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The acceptability of efficiency-enhancing environmental taxes, subsidies and regulation: An experimental investigation

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Abstract

Public opposition to efficiency-enhancing policies is a significant barrier to addressing many environmental challenges. We use a market experiment to explore the acceptability of three types of instruments: Pigouvian taxes and subsidies, and quantity regulation. We find that overall more than half of voters oppose efficiency-enhancing policies. The results replicate previous findings of tax aversion, and, by providing evidence of subsidy and regulation aversion, the estimates also suggest the existence of a broader aversion to market intervention. Voters supported subsidies significantly more than taxes while supporting quantity regulation significantly less than taxes. This is consistent with norms against coercive policy instruments. Concerning a possible trade-off between acceptability and efficiency, estimates indicate differences across instruments. Support for regulation relative to not having any policy in place increases considerably if inefficient half measures are proposed instead of efficient full measures. This is less true for taxes and subsidies. The language used to describe the policy also influences acceptability, which is particularly apparent in the case of the tax instrument.

Keywords

Acceptability; Policy instruments; Tax aversion; Coercive policies; Lab experiment

1. Introduction

Public opposition to efficiency-enhancing policies is a significant barrier to addressing many environmental challenges. Indeed, identifying policies that mitigate or solve problems often is not the challenge; rather, it is the political difficulty of implementing the policies. This sort of opposition can arise from a lack of trust or understanding about policy instruments, but evidence has begun to show that it can also arise from behavioral considerations beyond the calculus of neoclassical economics. People often oppose Pigouvian taxes, even when the instrument improves material well-being ([Cherry et al., 2011](#), [Kallbekken et al., 2010](#) and [Kallbekken et al., 2011](#)), and perceptions of unfairness and coerciveness can create resistance to efficiency-enhancing taxes and regulations ([Baron and Jurney, 1993](#), [Dresner et al., 2006](#), [Eriksson et al., 2006](#), [Fujii et al., 2004](#) and [Kallbekken and Sælen, 2011](#)). Therefore, to improve the feasibility of efficient solutions, it is important to consider and understand not only the material effects of policy, but also the behavioral elements that provoke opposition. This is illustrated by recent studies that show policies can incorporate certain elements to improve the acceptability of a given policy instrument, such as earmarking revenues to increase support for taxation ([Harrington et al., 2001](#), [Hsu et al., 2008](#), [Schade and Schlag, 2003](#), [Schuitema and Steg, 2008](#) and [Sælen and Kallbekken, 2011](#)).

The existing literature, however, focuses largely on tax instruments, with only a few studies considering other context-specific policy instruments in addition to taxes.¹ In addition, most studies in this area rely on survey methods that might not effectively disentangle material interests from possible behavioral influences. Herein we extend the literature by providing a systematic investigation of behavioral elements that affect the acceptability for a spectrum of policy instruments. We investigate the acceptability of taxes, subsidies and direct regulation, at efficient and inefficient levels, and we use experimental methods to control for material interests and ensure equivalency across policy instruments. From this framework, we investigate four issues. First, studies have documented the existence of tax aversion—the opposition to a tax that is materially beneficial ([Kallbekken et al., 2010](#) and [Kallbekken et al., 2011](#))—but the literature is silent on whether such aversion exists with other instruments as well. We replicate a test of tax aversion, but also examine whether this type of aversion is actually a broader behavioral phenomenon observed also with subsidies and regulation. Second, we take advantage of the controlled laboratory setting to investigate the relative support for equivalent tax, subsidy and regulation instruments. Previous work suggests that opposition is heightened when the instrument is viewed as coercive ([Attari et al., 2009](#), [Baron and Jurney, 1993](#), [Jakobsson et al., 2000](#) and [Steg et al., 2006](#)). By controlling for material interests, we are able to more precisely isolate such behavioral influences on relative acceptability. Third, we examine differences in the acceptability of efficient and inefficient measures for all three instruments—tax, subsidy and regulation—which might reveal a trade-off between efficiency and acceptability. Of particular interest are the behavioral implications if this trade-off varies across instruments. Fourth, we explore how language can influence the level of acceptability by varying the description of each instrument. While previous studies report that language matters in the case of taxes

(e.g., [Kallbekken et al., 2011](#) and [Hardisty et al., 2010](#)), we consider all three instruments.

2. Experimental design and hypotheses

[Falk and Heckmann \(2009\)](#) point out that experimental methods are well-suited for inquiries of individual decision-making because the lab offers control over key elements that are often fixed or unobservable in the field. In our case, the lab allows us to control the effectiveness of the alternative instruments, and the individual payoffs they produce; thereby isolating behavioral influences beyond material self-interest.² By allowing for such control in a general setting, a lab experiment complements earlier survey based studies that

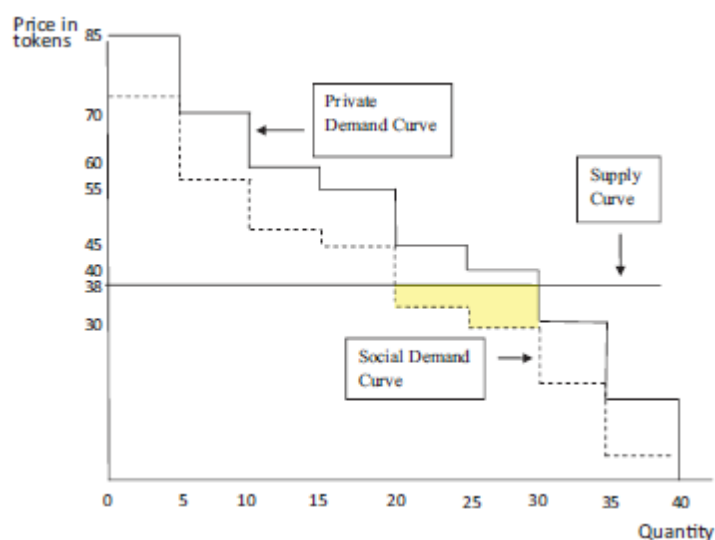


Fig. 1. Supply, demand and efficiency gains.

focus on more context-specific policy proposals. One important concern of lab experiments is that the results might not generalize to the “real world” (the issue of external validity). This is a valid point, but there are also many results suggesting that some of the objections are overstated. It has for instance been shown that students, which are often used as participants, do not differ significantly from other groups in important settings, although in some settings they are not representative of the general population ([Falk and Heckmann, 2009](#)). Also, behavior in lab experiments has been shown to be similar to behavior in field (“real world”) experiments ([Güth et al., 2007](#)). [Bardsley \(2010\)](#) argues, however, that “the relational nature of social psychological phenomena is systematically overlooked”. The fact that our results fit well with results obtained using other methods, such as surveys, gives us some additional confidence in their external validity. In the remainder of this section, we explain the basic market setting, details of the alternative policy instruments, experimental framework, procedures, and specific research hypotheses.

2.1. Experimental market

We construct an experimental market with externalities, in which the externality can be internalized with an efficient Pigouvian tax/subsidy or reduced with a quantity regulation.

The market consists of five buyers who make a choice on how many units (between 0 and 8) of a fictitious good to buy at a pre-set price from an automated seller. All trading occurs in tokens, with 100 tokens equal to US\$1. The buyers impose external costs on each other through their purchases. They are informed about their resale values (which are 85, 70, 60, 55, 45, 40, 30, and 15 tokens for the eight units, respectively), and also that the market price is 38 tokens, which stays constant throughout the experiment.

Whenever a buyer purchases a unit of the good, it imposes external costs of 3 tokens on each of the four other buyers in their group. The marginal damage from each unit purchased is therefore 12 tokens. The market equilibrium, without any policy, has all buyers purchasing six units at a price of 38. In

Table 1. Experimental setting.

Instrument	Stage 1	Stage 2		Stage 3				Stage 4		
	No policy	Tax or subsidy		Regulation				Tax or subsidy		
Referenda	None	Full vs. no policy	Half vs. no policy	Full vs. half	Full vs. no policy	Half vs. no policy	Full vs. half	Full vs. no policy	Half vs. no policy	Full vs. half
Market periods	1-5	6-8	9-11	12-14	15-17	18-20	21-23	24-26	27-29	30-32

Note: The instrument is either a tax or subsidy, depending on session, in stages two and four and is a quantity regulation in stage three in all sessions; referenda presents pairwise choices of full measure, half measure and no policy; market periods operate under the policy selected by the referenda. The other treatment variable, language, varied across sessions.

this equilibrium, each buyer gains a payoff of 55 tokens (consumer surplus of 127 tokens minus external costs of 72 tokens) from the purchases of others). The socially optimal outcome is for each buyer to purchase four units, which results in an aggregate improvement of 75 (15 tokens per buyer) over the market equilibrium. This translates to a 27% efficiency gain.³ The shaded area in [Fig. 1](#) represents the efficiency improvement of the social optimum over the market equilibrium.

2.2. Policies

The experiment considers six policy schemes—three instruments, each at two efficiency levels. For an (efficient) *full tax/subsidy*, the rate is equal to the marginal external cost of 12, and for an (inefficient) *half tax/subsidy*, the rate is equal to half the marginal external cost, i.e., 6. In the case of a *full-quantity regulation* and *half-quantity regulation* subjects cannot buy more than four and five units, respectively.

With a tax scheme in place, participants pay for each unit they buy, and the tax revenues are then returned in lump-sum fashion to the entire group at the end of the period; with a subsidy scheme, the participants receive a subsidy for each of the eight units they do not buy (including the ones they would not buy anyway since their values are below the price), and the subsidy cost is then paid lump-sum by the entire group at the end of the period. Note that fundamentally there is no difference between a tax and a subsidy with the same rate: given a certain amount of purchases, participants realize the same payoffs independent of whether there is a tax or an equivalent subsidy.⁴ Full tax, full subsidy and full quantity-regulation schemes are efficient in equilibrium because the former two make the participants internalize the external costs their

purchases cause, while the latter does not allow buying any units that cost the group on aggregate more than they benefit it. With all three schemes, the new equilibrium quantity declines on the aggregate from 30 to 20 units, with individual buyers reducing the number of units purchased from 6 to 4 units. In each case, the market equilibrium is shifted to equal the socially optimal outcome.

Half tax, half subsidy and half quantity-regulation schemes are, while efficiency-improving compared to the baseline without policies, not efficient. In the new equilibrium, buyers reduce their purchases by only one unit each, for a total reduction from 30 to 25. With a full tax/subsidy/quantity regulation, individual equilibrium payoffs increase to 70 (from 55 without any policy); with a half tax/subsidy/quantity regulation, they increase only to 65.

2.3. Experimental design

Table 1 summarizes the experimental design.⁵ Sessions consisted of four stages. The first stage consisted of five market periods without any policy instrument, which served to familiarize subjects with the market environment. In the three subsequent stages, subjects voted in nine referenda—three in each stage—that determined which policy instrument, if any, would be implemented in the subsequent three market periods. The experiment has three treatment variables that alter the characteristics of the referenda: instrument (tax, subsidy and regulation), efficiency (full measure, half measure and no policy), and language (label and generic, see below). Treatments were applied within and between sessions in the following manner. The instrument presented in the referenda varied across stages and sessions. In tax and subsidy sessions, stages one and three present tax or subsidy referenda, respectively. Stage two presents regulation referenda in both the tax and subsidy sessions. The efficiency of an instrument varies within each stage, with the three referenda of each stage presenting the following choices: full measure vs. no policy, half measure vs. no policy, and full measure vs. half measure.

The language used to describe the instruments varies across tax and subsidy sessions. In the label-language treatment, the market instruments are described using the terms “tax” or “subsidy,” while the generic language uses “payments” instead. In a tax session, subjects either “pay a tax” or make an “additional payment” for each unit they

Table 2. Market efficiency and individual payoffs by policy instrument and language.

	No policy	Full			Half		
		Tax	Subsidy	Regulation	Tax	Subsidy	Regulation
Pooled	82.6%	95.7%	94.2%	98.6%	90.5%	90.5%	93.4%
	57.84	66.98	65.95	69.00	63.38	63.33	65.38
	(14.00)	(6.60)	(10.82)	(10.20)	(7.11)	(9.76)	(9.46)
	[705]	[420]	[315]	[240]	[360]	[135]	[390]
Generic language	82.5%	96.7%	93.9%	97.8%	91.6%	90.4%	93.6%
	57.77	67.67	65.74	68.47	64.15	63.25	65.50
	(16.57)	(6.49)	(10.67)	(12.80)	(8.21)	(12.37)	(9.57)
	[345]	[75]	[135]	[75]	[135]	[60]	[120]
Labels language	82.7%	95.5%	94.4%	98.9%	89.9%	90.5%	93.3%
	57.90	66.83	66.11	69.24	62.91	63.40	65.33
	(11.01)	(6.62)	(10.96)	(8.80)	(6.33)	(7.10)	(9.43)
	[360]	[345]	[180]	[165]	[225]	[75]	[270]

Note: Numbers in each cell are efficiency of the market outcomes under the respective policy (% of social optimum), mean profit of buyers, standard deviations of profit in parentheses and number of observations in brackets.

purchase, and in a subsidy session, they either “receive a subsidy” or “receive an additional payment” for each unit they do not purchase. The differences in language for the regulation schemes are more subtle: in the label-language treatments the instructions either say “the policy allows buyers to purchase up to [...] units in each market session” (in sessions with a subsidy) or “the policy restricts buyers from purchasing more than [...] units in each market session” (tax). In the treatments with generic language, we say in both cases “the policy sets a purchasing limit of [...] units in each market session.”

2.4. Procedures

We conducted the experiment in the spring of 2011 at Colorado State University. A total of 95 subjects participated in five sessions, each consisting of nine referenda; therefore, we observe 855 voting decisions. To facilitate subject understanding of the experimental setting, we began each session by administering a quiz and reviewing the answers. Each session lasted about 90 min, and participants earned an average of about US\$20. The experiment was programmed and conducted with the software z-Tree (Fischbacher, 2007).

2.5. Hypotheses

From the experimental design, we examine four sets of hypotheses that inform the research questions presented in Section 1. To replicate previous reports of tax aversion and investigate whether the behavioral phenomenon extends to other instruments, we test if subjects oppose tax, subsidy and regulatory instruments that improve material welfare. To investigate whether any aversion varies across instruments, we test if subjects indicate equal support for tax, subsidy and regulatory instruments. To investigate the possible tradeoff between efficiency and acceptability, we test if subjects express equal support for an efficient and inefficient instrument and whether any differences exist across instruments. And to explore the influence of language on acceptability, we test if support for instruments is equal across labeling and generic descriptions.

3. Results

To confirm that a vote for a policy would indeed be an efficiency-enhancing vote, we first review how the actual policy instruments affected market outcomes. Table 2 reports, for each policy scheme realized through a vote, market efficiency, as measured by the percent of earnings generated relative to the optimal outcome, and the underlying mean payoffs earned by individual buyers. The numbers confirm that market efficiency is lowest in cases of no policy (82.6%), higher with half measures (90.5–93.4%) and highest with full measures (94.2–98.6%). These numbers correspond well to the predicted levels of 78.6, 92.9 and 100.0%. Comparing across instruments, taxes and subsidies appear to generate similar levels of market efficiency, with regulation leading to levels that exceed both taxes and subsidies. The strong performance of regulation is expected considering the instrument restricts the decision space, which prevents subjects from erring on one side by buying too many units, and it does not involve any enforcement or compliance complications.

We now turn to the issue of acceptability by examining voting behavior. [Table 3](#) provides the descriptive statistics for the level of support, as measured by the percentage of yes votes, across referenda type, policy instruments and language. The aggregate numbers reveal four findings. First, we observe substantial tax aversion: the opposition to taxes that improve material well-being. Overall, about half of voters did not support Pigouvian tax instruments. The observed tax aversion corresponds to levels previously reported in the literature ([Cherry et al., 2011](#), [Kallbekken et al., 2010](#) and [Kallbekken et al., 2011](#)). Second, in an extension of the literature, we find that the ‘tax aversion’ phenomenon is not limited to taxes. Though the level of aversion varies, we find significant opposition to efficiency-enhancing market intervention, whether it is taxes, subsidies or quantity regulation. Tax aversion therefore appears to be a more general aversion to intervention in the market. Third, the numbers show a trade-off between acceptability and efficiency and that this trade-off varies across instruments. Specifically, support for full market mechanisms (tax and subsidy) was greater when the alternative was a half measure,

Table 3. Acceptability of intervention by policy instrument and referendum type.

	Full vs. no			Half vs. no			Full vs. half		
	Tax	Subsidy	Regulation	Tax	Subsidy	Regulation	Tax	Subsidy	Regulation
Pooled	47.5% (50.1) [120]	55.7% (50.0) [70]	44.2% (49.9) [95]	57.5% (49.6) [120]	55.7% (50.0) [70]	66.3% (47.5) [95]	62.5% (48.6) [120]	85.7% (35.2) [70]	48.4% (50.2) [95]
Generic language	35.0% (48.3) [40]	56.7% (50.4) [30]	42.8% (50.2) [35]	50.0% (50.6) [40]	60.0% (49.8) [30]	60.0% (49.7) [35]	47.5% (50.6) [40]	76.7% (43.0) [30]	42.8% (50.2) [35]
Labels language	53.7% (50.2) [80]	55.0% (50.4) [40]	45.0% (50.2) [60]	61.2% (49.0) [80]	52.5% (50.6) [40]	70.0% (46.2) [60]	70.0% (46.1) [80]	92.5% (26.7) [40]	51.7% (50.4) [60]

Note: Numbers in each cell are percentage of votes in support of the respective policy with standard deviations and number of observations in parentheses and brackets.

Table 4. Panel estimates of voting models.

	Pooled	Tax	Subsidy	Regulation
Subsidy	0.133 (0.009)	-	-	-
Regulation	-0.214 (0.001)	-	-	-
Labels language	0.101 (0.061)	0.175 (0.026)	0.022 (0.802)	0.070 (0.361)
Half measure vs. no measure	0.074 (0.244)	0.100 (0.074)	0.000 (1.000)	0.221 (0.000)
Full measure vs. half measure	0.305 (0.000)	0.150 (0.007)	0.300 (0.000)	0.042 (0.482)
Constant	0.329 (0.000)	0.358 (0.000)	0.544 (0.000)	0.398 (0.000)
Chi-square	57.95 (0.000)	12.37 (0.006)	24.45 (0.000)	16.19 (0.001)
N	855	360	210	285

Note: Dependent variable is the individual vote (1 = yes; 0 = no); p-values are reported in parentheses; estimates condition on time-specific effects and subject-specific effects.

as compared to the case of the alternative being no policy. This is not the case with regulation—support for full regulation was similar whether the alternative was a half

measure or no policy. However, support for half regulation is much stronger (by 22 percentage points) than support for full regulation when the alternative is no policy. There is no such effect for subsidies, and a weaker effect (10 percentage points) for taxes. This might suggest the motivation underlying the aversion to market mechanisms (taxes and subsidies) might differ from the aversion to regulation. Fourth, the language used to describe the policy influences acceptability. This is particularly apparent in the case of the tax instrument. The influence of language follows a considerable line of research documenting the impact of labeling and framing (Bütler and Maréchal, 2007, McCaffery and Baron, 2003, Ross and Ward, 1996 and Tversky and Kahneman, 1981).

We follow the aggregate numbers with a conditional analysis by estimating the probability of voting in favour of a proposed policy instrument with the following linear probability model:

$$Y_{it} = \alpha + \theta \text{Instrument}_{it} + \psi \text{Efficiency}_{it} + \delta \text{Language}_i + \phi_t + u_i + \varepsilon_{it}$$

where Y_{it} is a binary variable that indicates whether the i th subject voted in favour of the proposed instrument in referendum t (=1 if yes; =0 otherwise); Instrument_{it} is a vector of indicator variables that signifies the policy instrument proposed to subject i in referendum t (subsidy, regulation; tax omitted); Efficiency_{it} is a vector of two indicator variables that signify the efficiency options presented to subject i in referenda t (half vs. no, full vs. half; full vs. no omitted); Language_i is a binary variable that indicates one of two descriptions of the policy instruments (=1 if labels; =0 if generic); ϕ_t is a set of $T - 1$ ($T = 9$) dummy variables that capture potential referenda timing effects; α is the estimated intercept, u_i are random effects that control for unobservable individual characteristics (e.g., risk aversion), and ε_{it} is the well-behaved error term.⁶ Four models are estimated, a pooled model that examines voting behavior across all policy instruments and three instrument models that examine voting behavior specific to each policy instrument.

Estimates of the voting models, presented in Table 4, sharpen the observations from the aggregated data. Overall, estimated parameters reveal significant opposition to all three policy instruments, despite being more efficient than no policy. Thus, results replicate previous findings of tax aversion but, by providing evidence of subsidy and regulation aversion, the estimates also suggest the existence of a broader aversion to market intervention. However, despite the instruments yielding equal payoffs in equilibrium, opposition does vary across policy instruments. From the pooled model, voters supported subsidies significantly more than taxes while supporting regulation significantly less than taxes. The conditional estimates indicate that support was 13.3 percentage points higher for subsidies and 21.4 percentage points less for regulation, both in comparison with taxes.

Concerning a possible trade-off between acceptability and efficiency, estimates indicate differences across instruments. Support for regulation relative to no policy increases considerably if inefficient half measures are proposed instead of efficient full measures

($p < 0.001$, pooled model). This is less true for taxes and subsidies. But for the two market mechanisms, support increases for an efficient full measure if the alternative is an inefficient half measure instead of no policy ($p = 0.007$ and <0.001). This is not the case for regulation.

The divergent result between the market mechanisms and regulation suggests a difference in underlying motives. In particular, the results are consistent with previous results that perceptions of coercion can negatively affect the acceptability of policies (Baron and Jurney, 1993), as the most coercive instrument (regulation) receives the least support, and the instrument usually perceived as least coercive (subsidies) receives the most support.

Estimates provide mixed results for the impact of language. Across the pooled and policy models, estimates reveal that the description of the policies (language) influenced support for taxes ($p = 0.026$), but not subsidies or regulation ($p = 0.802$ and 0.361). The positive effect of the tax label differs from some previous findings that show a negative effect, which might be due to differences in the use of the tax label and the alternative choice to the tax instrument. Further, the imprecise nature of language impedes clean comparisons across studies.

4. Conclusions

Public opposition is a primary barrier to implementing policies that can mitigate or solve many of the world's environmental problems. Research shows the underlying elements of the opposition goes beyond standard self-interest. Therefore, improving the prospects of efficiency-enhancing policies requires a better understanding of acceptability. In this study, we complement previous work by using a controlled market setting to investigate the behavioral influences behind the acceptance of alternative policies. We replicate previous reports of tax aversion, but also find this type of aversion exists with subsidies and quantity regulation. Thus, so-called tax aversion might be a broader type of policy or intervention aversion. This has implications for the efforts to understand and overcome such aversion, and suggests the challenge of implementing effective solutions is more daunting than previously thought. It also raises the issue of whether previous findings that suggest ways to overcome tax aversion, e.g. using trial runs (Cherry et al., 2011), can be effective with alternative policy instruments.

We also find the extent of policy aversion differs across the three instruments, with the numbers indicating that subjects prefer taxes over regulation and subsidies over taxes. Further, the numbers reveal a trade-off between acceptability and efficiency, but it also varies across the instruments. Differences in aversion and preferences are consistent with previous reports that perceptions of coercion negatively affect a policy's acceptability. This suggests that perceived infringement on personal freedom might be a major reason for the opposition to efficiency-enhancing policies, and that providing alternatives (e.g., improving public transit at the same time as increasing fuel taxation) might improve public support (see Kallbekken and Aasen, 2010).

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