant attentional biases in subjects' stated use of information for making their decisions. We argue that these effects occur because economic policy instruments and standards naturally invoke two different assessment approaches—monetary-based and performance-based judgments—leading to different attentional and judgmental biases that are inconsistent with the expected outcome in standard economic theory. These inconsistencies were larger with economic instruments than with performance standards even though managers' attention to abatement costs and to the minimization of those costs were found to be greater with economic instruments than under performance standards. These investment inefficiencies are remarkable given that our subjects are managers and senior investment advisors from large and medium-size firms who have experience with real investment decisions in response to both economic policy instruments and performance standards in Sweden. The prevalence of such effects presents a challenge to policy researchers as well as regulators in their choice and design of policy instruments and is of importance and concern in relation to economic policy in general.

I. Survey Design and Experimental Manipulations

A. Population and participants

[3] The reliance of decision makers on simplified decision rules for cognitively demanding tasks has received much attention in the literature on bounded rationality (Simon 1955, 1979). The term refers to the limited capacity for rationality that can arise when solving complex problems, processing large amounts of information, or making decisions in the presence of uncertainty and incomplete information.

Experienced managers and senior advisors were recruited for the experiment from large and medium-size firms in Swedish industry. Their ordinary work duties involve analyzing and preparing technical and economic background information for investment decisions and recommending decisions to the firm's CEO or board of directors. The subject pool was identified through the Swedish regulatory register of plants classified as engaging in environmentally hazardous activities (EHA) by the Swedish Environmental Code.[4] Typically, the EHA classification is given only to plants larger than a certain size, which is usually determined by production volume. The EHA category implies that our sample represents large and medium-size firms, including the largest firms in Sweden. We therefore expect managers and senior advisors in our sample to be among the most experienced in Swedish industry. Moreover, each regulated plant in the EHA category is generally regulated by various types of policy instruments, including the Swedish Environmental Code, as well as economic policy instruments, such as the Swedish NO_x charge, the Swedish CO_2 tax, and the CO_2 emissions trading system EU ETS. Hence, our subjects generally have broad experience with various types of economic policy instruments and standards.

All EHA-registered firms in the chemical, pulp and paper, and steel sectors, as well as all firms operating combustion plants for production of electricity and heat in Sweden, were included in the sample pool. Altogether, 385 firms were identified. For the pilot study, 54 firms were randomly drawn from the total of 385 firms, and for the final experiment, the remaining 331 firms on the list were contacted by phone in February and March 2014. Within each firm, a search for the manager or senior advisor in charge of environmental investment decisions was conducted. In 52 firms (16 percent), neither the manager nor the senior advisor with said responsibilities was reached after three phone calls (for reasons such as meetings, traveling, or parental leave). In 34 firms (10 percent), a target subject was reached by phone but declined to participate. In 245 firms (74 percent), either a manager or a senior advisor was identified and agreed to participate. Upon acceptance, subjects were informed that a link to an online questionnaire would be sent by e-mail within 24 hours after the call. After up to three reminders by phone and e-mail, 164 subjects (57 percent), of whom 69 were managers and 95 were senior advisors, had completed the experiment. Among the 69 managers, 39 were members of the firm's senior management team.

[4] The Swedish regulatory register is Svenska miljörapporteringsportalen (SMP). The declaration data used is reviewed by the Swedish Environmental Emissions Data (Svenska Miljö Emissions Data, SMED) on behalf of the Swedish Environmental Protection Agency.

B. Incentives and treatments

The subjects received the online survey via e-mail with the stated aim of "better understanding the effects of environmental regulations on firms' investments in cleaner technologies." The subjects were never informed in phone calls, e-mails, or the online survey that they were participating in an experiment or that there were different treatments (see Appendix A.1 for more details on the recruitment process).

In the experiment, subjects were presented with six investment alternatives that differed in terms of abatement level and cost. They were instructed to choose the investment alternative that would yield the highest net revenue for a hypothetical firm. The choices made by the subjects were incentivized, yet the incentives in terms of relative monetary payoff were low in relation to the high monthly earnings of the subjects. However, studies have shown that the size of the stake does not have a significant effect on qualitative outcomes (e.g., in public goods experiments such as Kocher, Martinsson and Visser (2008). Rather, it is the move from unincentivized to incentivized choices that matters. For practical reasons, we incentivized this experiment using cinema tickets (see Appendix A.6 for details). The cinema tickets were easy to transfer via e-mail to the subjects (this would not have been the case had the payments been made with the corresponding amount of money). No time limits were imposed for completing the experiment and ex-post questionnaire, and it took each subject on average 15 minutes to complete the full survey (see Appendix A.6 for the full survey).

The subjects were randomized into the three treatments described in Table 1.[5]

Table 1. Policy instrument treatments

Treatment	Regulator's information
Performance standard	The condition for your investment decision is that the firm should meet an emissions limit of 75 grams per kWh output on an annual average basis according to the Swedish Environmental Code.
Tax	The condition for your investment decision is that the firm will pay an emissions tax of SEK[a] 250 per kg of emissions each year.
Subsidy	The condition for your investment decision is that the firm will receive a subsidy of SEK[a] 250 per kg emissions reduction each year.

[5] Experimental economics has been criticized by experimenters in other disciplines, such as psychology and political science, for failing to study control groups (Green and Shapiro 1994; Jones 1999a, b). The common defense is that the theoretical prediction of the rational choice serves as the objective comparison (from the experimental design point of view), or control. Since we are primarily interested in the behavioral response to economic incentives, we impose an alternative hypothesis, as control or benchmark, in the form of a performance standard treatment without any economic policy incentives.

[a] SEK = Swedish krona

The experiment was designed such that the stringencies of the three policy instruments were identical, and the only difference between the treatments was the sentence containing the regulatory information in Table 1.[6] (The formal optimization problems with optimal conditions for each treatment are shown in Appendix A.2.)

Shifting from performance standards to an economic instrument will, besides introducing economic incentives, introduce distributive effects. Studies have shown that people put more negative weight on a loss than they put positive weight on a similar-size gain (Kahneman and Tversky 1979; Tversky and Kahneman 1991; Goldberg and von Nitzsch 2001). To control for any reference dependencies, including loss aversion, we included a subsidy (negative tax) treatment to serve as an exact mirror of the (positive) tax treatment.

The subjects were randomly assigned to one of the three treatments in Table 1. Of the 164 subjects who completed the experiment, 52 were assigned to the tax treatment, 45 to the subsidy treatment, and 67 to the performance standard treatment. The average subject was 49 years old and had 14 years of work experience in the current position (manager or senior advisor). Fifty-two percent of the subjects were male. The subjects in the tax treatment differ significantly from the other subjects in a few variables. (This is discussed further in Appendix A.3.)

C. Information and choice set

The investment alternatives were presented using three different categories of information:

1. regulatory information about the stringency and type of policy instrument in place (*varies across treatments*; see Table 1);
2. emissions performance levels, grams of emissions per kilowatt hours of output (g/kWh) for each of the six investment alternatives (*identical across treatments*); and
3. total, average, and marginal costs of the six investment alternatives (*identical across treatments*)

[6] Note that we did not include any penalty in the performance standard treatment. It is uncommon in Sweden to immediately impose a fixed penalty for a firm that suddenly violates an emissions limit value. If a firm is found in violation, authorities communicate with the firm, resulting in an analysis of the cause and a joint plan for how the firm will comply with the rules.

The investment alternatives were presented to the subjects in the form of a choice set containing information categories 2 and 3 (see Table 2). The choice set contained six different investment (abatement) levels, A through F, with varying emissions performance and abatement costs. The columns show investment alternatives A–F, and the rows provide information about outcomes in terms of the emissions performance and costs associated with each alternative.[7]

Table 2. Choice set with information variables in all treatments (information categories II and III)

	Alt A	**Alt B**	**Alt C**	**Alt D**	**Alt E**	**Alt F**
Emissions performance (g/kWh)	95	90	85	80	75	70
Total annual investment cost (SEK)	21,250	25,000	31,250	40,000	51,250	65,000
Marginal cost of abatement (SEK/kg)	50	100	150	200	250	300
Average cost of abatement (SEK/kg)	430	250	210	200	210	220

Immediately after making the investment choice, while still seeing the choice set in Table 2 on the computer screen, subjects were asked to grade, on a six-item Likert scale, how relevant each information variable was for their choice. In the experiment, all alternatives except C included information attributes with different minima or maxima.

The set of information variables in Table 2, identical in all treatments, was designed to mimic real-world complex decision making in that subjects were presented with redundant as well as relevant but insufficient numerical information for investment choice based on numerical calculations. Instead, subjects needed to rely on other than merely numerical information to pick an investment alternative that would maximize net revenue. For instance, in the tax treatment, the set of information variables was arranged such that alternative E was the unique alternative with a marginal cost of 250 SEK/kg, which equals the tax level in the tax treatment and the subsidy level in the subsidy treatment. Assuming continuously differentiable cost functions in line with standard economic theory, this alternative corresponds to the choice that maximizes net revenue. Accordingly, this alternative is the rational choice in standard economic theory (see Appendix A.2 for optimal conditions). Failing to take this information into account and choosing an alternative other than E would give rise to investment inefficiencies in terms of standard economic theory.

[7] The minimum average cost, where marginal cost equals average cost, is found in alternative D. The production volume is assumed to be constant across A–F, implying that cost minimization will straightforwardly also maximize net revenue.

Hence, the experimental design allows a subject, aware of the optimal condition in standard economic theory, to identify the alternative that maximizes net revenue as the one where the marginal cost equals the tax rate (or the subsidy rate in the subsidy treatment). If subjects use this "optimal rule," the problem is straightforward. For instance, in the tax treatment, the subject identifies the marginal cost as the relevant information. Second, the subject compares each alternative in the list until he or she finds one that has (or comes closest to) the marginal cost of 250 SEK/kg in alternative E. After finding this, the subject continues to check all remaining alternatives, verifying that E is unique among all alternatives. The information about total cost, average cost, and emissions performance is redundant.

In the performance standard treatment, the alternative with an emissions performance of 75 grams per kWh output in alternative E fulfills the standard at the lowest marginal cost (by constrained maximization). Thus, the rational subject first identifies E and F as the permissible alternatives, and then chooses (now under the binding constraint) from them the alternative with the lowest marginal cost, which is again E, with the marginal cost of 250 SEK/kg (for optimal conditions with binding constraints see Appendix A.2). The information about total cost and average cost is redundant as in the other treatments.

In the experiment, we intentionally avoided placing the investment alternative with information corresponding to maximized net revenue in standard economic theory close to the middle of the choice set in Table 2 because several sources in the experimental literature show that individuals tend to opt for an intermediate—that is, a compromise alternative—instead of an extreme alternative, in particular when faced with a range of possibly non-dominated alternatives (Simonson 1989; Simonson and Tversky 1992; Tversky and Simonson 1993). We also avoided placing the investment alternative with information corresponding to maximized net revenue at one extreme of the choice set because of the possibility of order dependence. Although a rational decision maker's choice is order independent, meaning that any permutation of the order in which alternatives are presented will not affect the choice, bounded rationality may result in order dependence. Salant (2011) shows that any choice rule that is procedurally simpler than rational choice is order dependent. Hence, the order of the alternatives presented to the decision maker may affect choice behavior. The order effect is easily demonstrated; for example, in the satisficing procedure described by Simon (1955), the decision maker assigns each alternative as either satisfactory or not and chooses the first satisfactory alternative. If no alternative is satisfactory, the last alternative is chosen (Simon 1955). Hence, a satisficing decision maker displays order effects. Thus, placing a satisfactory

alternative toward the beginning of the list of alternatives increases the likelihood that it will be chosen (primacy effect), and so does placing a nonsatisfactory alternative in the last position (recency effect).

II. Results

We now turn to the analysis of the experimental data. First, we test for treatment effects—that is, whether the subjects' investment choices are influenced by the type of policy instrument, and whether we can reject or accept the prediction of the standard economic theory of no difference in investment choices across treatments. Second, we test whether the type of policy instrument affects subjects' attention to the different information attributes. Third, we analyze whether investment inefficiencies, in terms of standard economic theory, can be explained by bounded rationality and attentional biases in information reliance. Finally, we discuss welfare implications of the results.

A. Treatment effects

Figure 1 provides a qualitative illustration of the frequencies of observed choices and stated information relevance across policy treatments. (A quantitative overview of frequencies and means is found in Appendix A.4.)

Figure 1. Investment choice by treatment (bubble size is proportional to the frequency in each treatment)

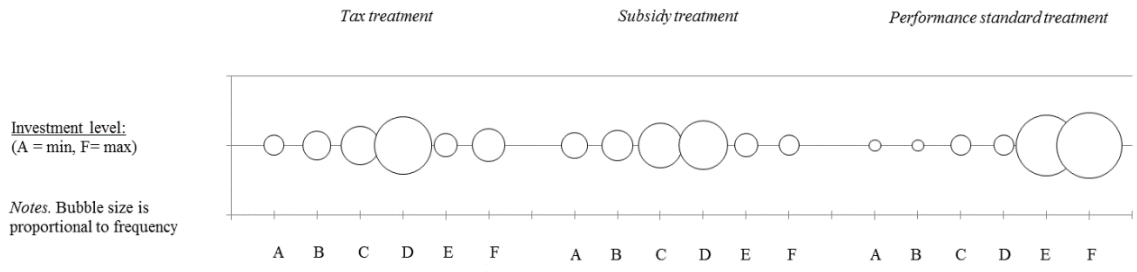


Figure 1 shows clear evidence of treatment effects on investment levels (note that abatement increases from A to F; that is, investment choice A corresponds to the smallest emissions reduction and F to the largest).[8] In the performance standard treatment, alternatives E and F are more frequent choices than in the economic policy treatments. A comparison of the investment levels in the economic policy treatments (tax and subsidy) with those in the performance standard treatment reveals that the investment levels under any of the economic instruments are

[8] Here we refer to the "total annual investment cost," which is monotonically increasing in choices A–F.

significantly lower than under the performance standard.[9] In the performance standard treatment, 88 percent of the subjects chose alternative E or F (E and F are the only two choices that comply with the standard). About 40 percent chose alternative E, which has a marginal cost that equals the tax and subsidy levels. In the tax and subsidy treatments, only 3.9 and 8.9 percent, respectively, chose E. The most commonly chosen alternative in the tax and subsidy treatments was instead alternative D (46 and 33 percent of the subjects, respectively). (Tables A.4.1–A.4.3 in Appendix A.4 give quantitative overviews of frequencies per treatment.)

We conclude that the observed choices are not consistent with the prediction of standard economic theory that the choices should not differ across treatments. We also see indications of investment inefficiencies in all treatments (i.e., choices that fail to take into account the optimal conditions in alternative E). Replacing performance standards with an economic instrument reveals another striking result. The average response time for making the choice increased by 52 and 91 percent in the tax and subsidy treatments, respectively, compared with the performance standards. The difference in response time is significant in a Mann-Whitney test,[10] which suggests that the cognitive complexity indeed increased with economic instruments compared with performance standards.

To control for reference dependencies when switching from performance standards to taxes, we introduced a subsidy (negative tax) with stringency identical to that for the tax treatment. A comparison reveals that the average investment level is slightly lower with the subsidy than with the tax, which possibly indicates such dependencies. However, a Mann-Whitney test shows that the difference is not significant.

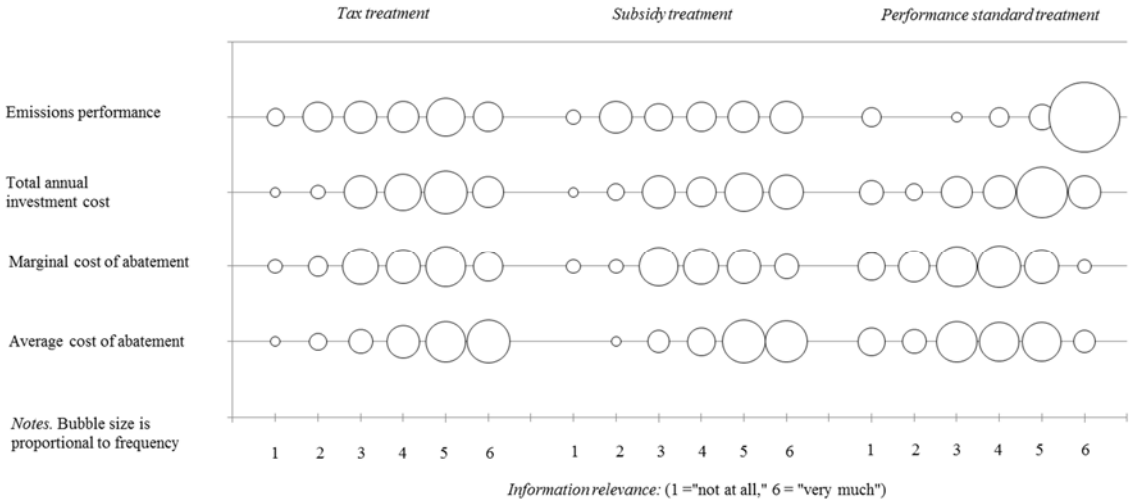
B. The effect of policy instrument on subjects' attention to information

Immediately after making their choices in the experiment, subjects were asked to rate the relevance of each information variable in the choice set (information categories 2 and 3) for the choice of investment made. The subjects' responses reveal that their decisions were significantly influenced by the type of policy instrument (see Figure 2). In the two economic policy treatments, subjects ranked the relevance of the information on emissions performance significantly lower than did subjects in the performance standard treatment, and the relevance

[9] Tax vs. performance standard: Mann-Whitney U-test, mean vs. mean, p = 0.0000. Subsidy vs. performance standard: Mann-Whitney U-test, mean vs. mean, p = 0.0000.
[10] Tax vs. performance standard: Mann-Whitney U-test, mean vs. mean, p = 0.0050. Subsidy vs. performance standard: Mann-Whitney U-test, mean vs. mean, p = 0.0035.

of costs information was ranked significantly higher than the relevance of the emissions performance information (within-comparison).[11] Subjects in both the tax and the subsidy treatments on average ranked information about the average cost of abatement as the most relevant information for the investment choice made. In the performance standard treatment, the emissions performance information was instead ranked highest (within-comparison; all are statistically significantly different from the information that in each treatment is ranked as the second most important).[12]

Figure 2. Stated relevance of information types by treatment (bubble size is proportional to frequency)



While information about total annual investment cost is ranked as important in all three treatments (no significant difference among the treatments),[13] marginal cost is ranked as the least important information in the subsidy and performance standard treatments,[14] and it is ranked as the second least important information in the tax treatment (within-comparison).[15] It

[11] Tax vs. performance standard: Mann-Whitney U-test, mean vs. mean, p = 0.0000. Subsidy vs. performance standard: Mann-Whitney U-test, mean vs. mean, p = 0.0000.

[12] Wilcoxon signed-rank test: *Tax treatment* test if information about average cost (median) is equal to the median of the information about investment cost, p = 0.0968. *Subsidy treatment* test if information about average cost (median) is equal to the median of the information about investment cost, p = 0.0693. *Performance standard treatment* test if information about emissions performance (median) is equal to the median of the information about investment cost, p = 0.0000.

[13] Mann-Whitney U-test, mean vs. mean: tax vs. subsidy treatment: p = 0.6438; tax vs. performance standard treatment: p = 0.9226; subsidy vs. performance standard treatment: p = 0.4910.

[14] However, it is only significantly different from the second least important information, as ranked by subjects, in the performance standard treatment.

[15] But it is not significantly different from information ranked as least important in the tax treatment, the emissions performance information. Wilcoxon signed-rank test: *Tax treatment* test if information about marginal cost (median) is equal to the median of the information about emissions performance, p = 0.7676. *Subsidy treatment* test if information about marginal cost (median) is equal to the median of the information about emissions

should be noted, however, that marginal cost information is deemed significantly more important in the tax and subsidy treatments than in the performance standard treatment (between-comparison).[16]

Clearly, the policy treatments draw subjects' attention to either a monetary variable (a tax or a subsidy level) or a performance variable (emissions limit value). One may ask if these attentional biases can also explain the differences in investment choice between the economic policy treatments and performance standard treatments. In the case of performance standards, only 40 percent of the subjects succeeded in choosing alternative E, which has the lowest cost (across all cost variables) among complying investment alternatives (constrained maximization). Their focus on emissions performance may have caused them to underweight cost information, thus failing to choose alternative E even though this is a simpler task, as fewer (complying) alternatives exist than in the treatments with economic instruments, where all alternatives in the choice set are compliable. Thus, the performance-based judgment (in the performance standard treatment) seems to divert attention from the monetary attributes required for identifying cost-efficient investment levels by constrained maximization. When firms do not respond by (constrained) maximization under standard regimes, the total cost inefficiency under standards may be even larger than the usual inefficiency from not exploiting the heterogeneity in abatement costs within the industry.

In the case of economic policy instruments, however, subjects' attention is significantly drawn toward cost information variables, but apparently not sufficiently to lead them to choose investment alternative E, which constitutes the optimal condition of a marginal cost that equals the tax and subsidy level. Instead, the most commonly chosen alternative in the tax and subsidy treatments was alternative D (46 percent and 33 percent of the subjects, respectively), which is consistent with the choice rule that minimizes the average cost across investment (abatement cost) alternatives rather than the total cost to the firm (the sum of abatement cost and compliance cost), as in alternative E. The attentional bias now occurs between different types of cost information rather than between cost and performance information as in the performance standard treatment. A majority of subjects exhibited behavior that is consistent with minimizing average cost across alternatives in the choice set. Consequently, they minimized abatement cost

performance, p = 0.6644. *Performance standard treatment* test if information about information about marginal cost (median) is equal to the median of the information about average cost, p = 0.0716.

[16] Mann-Whitney U-test, mean vs. mean: tax vs. subsidy treatment: p = 0.7574; tax vs. performance standard treatment: p = 0.0097; subsidy versus performance standard treatment: p = 0.0282.

across alternatives rather than *the sum* of abatement and compliance costs. (In the experiment, we explicitly instructed the subjects to choose the investment that resulted in the highest possible net revenue; see Appendix A6.)

We hypothesize that subjects in the tax and subsidy treatments may have overweighted the impact of their own abatement costs, since these costs can be argued to be more salient than the compliance costs. The behavioral literature suggests a number of explanations and results showing similar biases as in our findings. Schkade and Kahneman (1998) find that subjects overestimate the impact of events that are more salient to them than other events. Amir, Ariely, and Carmon (2008) find an additional explanation—that price assessments focus on the features of the transaction cues (prices, costs, market norms, and so on). Hsee et al. (2003) suggest that attentional bias to various types of variables can lead to inconsistencies between choices and preferences. Further, the prominence effect may result in preference reversals, since choices become more informed by the most prominent attribute of evaluated alternatives (Tversky, Sattath, and Slovic 1988). Overall, these results show, in accordance with our study, that it is difficult to appropriately balance the importance of considerations that are the focus of attention with the importance of considerations that are currently in the background.

C. *Effects of bounded rationality and attentional biases*

To test whether attentional biases in information can provide an explanation for our observed investment choices, we apply a multinomial probit model to the full sample, with the investment choice as the dependent variable and stated relevance of the categories of information as independent variables. Exactly how bounded rationality enters the revealed choices is uncertain, as the subjects also bring their own aggregate of unmeasured and unmeasurable idiosyncrasies. The model accommodates this intrinsic heterogeneity by allowing the coefficients to vary across subjects. Elements of bounded rationality may then enter either as explained variation (here stated irrelevant information) or as errors if the model does not capture the explained variation due to bounded rationality. Table 3 contains the predicted probabilities and marginal effects of the multinomial probit model estimated on the full sample.[17]

[17] We ran two tests with multinomial probit models. The first model used choice E (the rational choice) as base category and thereby showed whether a choice becomes more or less likely than choice E, which has a marginal cost equal to the tax (subsidy rate) in the treatments, as well as what information was used for making this choice. The second model used choice A as base category. The estimated coefficients of the two models are presented in Tables A.5.1 and A.5.2 in Appendix A.5. The predicted probabilities at means and the marginal effects shown in Table 3 are identical for the two models.

Table 3. Predicted probabilities and marginal effects on choice in the multinomial probit model

Multinomial probit model						
Choice alternative	A	B	C	D	E	F
Emissions performance	–0.025	–0.058	–0.101	–0.087	0.103	0.168
	(0.013)	(0.017)	(0.024)	(0.029)	(0.030)	(0.032)
Total cost information	0.017	0.041	0.061	0.002	–0.042	–0.079
	(0.015)	(0.021)	(0.030)	(0.034)	(0.033)	(0.034)
Marginal cost information	0.022	–0.004	–0.003	–0.068	0.074	–0.021
	(0.016)	(0.021)	(0.029)	(0.035)	(0.035)	(0.036)
Average cost information	–0.026	0.009	0.021	0.181	–0.092	–0.093
	(0.017	(0.021)	(0.030)	(0.035)	(0.035)	(0.035)
Predicted probability at means	0.040	0.078	0.159	0.247	0.232	0.244
	(0.201)	(0.027)	(0.037)	(0.044)	(0.042)	(0.044)
Prob > chi^2 0.000						

Notes: Robust standard errors in parentheses

The relevance of the emissions performance (EP) information is statistically significant at the 5 or 10 percent level for all six investment choices. However, while the relevance of EP information is negatively correlated with choices A–D, it is positively correlated with investment choices E and F, indicating that a subject who stated EP as more relevant information had a higher probability of choosing E or F and a lower probability of choosing any of the choices A–D.

The relevance of total cost (TC) information shows an almost opposite pattern. Subjects who stated TC as more relevant information have a lower probability of choosing F and a higher probability of choosing B or C. The relevance of marginal cost (MC) information has a significant positive effect on the probability of choosing E, consistent with standard economic theory. Finally, subjects indicating a higher relevance of average cost (AC) information have an 18 percentage point higher probability of choosing D. This is consistent with a choice rule that seeks to minimize AC across alternatives, and it is also the largest significant marginal effect across all alternative-specific information variables.[18]

[18] To explicitly test the high coincidence of choosing D when AC has received high relevance, we test a binary probit model of a bounded rational choice rule in terms of a focal point at minimum average cost alternative using AC as relevant information (see Appendix A.5 and Table A.5.4). The model is significant in the tax treatment and in the overall sample model at the 10 percent significance level.

The means of the marginal costs in the observed choices across treatments span from 169 SEK/kg (subsidy treatment) to 262 SEK/kg (performance standard treatment), to be compared with the 250 SEK/kg tax and subsidy level. The unique alternative with a marginal cost of 250 SEK/kg, potentially the efficient choice in the tax and subsidy treatments by standard economic theory, was E. However, the largest explanatory factor for the differences between the means of observed marginal costs was that in the tax and subsidy treatments, alternative D was the most common choice (46 and 33 percent, respectively) among the subjects. The means of marginal costs in the tax and subsidy scenarios were 189 SEK/kg and 169 SEK/kg (standard deviations of 66.9 and 65.1), respectively, and thus considerably below the tax and subsidy level of 250 SEK/kg. On the other hand, the mean of the marginal cost in the performance standard treatment was 262 SEK/kg (standard deviation 50.8), significantly higher than the tax and subsidy level.

D. Welfare implications

Our experiment indicates that investment choices significantly deviate from the investment choice that equalizes firms' marginal costs with the tax or subsidy level. It also shows that these deviations are smaller with performance standards than with (equally stringent) economic instruments. This can mainly be explained by the fact that subjects in the tax and subsidy treatments tended to choose the alternative that minimizes average abatement cost rather than the one that equalizes marginal cost with the tax or subsidy level. In welfare theory, this behavioral anomaly leads to a social loss the size of which is determined by the distance between the socially efficient tax level and the minimum of the average cost function. These two levels coincide in the special case where the marginal abatement benefit function and the marginal abatement cost function intersect at the minimum point of the average abatement cost function. However, depending on whether the intersection of the marginal benefit and the marginal cost functions lies to the right or the left of the minimum average cost, there will be too little or too much abatement compared with the socially efficient level and with what is cost efficient for the firm itself.

In our experimental design, the minimum average cost was located on the right-hand side of the intersection of the marginal benefit and cost functions. In terms of welfare, the revealed attentional bias caused our subjects in the economic policy treatments to choose an abatement level that was too low compared with the socially efficient level. By analogy with the analysis of Weitzman (1974), the magnitude of this social loss depends on the relative slopes of the

marginal benefit and cost functions. In addition, bounded rationality in this case implies that firms systematically carry some losses. Overall, whether performance standards lead to higher cost efficiency within an industry compared with an economic instrument depends on how large the cost heterogeneity of available investment alternatives is compared with the variance of firms' revealed marginal abatement costs due to behavioral anomalies in firms' decisions.

III. Concluding Remarks

Economic policy instruments and performance standards inherently use and rely on different types of information variables. Consequently, firms' decisions in response to policy will be informed by different types of information variables depending on the type of policy instrument. This study was designed to explore whether these inherent differences in provided information between economic instruments and performance standards can cause attentional and judgment biases, which in turn can lead to investment inefficiencies not predicted by economic theory. We analyzed the choice behavior of 164 experienced managers and investment advisors in Swedish industry who were presented with the task of maximizing net revenue from abatement investments under three different but equally stringent environmental policy regimes in a randomized artefactual field experiment.

We found that the investment decisions made by managers and investment advisors, all of whom have experience with real investment decisions in response to these types of environmental policies in Sweden, are subject to investment inefficiencies and rarely use the choice rule consistent with standard economic theory. In particular, their investment choices were affected by the type of policy instrument. Specifically, inefficiencies were larger with economic instruments than with performance standards. These results were obtained even though the subjects' attention to abatement costs and to the minimization of those costs was greater with economic instruments than with performance standards.

Interestingly, we find that the most frequently used choice rule in the tax and subsidy treatments was consistent with a tendency to minimize costs *over abatement alternatives* rather than *over abatement alternatives taking into account the tax or subsidy rate*. Specifically, managers and senior advisors tended to minimize average abatement costs rather than the *sum* of abatement costs and regulatory costs, resulting in mean abatement levels with marginal costs significantly lower than the tax and subsidy levels. That is, subjects in the tax and subsidy treatments could have reduced costs further by increasing the abatement level, as the reduction in tax payments

(increase in subsidy earnings) would have more than compensated for the increase in investment costs.

Our experimental results also indicate that performance standards may result in even larger total cost inefficiencies than predicted by standard economic theory because of underexploited cost heterogeneities within industry. Performance-based judgments in firms' decision making may divert attention away from the monetary attributes required for fulfilling the cost efficiency part of constrained optimization under performance standards.

We hypothesize that our results occur because the different policy instruments invoke differences in the decision-making process by drawing subjects' attention to different types of information, resulting in attention and judgment biases that lead to investment inefficiencies not predicted by standard economic theory. Our results resemble findings in the theoretical and experimental literature in behavioral economics and psychology (we find evidence of similar information-type judgment biases in, e.g., Thaler 1985; Tversky, Sattath, and Slovic 1988; Schkade and Kahneman 1998; Hsee 1999; Hsee et al. 2003; Amir and Ariely 2007; Amir, Ariely, and Carmon 2008).

The consequence of our results for social efficiency is analogous to the findings of Weitzman (1974), where misunderstandings of the optimal abatement level lead to social losses that depend on the type of policy instrument (in Weitzman's case, price versus quantity instruments; in our case, price versus standards). Our findings suggest that it may not only be the regulator (due to asymmetric information) that causes social loss because of uncertainty about abatement costs when searching for the social optimal abatement level. Firms themselves may also make mistakes in their responses to policies, and the magnitude of these mistakes depends on the type of policy instrument and the shape of the abatement cost function.

The prevalence of such effects presents a challenge to policy researchers as well as regulators in their choice and design of policy instruments. We conclude that the insights from behavioral and experimental economics as applied to firm manager behavior have so far been a neglected area. Future research should use rigorous empirical research and randomized field experiments to adequately estimate the effects of policy interventions on firm behavior. Future policy research should seek to fully understand both the effects and causes of bounded rationality among managers and address the challenges that such effects present to policy making in the choice and design of policy instruments. This should involve follow-up studies on combinations

of economic instruments and information that could better correct for bounded rationality among mangers.

References

Allcott, H., and M. Greenstone. 2012. “Is There an Energy Efficiency Gap?” *Journal of Economic Perspectives* 26 (1): 3–28.

Amir, O., and D. Ariely, 2007. “Decisions by Rules: The Case of Unwillingness to Pay for Beneficial Delays.” *Journal of Marketing Research* 44 (1): 142–52.

Amir, O., D. Ariely, and Z. Carmon. 2008. “The Dissociation between Monetary Assessment and Predicted Utility.” *Marketing Science* 27 (6): 1055–64.

Armstrong, M., and S. Huck. 2010. “Behavioral Economics as Applied to Firms: A Primer.” CESifo Working Paper No. 2937.

Bloom, N., B. Eifert, A. Mahajan, D. McKenzie, and J. Roberts. 2013. “Does Management Matter? Evidence from India.” *Quarterly Journal of Economics* 128 (1): 1–51.

Camerer, C. F., and U. Malmendier. 2007. “Behavioral Economics of Organizations.” In *Behavioral Economics and Its Applications*, edited by P. Diamond and H Vartiainen, 235–90. Princeton, NJ: Princeton University Press.

Carlsson, F., and O. Johansson-Stenman. 2012. “Behavioral Economics and Environmental Policy.” *Annual Review of Resource Economics* 4: 75–99.

Cyert, R., and J. March. 1963. *A Behavioral Theory of the Firm*. Englewood Cliffs, NJ: Prentice-Hall.

Ellison, G. 2006. “Bounded Rationality in Industrial Organization.” In *Advances in Economics and Econometrics: Theory and Applications, Ninth World Congress*, Volume 2, edited by Richard Blundell, Whitney Newey, and Torsten Persson, 142–74. New York: Cambridge University Press, 2006.

Goldberg, J., and R. Von Nitzsch. 2001. *Behavioral Finance*. Chichester, UK: John Wiley and Sons.

Gowdy, J. M. 2008. “Behavioral Economics and Climate Change Policy.” *Journal of Economic Behavior & Organization* 68 (3–4): 632–44.

Green, D., and I. Shapiro. 1994. *Pathologies of Rational Choice Theory*. New Haven, CT: Yale University Press.

Gsottbauer, E. 2013. “Behavioral Economics and Environmental Policy: Theory and Experiments.” Doctoral thesis, Universitat Autónoma de Barcelona, Spain.

Gsottbauer, E., and J. van den Bergh. 2010. “Environmental Policy Theory Given Bounded Rationality and Other-Regarding Preferences.” *Environmental and Resource Economics* 49 (2): 263–304.

Harrison G. W. and List J. A. 2004. “Field Experiments.” *Journal of Economic Literature* 42: 1009–1055

Hsee, Christopher K. 1999. “Value Seeking and Prediction–Decision Inconsistency: Why Don’t People Take What They Predict They’ll Like the Most?” *Psychonomic Bulletin & Review* 6 (4): 555–61.

Hsee, C. K, J. Zhang, F. Yu, and Y. Xi. 2003. “Lay Rationalism and Inconsistency between Predicted Experience and Decision.” *Journal of Behavioral Decision Making* 16 (4): 257–72.

Jones, B. D. 1999a. “Bounded Rationality.” *Annual Review of Political Science* 2: 297–321.

———. 1999b. “Bounded Rationality, Political Institutions, and the Analysis of Outcomes.” In *Competition and Cooperation: Conversations with Nobelists about Economics and Political Science*, edited by J. Alt, M. Levi, and E. Ostrom, 85–111. New York: Russell Sage Foundation.

Kahneman, D., and A. Tversky. 1979. “Prospect Theory: An Analysis of Decision under Risk.” *Econometrica* 47 (2): 263–91.

Kocher, M.G., P. Martinsson, and M. Visser. 2008.”Does Stake Size Matter for Cooperation and Punishment?” *Economics Letters* 99 (3): 508-511

Machina, P. H. Parker, J. Sterman, E. Weber, B. Wernerfelt, and R. Wensley. 1999. “Bounded Rationality Modeling.” *Marketing Letters* 10 (3): 233–48.

Pollitt, M. G., and I. Shaorshadze. 2011. “The Role of Behavioural Economics in Energy and Climate Policy.” EPRG Working Paper 1130, Cambridge Working Paper in Economics 1165.

Prelec, D., and R. Herrnstein. 1991. “Preferences or Principles: Alternative Guidelines for Choice.” In *Strategy and Choice*, edited by R.J. Zeckhauser, 319–40. Cambridge, MA: MIT Press.

Salant, Y. 2011. “Procedural Analysis of Choice Rules with Applications to Bounded Rationality.” *American Economic Review* 101 (2): 724–48.

Schkade, D., and D. Kahneman. 1998. “Does Living in California Make People Happy? A Focusing Illusion in Judgments of Life Satisfaction.” *Psychological Science* 9 (5): 340–46.

Shafir, E., I. Simonson, and A. Tversky. 1993. “Reason-Based Choice.” *Cognition* 49: 11–36.

Shogren, J. F. 2002. “A Behavioral Mindset on Environmental Policy.” *Journal of Socio-Economics* 31: 355–69.

Shogren, J. F., and L. O. Taylor. 2008. “On Behavioral-Environmental Economics.” *Review of Environmental Economic Policy* 2 (1): 26–44.

Simon H. A. 1955. “A Behavioral Model of Rational Choice.” *Quarterly Journal of Economics* 69: 99–118.

———. 1979. “Rational Decision Making in Business Organizations.” *American Economic Review* 69 (4): 493–513.

Simonson, I. 1989. “Choice Based on Reasons: The Case of Attraction and Compromise Effects.” *Journal of Consumer Research* 16: 158–74.

Simonson, I., and A. Tversky. 1992. “Tradeoff Contrast and Extremeness Aversion.” *Journal of Marketing Research* 29 (3): 281–95.

Sorrell, S., A. Mallett and S. Nye, 2011. *Barriers to industrial energy efficiency: A literature review.* Development Policy, Statistics and Research Branch, Working paper 10/2011, United Nations Industrial Development Organization, Vienna.

Spiegler, R. 2011. *Bounded Rationality and Industrial Organization*. Oxford, UK: Oxford University Press.

Sunstein, Cass R. 2004. “Moral Heuristics and Moral Framing.” *Minnesota Law Review* 88 (6): 1556–97.

Syverson, Chad. 2011. “What Determines Productivity?” *Journal of Economic Literature* 49 (2): 326–65.

Thaler, R. 1985. “Mental Accounting and Consumer Choice.” *Marketing Science* 4 (3): 199–214.

Tversky, A., and D. Kahneman. 1991. “Loss Aversion in Riskless Choice: A Reference-Dependent Model.” *Quarterly Journal of Economics* 106: 1039–61.

Tversky, A., S. Sattath, and P. Slovic. 1988. “Contingent Weighting in Judgment and Choice.” *Psychological Review* 95: 371–84.

Tversky A., and I. Simonson. 1993. “Context-Dependent Preferences.” *Management Science* 39 (10): 1179–89.

Weitzman, M. L. 1974. “Prices vs. Quantities.” *Review of Economic Studies* 41 (4): 477–91.

Appendix

A.1 Recruitment Process of Managers and Senior Advisors

The target subjects, experienced managers, and senior advisors in environmental investment decisions were recruited from Swedish firms identified via the regulatory register of plants classified as performing environmentally hazardous activities (EHA) according to the Swedish Environmental Code.[19] All EHA-registered plants in the chemical, paper and pulp, and steel sectors, as well as all combustion plants for production of electricity and heat in Sweden, were selected for the sample. Since the regulatory registry covers plants and not firms, the firms had to be identified by their ownership of the plants using the ownership data from the mandatory annual environmental reporting for 2012.

The register of EHA-regulated plants led to a list of 385 firms operating plants within these categories. As the list includes some of the largest business concerns in Sweden, each owning several firms and production plants in different regions, the sample sometimes includes multiple firms belonging to the same business concern. Thus, two "firms" in the data may be owned by the same business concern, but in such a case they have different subjects, usually employed at firms in different regions of the country.

The plants in the EHA category are, in general, large and regulated by a range of different policy instruments, including technology and performance standards by the Swedish Environmental Code and the EU environmental law, as well as economic policy instruments such as the Swedish NO_x charge, the CO_2 tax, and the European Union's CO_2 emissions trading system (EU ETS). Therefore, the managers and senior advisors have experience with investment decisions in response to several types of policy instruments.

Typically, plant activities classified as EHA apply only to plants above a certain size, which is usually linked to production volume. For instance, plant activities in the steel industry are classified as EHA only if a plant's annual production of iron or steel exceeds 5,000 tonnes, and a boiler is classified as EHA only if its thermal input exceeds 20 megawatts. The regulation's conditions on size mean that our sample mainly represents medium-size to the largest firms and business concerns in the Swedish basic industry. The managers and senior advisors in our

[19] The Swedish regulatory register is Svenska miljörapporteringsportalen (SMP). The declaration data used is reviewed by the Swedish Environmental Emissions Data (Svenska Miljö Emissions Data, SMED) on behalf of the Swedish Environmental Protection Agency.

sample can therefore be considered as among the most experienced seniors in the Swedish industry, with an average age of 49 and working experience of 14 years.

All 385 firms on the list were contacted by phone in the search for the manager or senior advisor in charge of environmental investment decisions. Each subject was informed about the questionnaire by hearing a standardized introduction and then asked for his or her participation.

For the pilot study, 54 firms were randomly drawn from the 385 firms and contacted by phone. In total, target subjects in 36 firms were reached by phone during January 2014 and agreed to participate in the questionnaire. The subjects were informed that the link to the online questionnaire would be sent to their e-mail within 24 hours after the phone call. Of those who agreed to participate, 32 subjects (89 percent) responded to at least the first part of the online questionnaire, which included the experiment, and 23 subjects (64 percent) responded to all following questions. The subjects included in the pilot study were not sampled for the final experiment.

For the final experiment, the remaining 331 firms or plants on the list were contacted by phone during February and March 2014. In 52 of these firms (16 percent), the target subjects were not reached after three phone calls (for reasons such as meetings, traveling, or parental leave). In 34 firms (10 percent), target subjects were reached by phone, but they declined to participate after hearing the introduction during the phone call.

Thus, in the final experiment, managers and investment advisors from 290 firms (148 males and 142 females) agreed to participate during the phone call. The subjects were informed that the link to the online questionnaire would be sent to their e-mail within 24 hours after the phone call. After up to three reminders by either phone or e-mail, the web statistics of the online questionnaire showed that 230 (79 percent) of the subjects had visited the webpage with the introduction to the questionnaire; 200 subjects (69 percent) had responded to at least the first part of the questionnaire, which included the experiment; and 164 subjects (57 percent) completed the full questionnaire with all the following questions. Each subject had spent an average of 15 minutes answering the full questionnaire, including the experiment.

Out of the 164 full-responding subjects, 69 were managers with experience as the formal decision makers in their firms' environmental investments. Among these managers, 39 were also members of the firm's or the business concern's senior management team. The remaining

95 subjects were senior advisors who prepared or analyzed technical and economic background information for their firms' investment decisions.

A.2 Formal Optimization Problems with Optimal Conditions in the Treatments

The experiment was designed such that the stringency of the regulations was identical, in the sense that optimal conditions would be fulfilled for the same abatement level in each of the three treatments. The conditions and the corresponding abatement levels in all three treatments are identical as long as the subsidy rate *S* is set equal to the tax rate *T*, which occurs when the standards are set such that $\hat{e}_i = e_i(q, a^*)$ in equations (1.1)–(3.2).

A.2.1 Performance Standards Treatment

In the performance treatment, the rational firm maximizes profit subject to the constraint $e_i \leq \hat{e}_i$. The Lagrangean for cost minimization (equal optimal conditions to net revenue maximization when production output is constant) is

(1.1) $$L = Pq_i - c_i(q_i, a_i) + \lambda\left[\hat{e}_i - e_i(q_i, a_i)\right]$$

where *c* is production costs, *a* is abatement, *e* is emissions performance, *i* is a firm, and λ is the Lagrangean multiplier. The corresponding optimality conditions are

(1.2) $$-\frac{\partial c_i}{\partial a_i}\left(q, a^*\right) - \lambda \frac{\partial e_i}{\partial a_i}\left(q, a^*\right) \leq 0$$

(1.3) $$\lambda^*\left[\hat{e}_i - e^*{}_i\left(q, a^*\right)\right] = 0$$

(1.4) $$\lambda^* \geq 0$$

(1.5) $$\hat{e}_i - e_i\left(q, a^*\right) \geq 0$$

Thus, the rational firm first identifies which alternatives fulfill the constraint $e_i \leq \hat{e}_i$, and then chooses from this feasible set the alternative that has the lowest marginal cost (under the binding constraint) according to equations (1.1)–(1.5).

A.2.2 Tax Treatment

In the tax treatment, the rational firm should seek to maximize its net revenue after abatement costs and taxes. It solves the unconstrained problem

(2.1) $$\max Pq_i - c_i(q_i, a_i) - Te_i(q_i, a_i)$$

where *c* is production costs, *a* is abatement, *e* is emissions performance, and *T* is the Pigovian tax. The necessary and sufficient first-order conditions for a firm with positive output and abatement costs are

(2.2) $$-\frac{\partial c_i}{\partial a_i}\left(q, a^*\right) - T\frac{\partial e_i}{\partial a_i}\left(q, a^*\right) = 0$$

Thus, the rational firm should, according to equation (2.2), choose the alternative in which the marginal cost equals the tax rate.

A.2.3 Subsidy Treatment

In the subsidy treatment, a rational firm should seek to maximize its net revenue after abatement costs and taxes. It solves the unconstrained problem

(3.1) $$\max Pq_i - c_i(q_i, a_i) + Se_i(q_i, a_i)$$

where *c* is production costs, *a* is abatement, *e* is emissions, and *S* is the subsidy rate. The necessary and sufficient first-order conditions for a firm with positive output and abatement costs are

(3.2) $$-\frac{\partial c_i}{\partial a_i}\left(q, a^*\right) + S\frac{\partial e_i}{\partial a_i}\left(q, a^*\right) = 0$$

Thus, the rational firm should, according to equation (3.2), choose the alternative in which the marginal cost equals the subsidy rate *S*. Comparing equations (2.2) and (3.2) shows that the rational firm faces no reference dependence between taxes and subsidies due to differences in distributive effects.

A.3 Background Characteristics

In this section, we present background characteristics of the subjects and compare them among treatments. The subjects were randomly assigned to one of the three treatments. Mean values and standard deviations (s.d.) for all subjects and by treatment are presented in Table A.2.1.

Table A.2.1. Background characteristics of subjects

		Treatments		
Background characteristics of subjects	*All*	*Tax*	*Subsidy*	*Performance standard*
No. of subjects	164	52	45	67
Regulatory experience (6 = extensive experience, 1 = no experience)		Mean (s.d.)	Mean (s.d.)	Mean (s.d.)
-taxes and fees	3.68 (1.46)	3.46 (1.51)	3.67 (1.33)	3.87 (1.51)
-subsidies	2.28 (1.44)	2.15 (1.49)	2.31 (1.22)	2.36 (1.55)
-environmental laws (miljöbalken)	4.86 (1.24)	4.52 (1.18)	5.16 (0.98)	4.93 (1.39)
Percentage of subjects that have participated in an investment decision (related to reducing the firms' environmental pressure) within the last 10 years	89.6	78.8	95.6	94.0
Education: percentage of subjects with a university degree[a]	86.2	88.0	84.1	86.2
Years of working experience	13.89 (8.7)	10.75 (7.08)	15.56 (8.92)	15.16 (9.16)
Age of subjects (years)[b]	48.6 (8.7)	47.9 (7.33)	48.7 (9.3)	49.1 (9.3)
Percentage of male subjects	51.8	46.2	46.7	59.7

[a] A few subjects did not answer this question. The numbers of observations are as follows: total, 159; tax treatment, 50; subsidy treatment, 44; performance standard treatment, 65.

[b] Only 65 out of the 67 subjects in the performance standard treatment answered this question, for a total of 162 observations.

The subjects overall have quite extensive regulatory experience with environmental laws, but they have less experience with taxes and fees and substantially less experience on average with subsidies. Almost all subjects have participated in an investment decision related to reducing the firm's environmental pressure, but this share is on average lower for the subjects in the tax treatment. The subjects are well educated, and over 80 percent in all treatments have a university degree. The average length of working experience for all subjects is approximately 14 years (however, it is a little higher for the subjects allocated to the subsidy and performance standard treatments compared with the tax treatment). The average age of the subjects is 48.6 years, and approximately half of the subjects are female (this differs among treatments, however, and the share of males is almost 60 percent in the performance standard treatment).

Our testing reveals no statistically significant differences among the groups of subjects allotted to the three treatments regarding experience with taxes, fees, or subsidies; education; age; or gender. While we do not find any statistically significant differences in background characteristics between subjects in the subsidy and performance standard treatments, we do find

differences in the background characteristics of the group of subjects allotted to the tax treatment. Our results suggest that there is a statistically significant difference between the underlying distributions of the regulatory experience with environmental laws between the subjects in the tax and subsidy treatments (Mann-Whitney U-test, mean vs. mean, p = 0.0050) and between the subjects in the tax and performance standard treatments (Mann-Whitney U-test, mean vs. mean, p = 0.0184). The subjects in both the subsidy treatment and the performance standard treatment have more extensive experience than expected compared with the null hypothesis, while the subjects in the tax treatment have less experience.

We also find a statistically significant difference in the subjects' mean experience with participating in investment decisions among the three different treatments (Pearson $chi^2(2)$, p = 0.008). Comparing only two treatments at a time shows that there is no significant difference between subjects in the subsidy and performance standard treatment, but again the subjects in the tax treatment differ (in terms of participation in investment decisions) compared with both the subsidy treatment (Pearson $chi^2(2)$, p = 0.016) and the performance standard treatment (Pearson $chi^2(2)$, p = 0.013). The subjects in the tax treatment have less experience with participating in an investment decision than those in the subsidy and performance standard treatments.

Years of working experience follows the same pattern as for regulatory experience and experience of participation in investment decisions: the results suggest that there is a statistically significant difference in the underlying distributions of years of working experience between subjects in the tax treatment and subsidy treatment (Mann-Whitney U-test, mean vs. mean, p = 0.0052), as well as between subjects in the tax treatment and performance standard treatment (Mann-Whitney U-test, mean vs. mean, p = 0.0089). The subjects in the subsidy treatment and the performance standard treatment have more working experience than expected compared with the null hypothesis, and subjects in the tax treatment have less experience.

A.4 Summary Statistics on Investments and Stated Information per Treatment

Tables A.4.1–A.4.3 show the number of observed choices, frequencies, and means across treatments.

Table A.4.1. Performance standard treatment summary statistics

Choices	A	B	C	D	E	F	Average
Observed choices	1	1	3	3	27	32	5.24

Percentage observed choices	1.49	1.49	4.48	4.48	40.30	47.76	
Average response time (seconds)	51	174	236	177	306	162	242
Stated relevant information							
Emissions performance	1.00	3.00	5.00	4.33	5.63	5.63	5.43
Total annual investment cost	1.00	5.00	5.33	4.00	4.48	3.97	4.21
Marginal cost of abatement	1.00	3.00	3.33	3.67	3.63	3.13	3.33
Average cost of abatement	1.00	3.00	4.00	5.33	3.70	3.41	3.60

Table A.4.2. Tax treatment summary statistics

Choices	A	B	C	D	E	F	Average
Observed choices	3	5	10	24	2	8	3.79
Percentage observed choices	5.77	9.62	19.23	46.15	3.85	15.38	
Average response time (seconds)	301	269	355	360	966	354	369
Stated relevant information							
Emissions performance	2.33	2.80	3.60	3.83	5.00	5.50	3.90
Total annual investment cost	4.33	4.60	4.50	4.25	4.50	4.38	4.37
Marginal cost of abatement	5.33	3.80	4.10	3.88	5.50	3.50	4.00
Average cost of abatement	2.33	4.20	4.50	5.29	5.00	4.38	4.71

Table A.4.3. Subsidy treatment summary statistics

Choices	A	B	C	D	E	F	Average
Observed choices	4	7	12	15	4	3	3.38
Percentage observed choices	8.89	15.56	26.67	33.33	8.89	6.67	
Average response time (seconds)	268	294	655	383	497	681	462
Stated relevant information							
Emissions performance	4.25	4.00	3.33	4.47	3.5	6.00	4.09
Total annual investment cost	5.25	4.57	4.25	4.20	4.00	5.33	4.42
Marginal cost of abatement	4.50	4.29	4.00	3.53	4.75	3.00	3.93
Average cost of abatement	5.00	4.86	4.75	5.07	5.75	4.00	4.93

Table A.4.5 shows the share of top ranks that each information variable received by each choice and treatment. Thus, it shows the frequencies of observed pairs of choices and top-ranked information.

Table A.4.5. Frequencies of top-ranked stated information per choice

Choice	Stated information	Extreme points in experimental design	Revealed choice and stated information consistent with choice rule	Performance standard treatment (percent)	Subsidy treatment (percent)	Tax treatment (percent)
A	Performance	Minimum performance	Minimize performance across alternatives	25	20	0
	TC	Minimum TC	Minimize TC across alternatives	25	30	25
	AC	Maximum AC	Maximize AC across alternatives	25	30	0
	MC	Minimum MC	Minimize MC across alternatives	25	20	75
B	Performance	No extreme performance	Compromise performance across alternatives	0	15	13
	TC	No extreme TC	Compromise TC across alternatives	100	23	38
	AC	No extreme AC	Compromise AC across alternatives	0	38	25
	MC	AC=tax and subsidy	Rational choice based on AC information	0	23	25
C	Performance	No extreme performance	Compromise performance across alternatives	40	15	19
	TC	No extreme TC	Compromise TC across alternatives	60	31	33
	AC	No extreme AC	Compromise AC across alternatives	0	35	29
	MC	No extreme MC	Compromise MC across alternatives	0	19	19
D	Performance	No extreme performance	Compromise performance across alternatives	17	23	15
	TC	No extreme TC	Compromise TC across alternatives	17	29	18
	AC	Minimum AC	Minimize AC across alternatives	50	35	55
	MC	No extreme MC	Compromise MC across alternatives	17	13	12
E	Performance	Performance = standards	Fulfill standards (or compromise performance)	65	14	20
	TC	No extreme TC	Compromise TC across alternatives	20	14	20
	AC	No extreme AC	Compromise AC across alternatives	8	43	20
	MC	**MC = tax and subsidy**	**Rational choice based on MC information**	8	29	40
F	Performance	Maximum performance	Maximize performance (or fulfill with certainty)	67	60	55
	TC	Maximum TC	Maximize TC across alternatives	14	40	27
	AC	No extreme AC	Compromise AC across alternatives	7	0	9
	MC	Maximum MC	Maximize MC across alternatives	12	0	9

A.5 Multinomial Probit Model Estimation Results

Table A.5.1. Multinomial probit all base E (rational choice) as comparison

Multinomial probit model						
Choice alternative	A	B	C	D	E	F
Emissions performance	–0.645	–0.746	–0.733	–0.566	BASE	0.179
	(0.175)	(0.201)	(0.166)	(0.165)		(0.190)
Total cost information	0.354	0.432	0.381	0.136	BASE	–0.103
	(0.210)	(0.218)	(0.168)	(0.150)		(0.132)
Marginal cost information	0.564	–0.255	–0.237	–0.422	BASE	–0.278
	(0.293)	(0.213)	(0.189)	(0.186)		(0.187)
Average cost information	–0.503	0.345	0.368	0.810	BASE	0.102
	(0.285)	(0.200)	(0.188)	(0.202)		(0.169)
Prob > chi^2 0.000						

Note: Robust standard errors in parentheses

Table A.5.2. Multinomial probit all base A as comparison

Multinomial probit model						
Choice alternative	A	B	C	D	E	F
Emissions performance	BASE	–0.101	–0.088	0.078	0.645	0.824
		(0.178)	(0.149)	(0.149)	(0.175)	(0.206)
Total cost information	BASE	0.078	0.027	–0.219	–0.354	–0.457
		(0.242)	(0.216)	(0.210)	(0.210)	(0.217)
Marginal cost information	BASE	–0.311	–0.294	–0.479	–0.056	–0.343
		(0.287)	(0.277)	(0.282)	(0.293)	(0.295)
Average cost information	BASE	0.395	0.419	0.860	0.050	0.061
		(0.268)	(0.262)	(0.279)	(0.285)	(0.279)
Prob > chi^2 0.000						

Note: Robust standard errors in parentheses

Table A.5.3. Probit model estimation results

Model	(1)	(2)	(3)	(4)	(5)	(6)
Choice alternative	A	B	C	D	E	F
Emissions information	–0.237	–0.288	–0.304	–0.177	0.294	0.480
	(0.099)	(0.103)	(0.078)	(0.072)	(0.103)	(0.127)
Investment cost information	0.137	0.208	0.188*	–0.024	–0.041	–0.186
	(0.128)	(0.131)	(0.105)	(0.094)	(0.089)	(0.092)
Marginal cost information	0.254	–0.00133	0.017	–0.202	0.244	–0.060
	(0.202)	(0.115)	(0.094)	(0.091)	(0.116)	(0.104)
Average cost information	–0.289	0.0213	0.054	0.549	–0.182	–0.214
	(0.196)	(0.096)	(0.085)	(0.100)	(0.104)	(0.093)
Constant	–1.099	–1.225	–0.866	–1.541	–2.236	–1.086
	(1.101)	(0.838)	(0.677)	(0.618)	(0.803)	(0.905)
Pseudo R^2	0.191	0.105	0.103	0.194	0.102	0.242
N	164	164	164	164	164	164

Note: Robust standard errors in parentheses

Table A.5.4. Probit model (choice D = 1) with average information

Probit model (D = 1)				
Choice alternative	Tax	Subsidy	Standards	All
Average cost information	0.547	0.114	0.674	0.491
	(0.172)	(0.181)	(0.413)	(0.101)
Constant				
Prob > chi^2	0.001	0.531	0.103	0.000

Note: Robust standard errors in parentheses

Table A.5.5. Probit model (choice E = 1) with marginal cost information

Probit model (D = 1)				
Choice alternative	Tax	Subsidy	Standards	All
Marginal cost information	0.792	0.309	0.183	0.070
	(0.408)	(0.259)	(0.119)	(0.084)
Constant				
Prob > chi^2	0.052	0.234	0.122	0.404

Note: Robust standard errors in parentheses

A.6 Survey Investment Decision and Questionnaire

Project MISTRA Indigo: Research Study

We appreciate that you have taken your time to participate in this research study. The purpose of this study is to better understand the effects of various policy instruments on firms' environmental investments.

The project is funded by the Swedish Foundation for Strategic Environmental Research (Mistra), which, for instance, aims to create strong research environments, solve environmental problems and strengthen Swedish competitiveness.

The research study is conducted jointly by the School of Business, Economics and Law at the University of Gothenburg and IVL, the Swedish Environmental Research Institute, and is part of the research project Mistra Indigo led by IVL, the Swedish Environmental Research Institute.

You are asked to participate in this study because you have indicated that you have experience with participating in decisions about environmental investments in firms. In the study you will be asked to make an investment decision in a firm. It is not the firm that you are actually working within.

When you answer the questions we encourage you to use your experience from investment decisions. After you have made your selections, you will receive a questionnaire. The investment decision and the survey take together 15–20 minutes to complete.

You will after submitting the questions receive a gift card (cinema tickets) sent to you via email. The value of the gift card varies between SEK 100 and SEK 300 and is determined by the total costs that result from the investment option that you have selected. The higher the net return from the investment, the larger will be the value of the gift card.

You are anonymous. Your answers will be decoded and made anonymous and the final results will only be presented on an aggregated level without the ability to link your response to you or the firm where you work.

You will be able to see the results from the survey.

For questions about the survey, please contact NN

The questionnaire must be answered no later than 2014-03-24

The survey is automatically saved when you click Next.

You can close the window and continue later.

Investment decision [Tax treatment]

We want you to envision yourself in a situation where you are involved in a decision about which environmental investment a firm should make to reduce its environmental impact of harmful emissions. There are 6 different investment options, each of which will result in a certain reduction in emissions from the firm's production plant. The table below shows the different investment options together with the effects that each of them has on the firm's emissions and investment costs.

The condition for your investment decision is that the firm will pay an emissions tax of SEK 250 per kg of emissions each year. An investment that reduces emissions means that the firm must pay an annual investment cost, but it also means that the firm's environmental tax expenditure decreases. The firm's goal is that the investment results in as high net return as possible. Please indicate below which investment option, A to F, you believe that the firm should choose. All options A to F have the same economic life expectancy.

	Opt A	Opt B	Opt C	Opt D	Opt E	Opt F
Emissions performance (g/kWh)	95	90	85	80	75	70
Total annual investment cost (SEK)	21,250	25,000	31,250	40,000	51,250	65,000
Marginal cost of abatement (SEK/kg)	50	100	150	200	250	300
Average cost of abatement (SEK/kg)	430	250	210	200	210	220

Select one of the following options in the table above

- ○ Option A
- ○ Option B
- ○ Option C
- ○ Option D
- ○ Option E
- ○ Option F

*** Enter the information in the table below that you felt was most important to make your decision. Level 6 indicates very important information and level 1 no important information.**

	1	2	3	4	5	6
Emissions performance (g/kWh)	○	○	○	○	○	○
Total annual investment cost (SEK)	○	○	○	○	○	○
Marginal cost of emissions reduction (SEK/kg)	○	○	○	○	○	○
Average cost of emissions reduction (SEK/kg)	○	○	○	○	○	○

The survey is automatically saved when you click Next.
You can close the window and continue later.

Nästa >>

Investment decision [Subsidy treatment]

We want you to envision yourself in a situation where you are involved in a decision about which environmental investment a firm should make to reduce its environmental impact of harmful emissions. There are 6 different investment options, each of which will result in a certain reduction in emissions from the firm's production plant. The table below shows the different investment options together with the effects that each of them has on the firm's emissions and investment costs.

The condition for your investment decision is that the firm will receive a subsidy of SEK 250 per kg emissions reduction each year. An investment that reduces emissions means that the firm must pay an annual investment cost, but it also means that the firm gets a subsidy / tax reduction as compensation. The firm's goal is that the investment results in as high net return as possible. Please indicate below which investment option, A to F, you believe that the firm should choose. All options A to F have the same economic life expectancy.

	Opt A	Opt B	Opt C	Opt D	Opt E	Opt F
Emissions performance (g/kWh)	95	90	85	80	75	70
Total annual investment cost (SEK)	21,250	25.000	31,250	40,000	51,250	65,000
Marginal cost of abatement (SEK/kg)	50	100	150	200	250	300
Average cost of abatement (SEK/kg)	430	250	210	200	210	220

Select one of the following options in the table above

- Option A
- Option B
- Option C
- Option D
- Option E
- Option F

*** Enter the information in the table below that you felt was most important to make your decision. Level 6 indicates very important information and level 1 no important information.**

	1	2	3	4	5	6
Emissions performance (g/kWh)						
Total annual investment cost (SEK)						
Marginal cost of emissions reduction (SEK/kg)						
Average cost of emissions reduction (SEK/kg)						

The survey is automatically saved when you click Next.
You can close the window and continue later.

Nästa >>

Investment decision [Performance standard treatment]

We want you to envision yourself in a situation where you are involved in a decision about which environmental investment a firm should make to reduce its environmental impact of harmful emissions. There are 6 different investment options, each of which will result in a certain reduction in emissions from the firm's production plant. The table below shows the different investment options together with the effects that each of them has on the firm's emissions and investment costs.

The condition for your investment decision is that the c should meet an emissions limit of 75 grams per kWh output on an annual average basis according to the Swedish Environmental Code. The firm's goal is that the investment results in as high net return as possible. Please indicate below which investment option, A to F, you believe that the firm should choose. All options A to F have the same economic life expectancy.

	Opt A	Opt B	Opt C	Opt D	Opt E	Opt F
Emissions performance (g/kWh)	95	90	85	80	75	70
Total annual investment cost (SEK)	21,250	25,000	31,250	40,000	51,250	65,000
Marginal cost of abatement (SEK/kg)	50	100	150	200	250	300
Average cost of abatement (SEK/kg)	430	250	210	200	210	220

Select one of the following options in the table above

- ○ Option A
- ○ Option B
- ○ Option C
- ○ Option D
- ○ Option E
- ○ Option F

*** Enter the information in the table below that you felt was most important to make your decision. Level 6 indicates very important information and level 1 no important information.**

	1	2	3	4	5	6
Emissions performance (g/kWh)	○	○	○	○	○	○
Total annual investment cost (SEK)	○	○	○	○	○	○
Marginal cost of emissions reduction (SEK/kg)	○	○	○	○	○	○
Average cost of emissions reduction (SEK/kg)	○	○	○	○	○	○

The survey is automatically saved when you click Next.
You can close the window and continue later.

Nästa >>

Part 1

***Have you been involved in decisions about environmental investments that reduced environmental impact during the last 10 years? Select one of the following answers:**

- ○ Yes
- ○ No

If yes, in what way have you mainly been involved? [If yes otherwise hidden]

- ○ Decision Manager
- ○ Management team
- ○ Advisory, e.g. decision support
- ○ Other, please specify:

[If Advisory, otherwise hidden]

- ○ Technical Advisory, e.g., develop scientific or technical basis for decisions
- ○ Financial Advisory, e.g., provide financial basis for decisions
- ○ Other, please specify:

***Please indicate below what experience you have from different policy instruments relating to a firm's decision on investments to reduce environmental impact. Level 6 indicates very much experience and level 1 no experience.**

	1	2	3	4	5	6
Requirements subject to the Environmental Code	○	○	○	○	○	○
Requirements in regulation or by authorities	○	○	○	○	○	○
Environmental taxes or charges	○	○	○	○	○	○
Subsidies reduced environmental impact	○	○	○	○	○	○
Emissions trading or certificates trading	○	○	○	○	○	○
Other	○	○	○	○	○	○

Please specify:

- ○ Yes
- ○ No

The survey is automatically saved when you click Next.
You can close the window and continue later

Nästa >>

Part 2a

***Please indicate below how clear the signals are that you believe that a policy instrument provides to a firm in its decision on investments to reduce environmental impact. Level 6 indicates very clear signal and level 1 no signal at all.**

	1	2	3	4	5	6
Requirements subject to the Environmental Code	○	○	○	○	○	○
Requirements in regulation or by authorities	○	○	○	○	○	○
Environmental taxes or charges	○	○	○	○	○	○
Subsidies reduced environmental impact	○	○	○	○	○	○
Emissions trading or certificates trading	○	○	○	○	○	○
Other	○	○	○	○	○	○

*** You indicated other, please specify:**

It depends on the circumstances. Please specify:

The survey is automatically saved when you click Next.
You can close the window and continue later

Nästa >>

Part 2b

***Please indicate below the size of the effect that you think that each policy instrument generally has on a firm's investments to reduce environmental impact. Level 6 indicates very large effect and level 1 no effect at all.**

	1	2	3	4	5	6
Requirements subject to the Environmental Code	○	○	○	○	○	○
Requirements in regulation or by authorities	○	○	○	○	○	○
Environmental taxes or charges	○	○	○	○	○	○
Subsidies reduced environmental impact	○	○	○	○	○	○
Emissions trading or certificates trading	○	○	○	○	○	○
Other	○	○	○	○	○	○

*** You indicated other, please specify:**

It depends on the circumstances. Please specify:

The survey is automatically saved when you click Next.
You can close the window and continue later

Part 2c

***Enter below the degree to which you believe that a policy instrument generally distorts competition in a market. Level 6 indicates very large distortion and level 1 no distortion at all.**

	1	2	3	4	5	6
Requirements subject to the Environmental Code	○	○	○	○	○	○
Requirements in regulation or by authorities	○	○	○	○	○	○
Environmental taxes or charges	○	○	○	○	○	○
Subsidies reduced environmental impact	○	○	○	○	○	○
Emissions trading or certificates trading	○	○	○	○	○	○
Other	○	○	○	○	○	○

*** You indicated other, please specify:**

It depends on the circumstances. Please specify:

The survey is automatically saved when you click Next.
You can close the window and continue later

Nästa >>

Part 2d

***Enter below the degree to which you believe that a policy instrument will result in a fair distribution of costs in society. Level 6 indicates very fair and level 1 is not fair at all.**

	1	2	3	4	5	6
Requirements subject to the Environmental Code	○	○	○	○	○	○
Requirements in regulation or by authorities	○	○	○	○	○	○
Environmental taxes or charges	○	○	○	○	○	○
Subsidies reduced environmental impact	○	○	○	○	○	○
Emissions trading or certificates trading	○	○	○	○	○	○
Other	○	○	○	○	○	○

*** You indicated other, please specify:**

It depends on the circumstances. Please specify:

The survey is automatically saved when you click Next.
You can close the window and continue later

Nästa >>

Part 3

*** Do you think that the management (CEO and management team, or the like) in the firm you are working in is generally experienced in environmental issues? Select one of the following answers**

- ○ Yes, very experienced
- ○ Not very experienced
- ○ Not at all experienced

***Do you think that research and development in environmental issues is a priority area of the firm where you work? Select one of the following answers**

- ○ Yes, highly prioritized
- ○ Not highly prioritized
- ○ Not at all prioritized

The survey is automatically saved when you click Next.
You can close the window and continue later

Nästa >>

Part 4

***What is your highest completed education? Select one of the following answers**

- ○ High school, elementary school, junior secondary school or equivalent
- ○ Secondary education
- ○ University or college education
- ○ Other please specify:

***To which category does your education belong? Select one of the following answers**

- ○ Business Administration
- ○ Law
- ○ Economics
- ○ Environmental Science
- ○ Natural Science
- ○ Sociology
- ○ Engineering
- ○ Other please specify:

***How many years of work experience do you have in your current main tasks?**

years

Only numbers can be written in this field

***Which year were you employed in the firm you are currently working in?**

Only numbers can be written in this field

***What year were you born?**

Only numbers can be written in this field

*** Are you male or a feamle? Select one of the following answers**

- Male
- Female

The survey is automatically saved when you click Send.
You can close the window and continue later

Submit

Thanks. Your survey responses are saved.

In autumn 2014, the summarized results of the study will be available and you will then receive a link to them via email.

A.7 Monetary Incentives: Cinema Tickets

The subjects were informed that after submitting the questionnaire, they would receive a gift card (cinema tickets) sent via e-mail (see Appendix A.6). The value of the gift card (number of cinema tickets) was stated to be determined by the total cost that resulted from the investment option selected by the subject. The higher the net return from the investment, the larger the value of the gift card (the subjects were informed that the value would vary between SEK 100 and SEK 300). The price of a cinema ticket in Sweden (without any discounts) is 120–130 SEK, and the subjects were paid either one or two tickets. Subjects that chose alternative E containing the optimal condition that the marginal abatement cost is equal to the tax (or subsidy) rate in the economic instrument treatments and the minimum costs in the constrained optimization of the performance standard treatment—earned two cinema tickets, while all other subjects, regardless of choice, earned one ticket. The cinema tickets were sent out to the subjects via e-mail. There is one large cinema chain in Sweden called SF (www.sf.se), and the cinema tickets were valid in cinema theaters all across the country. SF provided an individual code for each ticket and a digital ticket (see below), which were attached to the e-mail sent out to each subject.


BIOBILJETT
VÄRDEKOD