An Experimental Study of Affirmative and Negative Motivations for Compliance in Emissions Trading Programs*

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Abstract

Future emissions trading programs may rely on self-reporting of emissions, raising concerns about enforcement and compliance. This study investigates the potential for so-called "affirmative motivations" to improve honest reporting under imperfect enforcement based on perceptions of a law's fairness and procedural legitimacy (Tyler 2006; May 2005). Using a computerized laboratory emissions trading market, we find that subjects report honestly more often than is economically rational and those who rate their allowance allocations as unfair are less likely to comply with reporting requirements. Compliance is also weaker when the experiment is framed explicitly as an emissions trading exercise rather than in a neutral context. These results suggest that affirmative motivations can significantly improve emissions reporting compliance, but that a perceived lack of legitimacy for emissions trading may be an important obstacle for this policy.

Keywords: emissions trading; compliance; affirmative motivations

INTRODUCTION

As emissions trading and other alternatives to so-called "command and control" policies expand and diversify, questions of firm behavior under imperfect enforcement have gained attention. Also known as "cap and trade" policies, emissions trading allows firms to buy and sell rights (or "allowances") to emit pollution in order to achieve pollution reductions at a lower overall cost (Montgomery 1972). Such policies have gained popularity in recent years, especially for international, federal and regional programs to reduce greenhouse gas emissions. As it has gained popularity, however, emissions trading has also been criticized as vulnerable to compliance and enforcement problems (e.g. Stranlund et al. 2002).

This is somewhat ironic since early emissions trading efforts, such as the 1990 U.S. acid rain program, have attained some of the strongest compliance records of all environmental policies to date. As of the last annual report, well over 99% of all sources had complied fully with the emissions requirements of the 1990 law, and overall SO_2 emissions have dropped substantially (EPA 2009). The acid rain program achieved a high level of compliance by requiring 24-hour continuous emissions monitoring on all affected SO_2 sources, as well as unique serial numbers for every allowance. Given the relatively small number of sources affected by the program (a few thousand large electricity-generating power plants), a nearly perfect enforcement mechanism of this type based on real-time emissions reporting to EPA was feasible and cost-effective.

Future emissions trading programs may have to rely on imperfect enforcement consisting of spot checks and self-reporting, however, as they extend to larger "baskets" of greenhouse gases (GHGs) responsible for complex problems like climate change. GHG emissions caps may be enforced "upstream" at places in the economy where there are limited immediate atmospheric

emissions, such as fuel refiners, mines, or importers of carbon-based energy (Stavins 2008). Continuous emissions monitoring will be inappropriate or too expensive for many of these reporting settings, so some self-reporting will be necessary. This has led, in turn, to criticism that such programs will be subject to fraud and lax enforcement (e.g. Green et al. 2007; Pearlstein 2009; Peeters 2006). How to maintain sufficient honest reporting in future emissions trading programs is therefore an important policy design question.

This study begins to answer that question through an experiment that investigates the role of negative and affirmative motivations for complying with emissions reporting requirements under imperfect enforcement. Negative motivations—fear of costly punishments for violations—are often cited as a primary reason for legal obedience (Becker 1968), and existing experimental research on emissions reporting focuses on negative motivations (e.g. Cason and Gangadharan 2006; Murphy and Stranlund 2007). Yet recent field research suggests that negative motivations do not explain the full range of legal compliance in society, and that less well-understood affirmative motivations play a significant role (Tyler 2006; May 2005; Torgler 2003; Winter and May 2001). Affirmative motivations rely on a personal sense of a law's legitimacy or morality as a determinant of compliance. Imperfect monitoring can make under-reporting of emissions profitable because of limits on potential negative consequence or fines (e.g., Tietenberg 2006: 65; Harrington 1988), so affirmative motivations may be vital to any future trading scheme's success.

This paper compliments field work on compliance (e.g. May 2005; Winter and May 2001) by evaluating affirmative motivations in a laboratory setting, where certain explanatory factors can be exogenously manipulated and confounding variables can be more carefully controlled. It also pushes experimental work in new directions by exploring the effect of non-

neutral framing of experimental conditions and the role of affirmative motivations. To achieve these goals, our experiment employed a full factorial design with 8 treatment cells: 2 monitoring conditions (high and low detection probabilities) × 2 permit endowments (equal or unequal) × 2 frames (environmental or neutral). In the environmental frame subjects were told to imagine themselves as managers of fossil fuel burning electricity plants who may buy permits to legally emit pollution or incur pollution abatement costs to avoid emissions. The neutral frame, by contrast, made no mention of pollution or emissions trading: subjects bought and sold "coupons" and had to choose a "number" (corresponding to a level of abatement and resulting emissions) that they reported to an "inspector," much as if they were playing a game of chance. We conducted 5 sessions (40 subjects total) in each of the 8 treatment cells, and an extra session in one cell, employing a total of 328 subjects. Subjects also completed pre- and post-trading surveys regarding their beliefs about and motivations for complying with rules, their attitudes toward the environment and environmental regulations, and their assessment of the fairness of their permit allocations and support for emissions trading more generally.

Our results indicate the importance of affirmative motivations in several ways. Most fundamentally, a significant percentage of subjects reported honestly in situations where dishonest reporting was clearly more profitable. The data also show that subjects who considered their permit allocations to be "unfair" underreported their emissions at significantly higher levels. These results indicate that individuals will behave according to affirmative motivations for compliance even in a laboratory setting where such motivations are likely to be weaker than in the field. They also indicate that moral judgments of fairness are an important motivation related to compliance with emissions trading rules. At the same time, honest reporting was significantly lower when experiments were framed in the emissions trading context. This

surprising "framing effect," combined with a strong disapproval of emissions trading as a policy in general among our subjects, suggests that a lack of perceived legitimacy for cap and trade programs may significantly hinder compliance based on affirmative motivations.

The paper proceeds in the following manner. First we present our hypotheses and review the existing research upon which they are grounded. Then we discuss our methods in more detail. After presenting our results, we discuss the significance of our findings for theories of compliance and improved design of emissions trading policies. Finally, we conclude with a few thoughts about future research questions in this and related areas suggested by our results.

HYPOTHESES AND EXISTING RESEARCH

The question of compliance is fundamental to public policy design and implementation, yet our knowledge of why individuals obey legal mandates remains limited. Negative motivations—fears of punishment for violations—are often cited as a primary reason for obedience (Becker 1968). Observed levels of regulatory compliance and enforcement in the field, however, suggest that affirmative motivations also play a significant if less well-understood role (Tyler 2006; May 2004; Torgler 2002, 2003; Winter and May 2001). Affirmative motivations rely on a sense of a law's procedural legitimacy or congruence with one's personal morality to motivate compliance (Tyler 2006).

As noted above, future emissions trading proposals are likely to rely on some degree of imperfect enforcement. The continuous emissions monitoring systems (CEMS) used for SO_2 emissions from power plants under the 1990 federal Acid Rain program are inappropriate for more broad-based GHG emissions. Many GHG programs will regulate a basket of pollutants that are extremely dispersed (via automobile tailpipes, for instance) or otherwise defy simple "end of

pipe" monitoring through CEMS. While other reporting options are possible (e.g. Tietenberg 2006), it is clear that some level of self-reporting will be required in the most recent emissions trading programs being developed in the U.S. (such as the Regional Greenhouse Gas Initiative or the Western Climate Initiative). Indeed, states have already created self-reported "climate registries" of emissions (Rabe 2004), and such registries are likely to play a role in any future federal cap and trade program.

Because imperfect monitoring can make under-reporting of emissions potentially profitable, depending on the penalty and enforcement structure, affirmative motivations may be critical to these trading schemes' success. Existing research on compliance with self-reported emissions and imperfect enforcement has yet to consider the role of affirmative motivations (e.g. Murphy and Stranlund 2007; Cason and Gangadharan 2006; Stranlund et al. 2005; Stranlund et al. 2002). These studies have focused instead on issues such as dynamic (state-dependent) enforcement policies, and how compliance depends on marginal abatement costs and permit banking opportunities.

Empirical evidence based on field and laboratory data has shown, however, that individuals sometimes comply with laws where simple financial calculations would recommend noncompliance. Tax policy is an example where the expected value of cheating on one's tax returns predicts greater noncompliance than found in countries like the United States or Sweden (Scholz and Lubell 1998; Rothstein 2000). Results from laboratory experiments also reveal systematic "overcompliance" in tax reporting (Torgler 2002; Alm and McKee 1998). Thus, our core hypothesis (H1) is that *subjects will report emissions more honestly than calculations of economic self-interest would dictate*. We note that this is an especially strong test for this hypothesis, since the experimental framework does not include real environmental consequences

or deliberative rule-making processes, thereby weakening any affirmative compliance motivations based on a policy's legitimacy, while maintaining a real economic incentive for dishonest reporting.

Beyond this general hypothesis, we have formulated several hypotheses specific to the role of affirmative motivations in emissions trading. The perceived fairness of an initial allocation is vital to a cap and trade policy's overall political acceptability (Ellerman et al. 2007; Raymond 2003), yet our understanding of public opinion regarding allocation remains limited. Governments have experimented with a wide range of allocation mechanisms, including distributions based on previous resource use (grandfathering), equal per capita shares, and auctions. Our hypothesis (H2), based on prominent norms in environmental policy and previous empirical research (e.g. Raymond 2008; Yamamori et al. 2008; Miller 1992; Eavey 1991), is that *subjects will rate egalitarian allocations as fairer than those based on grandfathering or auctions*.

Following this point, we theorize that personal evaluations of the fairness of one's allocation will shape affirmative motivations from personal morality to report honestly. A person's belief that a particular law treats him fairly, in other words, or is consistent with his personal morals, can be crucial to his choice to obey (Tyler 2006: 4). Others make a similar point about the "fairness" of a law's distribution of societal burdens and benefits, including Levi's (1997) idea of "contingent consent" to policies like military conscription based on a sense that other citizens are being asked to serve in a similar manner (see also Spicer and Becker 1980). Specifically, we hypothesize (H3) that *subjects rating their allocation as "unfair" will be significantly less likely to comply.* Moving beyond the initial allocation, we also hypothesize (H4) that *subjects who express an affirmative motivation to obey "fair" laws in general, and who*

assess the experiment's rules as "fair," will be more likely to comply.

Another type of affirmative motivation stems from a general belief in a law's "legitimacy"—that properly enacted and designed rules are valid limits on human freedom to be obeyed even when they are in conflict with personal convictions or values (Tyler 2006; May 2005; Gibson et al. 2005). We expect affirmative motivations based on perceptions of a policy's legitimacy also to improve compliance. This translates into hypothesis (H5) that *subjects who express a general affirmative duty to obey laws will be more likely to comply*. Focusing on emissions trading, it also generates the hypothesis (H6) that *subjects who approve of emissions trading as a legitimate policy option will be more likely to comply.*

Hypothesis H6 directly depends on subjects' environmental policy attitudes, and support for several other hypotheses could depend on subjects' knowledge of and preferences toward environmental regulations. This motivated us to introduce environmental framing as a treatment variable, contrary to the dominant practice in experimental research on compliance and environmental policy. Most laboratory experiments on emissions trading employ a neutral, non-environmental context, although a few exceptions exist (e.g. Bohm and Carlén 1999). Alm (1999) recommends neutral framing for compliance experiments by arguing that neutral terms obscure the experiment's context and purpose, thereby increasing experimental control by not inducing subjects to invoke mental scripts. Other researchers, particularly advocates of field experiments, argue that neutral framing can reduce control since subjects might impose their own context on the abstract experimental task and their personal contexts are not observed by the experimenter (Harrison and List 2004).

Prior research testing the influence of experimental framing effects is limited and has produced mixed results. Barr and Serra (2008) observe a significant framing effect in the

expected direction in an experiment on corruption: Subjects offered fewer bribes in the framed than in the neutral context. By contrast, Abbink and Henning-Schmidt (2006) find framing had no influence on the offering or acceptance of bribes. In tax compliance experiments, student subjects do not report more honestly in a framed context (Alm et al. 1992; Wartick et al. 1999).

Expert subjects participating in field experiments appear to find non-neutral framing most useful, because it allows them to more easily draw on their past experience during the experiment (Cooper et al. 1999; Alatas et al. 2009). Consequently, non-neutral context also appears to influence experts' behavior more than student subjects' behavior. This suggests that any framing effects we observe in our student subject pool might even underestimate the potential impact of framing for a pool of experts such as firms' environmental managers.

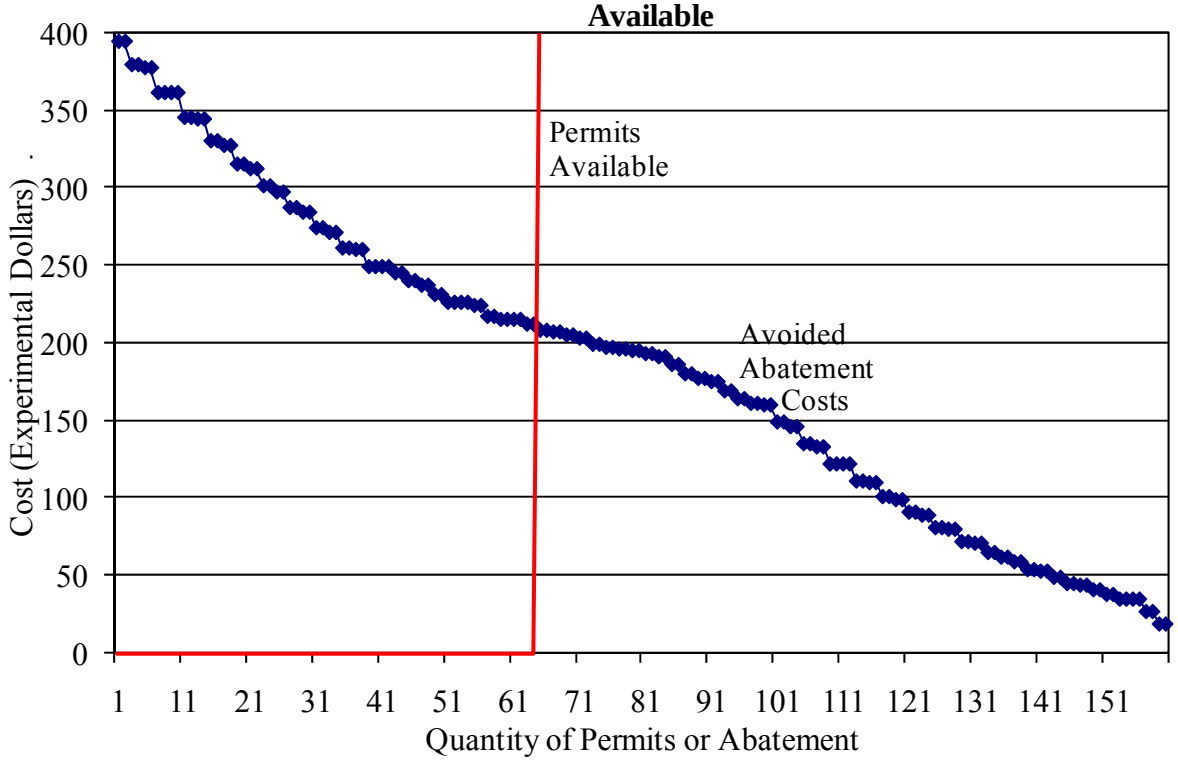
METHODS

The centerpiece of this experiment was a computerized laboratory emissions trading market constructed using the standard methodology of experimental economics. In these experimental treatments, subjects trade permits that allow them to avoid incurring costs of emissions abatement. All trades have real economic consequences affecting the cash earnings of subjects, thereby creating a real market—albeit one that is stylized and controlled (Smith 1982). In all our treatments, permit trading continued for 11, 2-minute periods of stationary repetition, although the exact number of periods was not announced to subjects. Trading occurred through the continuous double auction institution, which is widely used in laboratory markets and is similar to standard rules governing securities trading. Subjects submit public buy and sell price offers and trades occur when a trader clicks a button to accept another trader's offer. These offers and acceptances can occur through the computer network at any time during the trading period.

Following common experimental practice, trades occurred using "experimental dollars" that were then converted via a fixed, pre-announced exchange rate into actual U.S. dollars paid to subjects at the end of the experiment.

Subjects received an exogenous initial allocation of permits at the start of every period, and this endowment was unchanged across periods. Marginal abatement costs rose with the level of abatement and varied across subjects to create gains from trade. Figure 1 shows the aggregate marginal abatement cost schedule pooled across subjects, along with the total allocation of permits. Eight subjects interacted through the market, and each could choose to buy or sell permits. Sixty-four permits were available, so at the benchmark of full compliance prices in the range 208-212 experimental dollars cleared the market.

Figure 1: Avoided Marginal Abatement Costs and Total Permits Available



After the permit market closed and subjects finalized their permit holdings for the period, each subject chose a level of costly pollution abatement. Finally, subjects reported their level of pollution (after abatement) to the environmental regulator. These reports did not need to be accurate; if subjects were inspected and found to have misrepresented their emissions they were fined 400 experimental dollars (approximately double the average cost of a permit on the market) for every unit of pollution not reported. The probability of inspection was a treatment variable. Underreported emissions cause total emissions to exceed the initial cap, effectively expanding the permit "supply" outward and lowering the market-clearing price.

The experiment employed a full factorial design with 8 treatment cells: 2 monitoring conditions (high and low detection probabilities) × 2 permit endowments (equal or unequal) × 2 frames (environmental or neutral). In the high monitoring treatment, each subject had a 50 percent chance of being inspected; in the low monitoring treatment, the chance of inspection was 25 percent. The random draws to determine if a subject was inspected were independent across subjects and across rounds. An inspection resulted in a private notification to the subject at the end the period, given by his or her computer, indicating the inspection had occurred and the amount of the fine, if any non-compliance was detected.

In the environmental frame participants were told to imagine themselves as power plant managers who could buy permits to legally emit pollution or incur pollution abatement costs to avoid emissions. In the neutral frame, by contrast, subjects traded "coupons" and had to choose a "number" (this corresponded to the level of emissions after abatement) that they reported to an "inspector." (Subject instructions for both frames are presented in a comparative format in Appendix B). The instructions and computer screens for the neutral context removed all references to pollution, the environment, or any other feature of emissions trading. Instructions in

both frames avoided normative implications—they provided only factual information about the consequences of reporting choices, avoiding morally-loaded terms like "lying," "punishment," or even "dishonesty." The framed context with unequal endowments included a brief explanation that some participants received larger allocations based on a higher previous record of emissions (similar to many actual emissions trading policies), while others received smaller allocations because they represented newer facilities with lower historical pollution records. In the neutral context, unequal allocations were presented without additional explanation.

We conducted 5 sessions (40 subjects total) in each of the 8 treatment cells, and an extra session in one cell, employing a total of 328 subjects. Subjects also completed computerized pre- and post-trading surveys (including both open and closed-ended questions) to ascertain their beliefs about and stated motivations for complying with rules, their attitudes toward the environment and environmental regulations, and their assessments of the fairness of their permit allocations and the legitimacy of emissions trading more generally. (The full survey instruments are presented in Appendix A). We also measured subjects' risk preferences using a simple lottery choice problem presented in a multiple price list format prior to the trading exercise (Holt and Laury 2002).

Subjects were recruited from the general student population at Purdue University, using e-mail and a web-based sign-up tool. No subject participated in more than one session. Although all subjects were students, with 93 percent between 18 and 23 years old, they otherwise reflected a diverse socio-demographic mix. 61 percent of subjects were male. 28 percent were from nations other than the United States, and disciplines of study included business/economics (42 percent), engineering (28 percent), liberal arts (11 percent), and natural sciences (8 percent). Thus, the recruitment process generated a reasonably diverse pool of participants, rather than a

cohort of freshmen, say, from a single large introductory economics or psychology course.

We conducted two or three 8-person sessions simultaneously in the lab with identical treatment conditions, so either 16 or 24 subjects participated together at a time. The experimenter read the experimental instructions aloud while subjects followed along on their own copies. Subjects then took a 10-question, computerized quiz to confirm their understanding of key features of the instructions. Subjects earned 50 cents for each correct answer, so they could gain up to $5 from the quiz in addition to their trading earnings. After any incorrect answer the computer displayed a clarification, referring subjects to the part of the instructions where the issue was addressed. A practice period followed to further familiarize subjects with the double auction trading interface. As noted, subjects earned profits each period by buying and selling permits and avoiding fines. They also received fixed and exogenous revenues from output sales each period that could be used towards their abatement costs. Sessions lasted for about two hours (including sign-in, instructions, and payment distribution), and total earnings averaged US$29 per subject.

RESULTS

Compliance

Overall, there was substantial failure to accurately report emissions (i.e. noncompliance) in our experiments, in both the low and high monitoring treatments (Table 1). As expected, honest reporting was more common when inspection was more likely. This confirms the important contribution of negative motivations for compliance (as do the higher permit prices under the high-monitoring treatment discussed below in Figure 2). Compliance was also greater

in the neutrally framed sessions, a surprising result that we return to below. The endowment treatment has a much smaller impact on compliance behavior.

Table 1: Percentage of noncompliant emissions reports, by treatment conditions*

	Neutral Frame		Environmental Frame	
	Unequal Endowments	Equal Endowments	Unequal Endowments	Equal Endowments
Low Monitoring	39.5	31.8	53.2	53.9
High Monitoring	11.1	12.7	36.4	31.4

*Expressed as percentage of all emissions reports for each treatment condition.

Although Table 1 indicates that many subjects underreported emissions, a majority reported honestly even when realized median transaction prices exceeded the expected fine—making compliance economically irrational for those who were risk neutral or in many cases for those who were risk averse. This is particularly true for the low monitoring treatment, in which the marginal cost of compliance (the permit price) usually far exceeded the expected value of a fine (see Figure 2). The consequence of noncompliance in the case of inspection was a fine of 400 experimental dollars per unreported unit, but since the probability of inspection was 25 percent, the expected penalty in this treatment was only 100 experimental dollars per unit. Nearly all (98 percent) of median transaction prices in this treatment exceeded 100 experimental dollars, and most prices and marginal abatement costs exceeded 150 experimental dollars. Because these compliance costs exceed the expected penalty, full compliance was economically irrational for all but the most risk averse subjects in nearly every period in the low monitoring treatment. Nevertheless, a majority (55 percent) of all emissions reports under low monitoring were honest.

In fact, a substantial number of subjects in the low monitoring treatment (54 out of 160 subjects, or 34 percent) fully complied with reporting rules in at least 10 of the 11 trading

periods. This behavior cannot be attributed to confusion, since the mean score on the comprehension test for all subjects was 78 percent correct, and more than 80 percent of subjects answered at least 7 out of 10 questions correctly. In addition, Table 1 shows that subjects' were sensitive to differences in monitoring risks. Another indication of task understanding is that subjects who were classified as more risk-averse in the preliminary lottery choice problem consistently cheated less (see row 25 of Table 3). Thus, something other than negative motivations influenced the many subjects who complied more than was economically rational in the low monitoring cases. This "irrational" unwillingness of many subjects to cheat is consistent with behavior driven by affirmative motivations for compliance, per hypothesis H1.

Table 2: Fairness Ratings of Different Allocation Schemes

	Grandfathering	Equal Shares	Auctioning	Don't Know
Very Unfair	13%	5%	25%	
Somewhat Unfair	32%	18%	22%	
Neutral	20%	25%	21%	
Somewhat Fair	26%	36%	16%	
Very Fair	5%	10%	10%	
Don't Know	5%	5%	6%	
Which allocation is most fair?	12%	54%	23%	12%
Which allocation is most unfair?	38%	7%	46%	9%

Note: Totals may not add to 100% due to rounding.
These questions were asked only in the environmentally-framed treatments (N=168)

We asked subjects to rate various allocation schemes on a 5-point scale from "very unfair" to "very fair," after explaining each allocation option in the survey (see Appendix A for exact question wording). Table 2 shows that less than one-quarter of subjects considered an equal per capita allocation (which was defined as "giving permits to existing polluters free of

charge in proportion to the number of citizens they serve") as very or somewhat "unfair," while almost one-half evaluated grandfathering based on prior use as well as auctioning permits as very or somewhat unfair. (These differences are statistically significant; *t*-test two-tailed *p*-values<0.01 both for grandfathering to equal shares comparison and for equal shares to auctioning comparisons.) In a separate question, a majority of subjects rated equal shares allocation as the "most fair" of the options presented, also consistent with hypothesis H2.

Table 3 reports a series of cross-sectional multivariate tobit regression models to test our remaining hypotheses. In these models the subject is the unit of observation. Note that we provide estimates for all treatments pooled, as well as separate estimates for the framed and unframed treatments. The dependent variable is the total amount of misreported emissions for each subject across all periods. This variable ranges from 0 up to 220, as the maximum level of noncompliance is 20 units of unreported pollution in each of the 11 periods. In an alternative specification we used the number of periods each subject's reporting is noncompliant as the dependent variable, which ranges from 0 for honest reporting in all periods, to 11 for subjects who misreport emissions in every period. We also estimated a series of panel regressions that consider individual compliance decisions for each period. These alternative specifications provide similar results overall, so to conserve space we do not report them here.

In terms of measuring overall compliance, the total misreporting variable used in Table 3 is the most appropriate since it captures the total amount of cheating in a given session and treatment. (From a policy design and environmental performance perspective, an emissions trading policy is less successful if 1 out of 11 emitters fails to report 15 units of pollution than if 7 out of 11 emitters fail to report 1 unit of pollution each). The left column of the table provides summary statistics for the explanatory variables.

	Table 3: Tobit Models of Noncompliance (Total Amount of Misreporting)				
		Variable mean (std. dev.)	All Treatments	Neutral Context	Environmental Context
	Treatment Conditions and Endowment				
1	Indicator=1 if environmental	0.51	27.98**		
	context	(0.50)	(4.81)		
2	Indicator=1 if monitoring	0.51	-23.39**	-37.86**	-16.55*
	intensity is high	(0.50)	(5.12)	(9.84)	(6.71)
3	Indicator=1 if subject has a	0.26	-23.22**	-37.64**	-17.16*
	high permit endowment	(0.44)	(6.48)	(10.65)	(7.78)
4	Indicator=1 if subject has a	0.26	11.84	4.11	19.43*
	low permit endowment	(0.44)	(7.00)	(8.52)	(9.25)
	Questionnaire Responses				
5	Indicator=1 if subject viewed own	0.18	34.85**	39.07*	41.49*
	permit endowment as unfair	(0.38)	(12.78)	(17.06)	(16.45)
6	Indicator=1 if subject indicated personal beliefs as main	0.20	-14.31	-15.25	-11.57
	motivation for accurately reporting emissions	(0.40)	(7.71)	(10.23)	(10.40)
7	Indicator=1 if subject indicated personal beliefs as main	0.07	35.00**	50.67**	12.81
	motivation for misrepresenting emissions in reporting	(0.26)	(11.54)	(12.99)	(15.36)
8	Indicator=1 if subject agrees that he/she sometimes	0.71	8.61	10.74	9.97
	disobeys laws when the risk or consequences are low	(0.46)	(4.83)	(5.88)	(5.75)
9	Indicator=1 if subject believes in importance	0.68	2.53	14.61*	-4.80
	of following fair or just laws	(0.47)	(6.10)	(6.15)	(9.29)
10	Indicator=1 if subject believes in importance that	0.74	1.85	3.27	4.14
	obeying the law in general is the “right thing to do”	(0.44)	(5.94)	(7.63)	(10.58)
11	Indicator=1 if subject viewed own permit endowment	0.13	-25.02	-31.00	-29.87
	as unfair and believes in importance of following just laws	(0.33)	(15.78)	(22.44)	(19.72)
12	Indicator=1 if subject is considers him/herself	0.39	6.16	3.19	6.62
	an "environmentalist"	(0.49)	(5.61)	(8.12)	(7.09)
13	Indicator=1 if subject believes that global	0.63	0.90	-10.46	14.97
	warming is an important issue	(0.48)	(5.73)	(6.08)	(7.68)
14	Indicator=1 if subject correctly identifies a statement	0.09	4.53	27.78*	-4.36
	describing emissions trading and supports it as a policy	(0.28)	(10.76)	(11.66)	(16.35)
15	Indicator=1 if subject believes in importance of	0.47	2.62	8.70	0.08
	following laws because of fear of social embarrasment	(0.50)	(5.49)	(8.62)	(5.90)
16	Indicator=1 if subject believes in importance	0.84	0.01	-12.16	9.86
	of following laws because of legal penalties	(0.37)	(7.90)	(12.37)	(9.68)
17	Indicator=1 if subject indicates external motivations for	0.76	11.96	6.82	5.11
	accurately reporting emissions (text response)	(0.43)	(6.14)	(8.59)	(10.13)
	Demographic and Risk Preference Controls				
18	Indicator=1 if	0.61	8.59	14.09	2.46
	subject is male	(0.49)	(5.65)	(10.57)	(6.82)
19	Indicator=1 if	0.42	1.40	-8.56	11.63
	subject is business major	(0.49)	(6.21)	(8.93)	(8.15)
20	Indicator=1 if subject has	0.79	-27.74**	-41.60**	-29.76**
	lived in US for more than 5 years	(0.41)	(6.51)	(9.16)	(9.42)
21	Grade point average (self reported)	3.10	7.03**	-22.24**	9.86**
		(0.82)	(2.48)	(8.29)	(2.37)
22	Years of college	2.81	4.74	-1.14	5.44
		(1.00)	(2.62)	(3.56)	(4.32)
23	Indicator=1 if subject receives	0.31	-6.55	-7.56	-9.49
	need-based finanial aid	(0.46)	(4.47)	(4.42)	(7.37)
24	Indicator=1 if subject's lottery choices	0.11	10.76	4.10	17.53
	indicate risk seeking preferences	(0.31)	(8.08)	(12.71)	(10.66)
25	Indicator=1 if subject's lottery choices	0.48	-13.95**	-6.89	-16.68**
	indicate very risk averse preferences	(0.50)	(5.30)	(9.01)	(6.02)
	Intercept		-29.16	109.51**	-23.44
			(17.38)	(35.13)	(21.77)
	Number of Observations		326	158	168
	Observations censored at 0		119	77	42
	Log pseudolikelihood		-1133.81	-434.10	-676.85
	Note: Robust standard errors for regressions shown in parentheses, which are adjusted for session clustering. * and ** indicate estimates that are significantly different from zero at the 5 and 1-percent level (all two-tailed tests).				

Personal beliefs about a rule's fairness were important to motivate compliance for many subjects. Row 5 of Table 3 reveals that subjects who considered their permit allocation to be "unfair" complied significantly less, as hypothesized in H3. Subjects who received smaller allocations in the unequal endowment treatment tended to be the ones who considered their allocation unfair, but this factor is controlled for in the regression models. Subjects with smaller permit endowments (Row 4), who typically are permit buyers, also had a higher overall non-compliance rate, replicating the unexpected finding of Murphy and Stranlund (2007).

Consistent with H4 regarding the importance of personal assessments of a law's fairness for compliance, Row 7 shows that subjects attributing their noncompliance to a "personal belief that misreporting is justifiable in this context" cheated at significantly higher levels, especially in the neutral context. In addition, Row 9 indicates that subjects who rated personal beliefs that a law was "fair" or "just" as an important motivation for compliance in general misreported significantly more in the neutral context, where the rules were designed to appear more arbitrary and game-like. Both relationships are consistent with H4, in that we expected subjects to find false reporting more personally acceptable behavior in the neutral context.

We measured affirmative motivation from legitimacy in several ways. Subjects who agreed with the statement "sometime I disobey laws when the risks or consequences of being caught are low" were considered to have weaker affirmative motivations to comply through legitimacy in general. Row 8 shows that these subjects reported dishonestly at marginally-significant higher levels (two-tailed p-values range from 0.07 to 0.08), consistent with H5. On the other hand, knowledgeable support for emissions trading as a policy option (Row 14), another potential proxy for affirmative motivations through legitimacy in the framed treatments, had no significant effect on compliance in the framed treatments (although it did increase

noncompliance significantly in the neutral context), contrary to our expectations in H6. Less than 10 percent of all subjects both understood and approved of emissions trading, however, so this variable may not represent a fully reliable test of this hypothesis. (In addition, we moved questions on emissions trading to after the experimental market in the neutral frame, to avoid priming subjects, which may also have affected the results for this variable in that frame).

Indeed, much to our surprise, Table 1 indicates that compliance was much better in the neutral, unframed context. Row 1 of Table 3 shows that this difference is highly statistically significant. This finding contradicts our expectation that affirmative motivations to comply would be more likely to be activated in a framed context related to environmental protection, rather than a neutral context resembling a game of chance where bluffing could be seen as more acceptable behavior. Task understanding cannot explain this difference, considering that subjects scored better on the comprehension quiz in the neutral context (79 percent correct) than in the framed context (76 percent correct). The fact that framing had a significant, positive effect on noncompliance suggests that lack of public support for emissions trading as a policy option may weaken motivations from legitimacy and lead to less compliance. This is in spite of the fact that subjects believing in the importance of following "fair or just" laws cheated significantly more only in the neutral frame, per hypothesis H4.

These results suggest a tension between affirmative motivations through morality versus legitimacy in our results. In other words, affirmative motivations through morality may have been somewhat weaker in the neutral context (per H4), but that effect may have been overwhelmed by much weaker affirmative motivations through legitimacy in the framed context. We certainly found little support for emissions trading as a policy option among our subjects: Relatively few (33 percent) correctly understood what emissions trading was prior to our

instructions and only a small minority (16 percent) were "supportive" or "very supportive" of emissions trading as a policy option. Support for emissions trading among subjects who understood the policy correctly was only slightly higher (28 out of 105, or less than 27 percent). Thus, the negative effect of framing could be interpreted as evidence that emissions trading's lack of perceived legitimacy increased noncompliance. In other words, it suggests that our expectation about the role of affirmative motivations through legitimacy under H6 may have been correct, but our expectation of the degree of public support for emissions trading was too high. Recent public opinion research confirms this lack of public support for emissions trading (e.g. Maibach et al. 2009; Rabe and Borick 2008). This finding is still fairly speculative, however, especially given that informed support for emissions trading was not significantly associated with greater compliance in the environmentally framed treatment. We discuss these ambiguities further below.

Permit Market Performance

The permit market functioned consistently with the compliance and reporting behavior reported above. Subjects were not allowed to bank permits, and had stationary abatement costs and a constant permit endowment, so all periods had identical economic incentives. Price volatility was large in some sessions, partly because of clear outlier prices, but was small in other sessions. Therefore, we employ the median transaction price in each period as a summary statistic for the central tendency of prices since it is less sensitive to outliers. Figure 2 presents the average of these median prices across sessions within the high and low monitoring treatments, separately for each of the eleven periods. This price average is within or slightly below the full-compliance benchmark (208-212 experimental dollars) in the high monitoring

treatment, consistent with the greater influence of negative motivations to comply in that context. Prices were lower, and fell over time, in the low monitoring treatment. This is consistent with the higher noncompliance rate (that should drive permit prices downward) for the low monitoring treatment documented in Table 1.

Figure 2: Average Median Permit Transaction Prices for Low Monitoring and High Monitoring Treatments

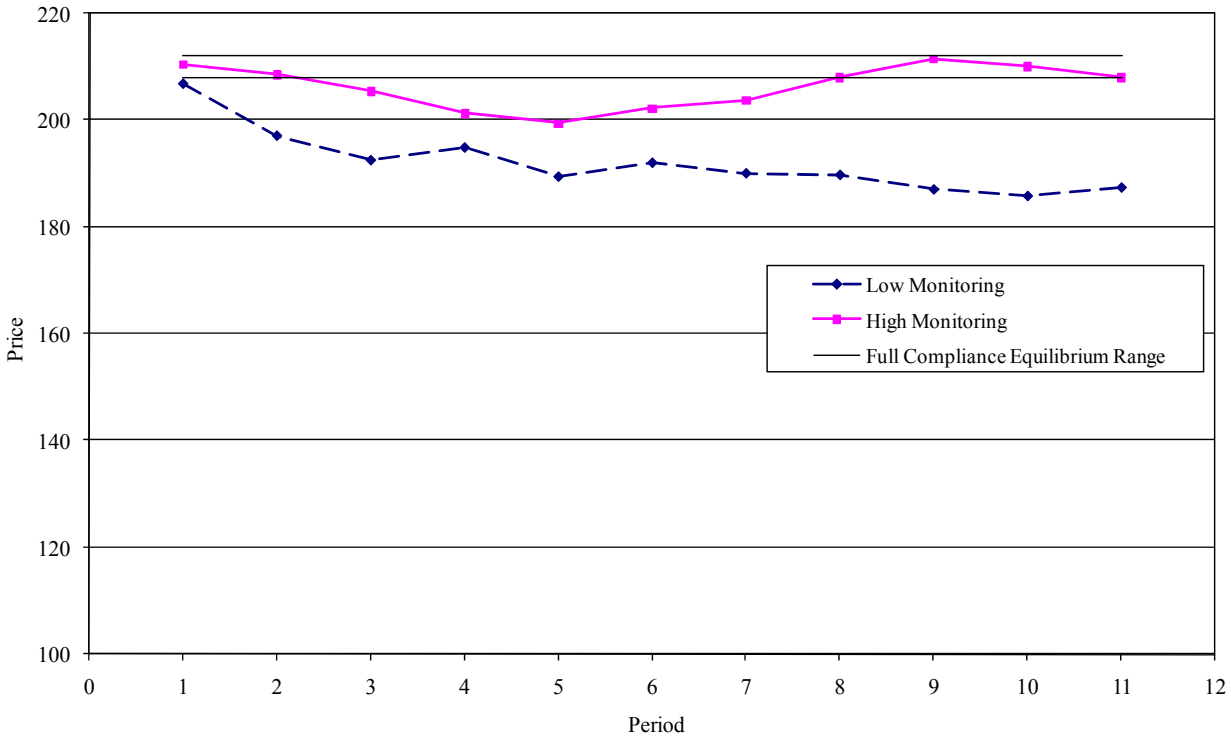


Table 4 reports linear OLS regression models of the median transaction price (column 1) and transaction quantity (column 2) in each period, using treatment dummies, a nonlinear time trend (1/period), and the previous periods' amount of emissions control as independent variables. We use previous period emissions control rather than the current period control because subjects determine the current control choices in the same period as they determine their transaction prices and quantity. If we had instead used current period emissions control, endogeneity of this variable could lead to biased coefficient estimates. The market performed largely as expected,

both in terms of transaction prices and quantities. The monitoring treatment dummy is not significant once the amount of emissions control is included as an explanatory variable, because control is substantially higher with high monitoring (averaging 86 units of control) than with low monitoring (averaging 74 units). In other words, greater emissions control is associated with higher permit prices. The transaction quantity model shown in column 2 indicates that trading volume is higher with equal permit endowments, which is expected because 26 trades are required to equalize marginal abatement costs with equal permit endowments, compared to 14 required trades with unequal endowments. Transaction volume is also lower in the environmental frame treatment.

Table 4: OLS Models of Median Transaction Prices and Trading Volume

Variable	Dependent Variable: Median Transaction Price	Dependent Variable: Trading Volume
=1 if High Monitoring	-1.06	2.19
(0 otherwise)	(13.74)	(1.26)
=1 if Equal Endowments	-20.68	3.67**
(0 otherwise)	(12.12)	(1.18)
=1 if Environmental Frame	19.32	-4.64**
(0 otherwise)	(12.72)	(1.14)
Previous Period Total	1.28**	-0.17**
Emissions Control	(0.41)	(0.04)
1/Period	-6.82	-2.36
	(27.47)	(2.68)
Intercept	97.85**	30.50**
	(30.64)	(3.31)
R-squared	0.15	0.25
Number of Observations	410	410

Note: Robust standard errors, shown in parentheses, are based on correlation (clustering) within sessions. * and ** denote coefficient is statistically different from zero at the 5% and 1% levels, respectively (two-tailed tests).

DISCUSSION

The most important finding of this study is the confirmation of hypothesis H1: A great deal of compliance behavior in our experiments cannot be explained by negative motivations. Many subjects honestly reported their emissions when the expected value of such reporting was negative, despite the significant impact on their cash earnings. Some might attribute this behavior to confusion, but we think this is an unlikely explanation given that subjects passed initial tests on the rules of the experiment and the economic implications of compliance versus non-compliance, and because reporting behavior was consistently related to personal beliefs and risk preferences.

This result is more impressive since the experimental design provided a challenging case for demonstrating the influence of affirmative motivations. The experiment incorporated realistic negative motivations in terms of cash gains from successful under-reporting, while affirmative motivations were not grounded in similarly realistic environmental or political processes. Subjects in the framed experiments understood that underreporting "their emissions" would not affect actual environmental conditions, and that the rules presented were only stylized representations of actual policy choices. Thus, one would expect affirmative motivations to be weaker in this setting, where thoughts about morality and legitimacy could be dismissed as irrelevant to a situation in which no actual political process created the rules and no smokestacks will emit pollution. The fact that many subjects still reported honestly even in this limited experimental context suggests how influential affirmative motivations to comply may be in actual practice.

It is also worth highlighting the relative popularity of equal per capita allocations versus other options like grandfathering or auctions. Although equal per capita allocations are fairly

uncommon in practice, they have appeared prominently in international negotiations regarding climate change policy and in recent U.S. cap and trade bills (Heyward 2007; Raymond 2010, 2008). While such allocations have often been dismissed as politically unrealistic, their perceived fairness suggests that equal per capita distributions could be more politically viable than previously thought. It is worth remembering in this regard that a now-common allocation mechanism, the auction, was recently considered politically unthinkable as well (Raymond 2010).

Our results also suggest the relative importance of affirmative motivations through morality. One of the more unambiguous findings in our analysis is that individuals rating their allocations as unfair were more likely to report dishonestly, even after controlling for numerous other factors. This strongly suggests that a rule's consistency with personal judgments of fairness may be important for compliance, beyond any affirmative motivations based on perceptions of a rule's procedural legitimacy or implementation style (May 2004; see also Olive 2009). For emissions trading policy design, this suggests that allocation rules are important not only for a policy's political viability, but also for its successful implementation.

It is important to temper this conclusion, however, with some confounding factors in our results and our research design. Relatively few respondents (18 percent) rated their allocations as unfair, making this finding less robust. In addition, the relationship between beliefs and actions is complex, and some respondents may have rationalized their noncompliance with strategic claims of unfairness in the post-experimental questionnaire. (The idea that our general results mainly reflect such *post hoc* rationalizations, however, is belied by the fact that subjects answered most survey questions before trading sessions occurred). More importantly, these caveats do not call

into question the basic finding that many subjects complied based on something other than negative motivations.

The results also suggest, in a more ambiguous manner, the importance of affirmative motivations from legitimacy. We introduced environmental framing because we expected it to activate greater affirmative motivations to comply. Instead, we observed a substantial compliance effect in the opposite direction. The remarkable increase in noncompliance in the framed treatments is difficult to explain fully, but would be consistent with a lack of motivations from legitimacy due to lack of support for emissions trading as a policy option. Other research has suggested that a policy's lack of perceived legitimacy leads to less willingness to comply (e.g. May 2004). The lack of support for emissions trading in general suggests one plausible reason, therefore, why the environmental frame led to so much more dishonest reporting.

On the other hand, other explanations are also possible. Our environmental frame suggested that subjects should imagine themselves as managers of a firm, a context that could have triggered a stronger motivation to maximize profits rather than protect the environment. Intermediate frames, such as one with a "firm manager" context but without any reference to environmental protection, could be used in future research to further isolate the roots of this framing effect. Thus, while more work is needed to confirm the role of legitimacy in the emissions trading context, our results suggest that the well-documented public mistrust of cap and trade as a policy instrument may have negative implications for compliance.

Regardless of its source, it is important to note that the framing effect was as large as the impact of doubling the monitoring rate from 25 to 50 percent (compare Rows 1 and 2 of Table 3). This should be of concern to experimental social scientists who typically regard framing effects as minor. As noted earlier, previous research has sometimes found smaller framing

effects with student participants than with expert participants drawn from the field, so our results may even underestimate the impact of framing for a subject pool of environmental managers. (Environmental managers may also have different views on the legitimacy of emissions trading than the general public, further affecting the impact of framing). As experimenters employ more "framed field experiments" outside the lab, it may be necessary to evaluate such pure framing effects in the lab if a main research goal is to compare lab and field experiment outcomes.

CONCLUSION

We conclude with a few thoughts about the theoretical and policy design implications of our findings, as well as some ideas for future research. First and foremost, our results provide new and original evidence that affirmative motivations play an important role in policy compliance. At the same time, we also find that personal judgments of morality may have an underestimated role in compliance decisions, one that may be in tension at times with the more commonly studied motivations through legitimacy. Indeed, the line between the two types of affirmative motivation can blur at the margins: Levi's (1997) well-known example of contingent consent to military conscription based on a policy's legitimacy also hinges fundamentally on what can only be called moral judgments of distributive justice about burden sharing. Thus, it seems clear that those moral judgments may be quite important in cases where burden sharing or resource allocation are an explicit part of a policy's design or implementation (see also Kingdon 2003: 94).

In addition, our results suggest a tension between affirmative motivations through morality and legitimacy. In our treatments, assessments of a rule's personal fairness tended to correlate with greater compliance, even as judgments about a policy's larger illegitimacy appear

to have engendered greater noncompliance. While our findings with respect to framing effects and the perceived legitimacy of emissions trading remain tentative, they do suggest a potential conflict between an individual's sense of being treated fairly by a rule and his or her sense of the rule's larger legitimacy in terms of overall approach, process of enactment, or implementation strategy. More work on untangling these different types of affirmative motivations is needed.

Research on emissions trading should also look more carefully at affirmative motivations in light of the results presented here. Although negative motivations will always play an important role in determining emissions reporting behavior, affirmative motivations are also relevant. Experimental or other field research on implementation of emissions trading programs should attend to the role of affirmative motivations in shaping and encouraging better compliance under imperfect enforcement. In particular, understanding how perceptions of the initial allocation affect compliance with emissions trading programs should be part of the general trend toward studying allocation design. In addition, understanding environmental managers' perceptions of the legitimacy of emissions trading as a policy option also seems quite important given the powerful framing effect found here.

Finally, these results are timely for those trying to design new emissions trading programs that will rely on self-reporting with imperfect enforcement. The Western Climate Initiative is creating a regional cap for six GHGs within a number of western US states and Canadian provinces; it remains in the design phase as of this writing but will soon have to confront reporting issues. The Regional Greenhouse Gas Initiative (RGGI) is less vulnerable to these challenges since it focuses only on CO_2 emissions from large source power plants. But RGGI could also encounter similar compliance issues as it expands in the future. Any U.S. federal program seems likely to encompass multiple GHGs as well, with similar reporting issues.

Some have expressed concern about fraud and dishonest reporting in these GHG cap and trade systems. The results reported here help identify additional levers for encouraging greater compliance at lower enforcement costs, through enhanced affirmative motivations.

By introducing new ideas from experimental work on emissions trading, this project raises at least as many questions as it answers. What would happen to affirmative motivations, for example, if researchers manipulated the environmental consequences of under-reporting or the political process for determining an allocation? Our expectation is that extensions of this research providing real environmental consequences for underreporting emissions would increase the positive effect of affirmative motivations on compliance. This could be tested through the purchase at the end of a future experiment of a variable number of "carbon offset" credits that shrank with increases in the number of unreported emissions, or other measures associating increased actual GHG emissions with experimental abatement and reporting decisions (Boyce et al. 1992).

In addition, it would be useful to manipulate the process by which permit allocations or program rules are created, rather than giving subjects a fictional background story in a framed treatment. Here, one could emulate the work of other scholars by allowing subjects to negotiate and adopt an allocation scheme prior to the start of an exercise (Ostrom 1998; Simon and Sulkin 2002), to vote on noncompliance penalties for underreporting (Feld and Tyran 2002), or to impose a "Tullock" auction in which subjects emulate a political rent-seeking process to obtain their initial allowance endowments (Tullock 1980). These innovations would add more realism to the affirmative motivations part of the research design, and should result in stronger effects on compliance behavior as well as improved external validity. Using these new manipulations, one could also create situations where affirmative motivations through morality conflict more

directly with motivations through legitimacy, to better understand how subjects reconcile these types of normative conflicts in their compliance behavior.

External validity is always a concern for experimental research, particularly when it is conducted in the controlled and "sterile" setting of a laboratory, and it is true that environmental compliance officers face a different set of professional incentives than subjects in our experiment. Thus, although we are confident that the basic motives for compliance (affirmative versus negative) are parallel, it would be worthwhile to test and refine these findings in the field. This could be done by soliciting experimental subjects from the general population, or from managers in energy and manufacturing industries. In the future, one could even survey and interview a sample of environmental managers on their relevant beliefs, and then compare those data with public inspection results of reporting compliance.

In sum, these findings suggest some important opportunities and concerns regarding the design of more complicated emissions trading programs with self-reporting. They also open the door to a new research agenda on framing and affirmative motivations in experimental economics and public policy design. While the initial results presented here are consistent with our basic expectations, they also contain surprises and ambiguities that recommend multiple lines of fruitful additional research.

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Appendix A: Survey Instruments

(Subjects completed questionnaires using lab computers)

Pre Permit Trading/Reporting questions

1) Please indicate how you feel about the following statements:

a) "It is important to me to obey all laws"
b) "It is sometimes OK to disobey laws that I feel are unfair"

(1 strongly disagree, 2 disagree, 3 neither agree nor disagree, 4 agree, 5 strongly agree)

2) Please indicate how you feel about the following statements:

a) "Sometimes I disobey laws when the risk of being caught is low"
b) "Sometimes I disobey laws when the consequences of being caught are low"

(1 strongly disagree, 2 disagree, 3 neither agree nor disagree, 4 agree, 5 strongly agree)

3) Please explain in a few sentences the primary reasons **why** you do or do not obey legal rules?

4) Please indicate how you would feel about a person who took the following actions:

a) Reporting too little income on a personal tax return
b) Failing to correct a person who gives you too much change on a purchase
c) Exceeding the posted speed limit by 10 miles per hour on an interstate highway
d) Illegally disposing of industrial waste

(1 = strongly disapprove; 2 = disapprove, 3 = neutral 4 = approve, 5 = strongly approve, 6 = don't know)

5) Please indicate how you would rate the importance of the following **personal** motivations for your decision to obey or not obey a law?

a) Fear of social embarrassment/stigma for breaking law
b) Fear of financial or other legal penalties for breaking law
c) Personal belief that this particular law is fair or just
d) Personal belief that obeying the law in general is the "right thing to do"

(1 = not at all important, 2 = slightly important, 3 = somewhat important, 4 = important, 5 = extremely important, 6 = don't know)

6) Are you familiar with the phenomenon of global warming?

a) Yes
b) No

7) To the best of your knowledge, which statement most accurately describes the phenomenon of global warming?

a) Release of CFCs and other compounds is creating a "hole" in the stratospheric ozone layer leading to higher average global temperatures
b) Increase in Carbon Dioxide and other gases in the atmosphere from the burning of fossil fuels and land use changes leading to higher average global temperatures.
c) Release of high temperature industrial wastes into the air and water that result in toxic gas emissions that are harmful to humans.
d) Increase in aerosols in the atmosphere from volcanoes and other sources leading to higher average global temperatures.
e) Don't know

8) In your opinion, how important is the problem of global warming compared to other issues in the world today?

(1 = not at all important, 2 = slightly important, 3 = somewhat serious, 4 = important, 5 = extremely important, 6 = don't know)

9) Have you ever heard of the idea of "emissions trading"?

a) Yes
b) No

10) To the best of your knowledge, which of the following statements most accurately describes the idea of emissions trading?

a) Distribution and exchange of "pollution rights" to equalize marginal costs of compliance with environmental standards
b) Payment of a fee to the government by companies for each unit of pollution they release in a given period of time.
c) Relocation of high polluting industries to relatively cleaner parts of the nation or world
d) Contracting between private companies to provide technical assistance for reducing overall pollution levels.
e) Don't know

11) How supportive are you of emissions trading as a policy for addressing environmental problems like global warming?

(1 = not at all supportive, 2 = slightly supportive, 3 = somewhat supportive, 4 = supportive, 5 = extremely supportive, 6 = don't know)

12) As you may know, emissions trading systems rely on the buying and selling of "pollution permits" that entitle the owner to emit a certain amount of air pollution into the atmosphere in a given year. Thus, every emissions trading policy must create a system for distributing these permits to various polluters on an annual basis. Some prominent distribution rules used by governments in the past include:

1) "Grandfathering" = that is, giving permits to all existing polluters free of charge based on their historical levels of energy input and emissions per unit of energy consumed.
2) "Equal shares Per Capita" = giving permits to existing polluters free of charge in proportion to the number of citizens they serve.
3) "Auction" = selling permits to polluters based on their willingness to pay

Consider an example of these rules in a simple, 2 firm emissions trading system
Firm A consumed 1,000 units of energy and emitted 3,000 units of pollution (i.e. 3 units pollution/unit energy) to serve 800 citizens
Firm B consumed 500 units of energy and emitted 1,000 units of pollution (i.e. 2 units pollution/unit energy) to serve 600 citizens.

Under grandfathering, A would get 3,000 pollution permits, B would get 1,000
Under Equal Shares, A would get 800 pollution permits, B would get 600
Under an Auction, A and B would get however many pollution permits they were willing to buy

Please indicate how "fair" you think each allocation rule is for an emissions trading system dealing with the problem of global warming on a 5 pt scale

a) Grandfathering
b) Equal Shares
c) Auction

(1=Very unfair, 2 = Somewhat unfair, 3 = Neutral, 4 = Somewhat fair, 5 = very fair, 6 = don't know)

13) Which of these three allocation options seem most fair to you?

Grandfathering, Equal Shares, Auction, don't know

14) Which of these three allocation options seems most unfair?

Grandfathering, Equal Shares, Auction, don't know

Post Permit Trading/Reporting questions

1) In your opinion, how fair was the initial allocation of permits you received in the experiment?

(Scale: 1= Very unfair, 2 = somewhat unfair, 3 = Neutral, 4 = Somewhat Fair, 5 = Very fair, 6 = don't know)

2) Explain why you judged the allocation as fair or unfair in a few sentences.

3) To the best of your recollection, during the experiment how frequently did you report an incorrect number of emissions to the inspector?

1=never, 2=rarely 3= often 4=always, 5=don't know

4) Please explain in a few sentences what your primary reason was for reporting an incorrect number of emissions

5) To the best of your recollection, during the experiment how frequently did you accurately report your emissions?

1=never, 2=rarely 3= often 4=always, 5=don't know

6) Please explain in a few sentences what your primary reason was for accurately reporting your emissions?

7) If applicable, which of the following motivations best describe your reasons for accurately reporting your emissions?

a) Fear of detection/financial penalties
b) Personal beliefs that misreporting is not appropriate behavior in this context
c) Not applicable – never reported accurately
d) Don't know

8) If applicable, which of the following motivations best describes your reasons for misrepresenting reporting your emissions?

a) Willingness to take the risk of not getting caught and being fined
b) Personal belief that misreporting is justifiable in this context
c) Not applicable – reported accurately at all times
d) Don't know

Demographic questionnaire:

1) What is your age in years?

2) What is your gender?

3) What is your main field of study at the University?
Business/Economics, Engineering, Education, Liberal Arts, Science, Information Technology, Medicine/Nursing/Health Sciences, Other

4) In what region were you born?
North America, Central/South America, Australia/New Zealand, Other Pacific Nation, South-East Asia, South Asia, Other Asia, Western Europe, Northern Europe, Eastern Europe, Africa

5) How long have you lived in the United States?
More than 5 years, 2-5 years, 1-2 years, less than 1 year

6) Where did you live when you were 15 years old?
In the countryside but not on a farm, on a farm, in a small city or town (under 49,999), in a medium-sized city (50,000-249,999), in a suburb near a large city, in a large city (250,000-2,999,999), in a metropolis (over 3,000,000)

7) What is your approximate cumulative GPA?

8) Are you an undergraduate student (what year?) or a graduate student?

9) How many economics experiments have you participated in before this one?
None, 1-2 previous, 3-5 previous, more than 5 previous

10) Are you currently receiving some form of financial assistance for your educational expenses?

Yes/No

11) Are you currently employed in a job while in school? If so, please indicate how many hours per week on average you work. If you study full time and do not work, enter 0.

12) What term best describes your ethnic identity?

African-American, Asian-American, Hispanic, White, Native American, Other

13) What is your political party affiliation, if any?

Democrat, Independent, Republican, Other, None

14) Are you registered to vote?

Yes, No

15) How Important do you consider religion in your daily life?

Very important, somewhat important, a little important, not at all important

16) Do you consider yourself an environmentalist?

Yes, No

Appendix B: Sample Experiment Instructions (High Monitoring, Neutral Framing, Unequal Endowment) – ***Key alternative phrasing from Environmental Framing treatment shown in italics***

General

This is an experiment in the economics of decision making. All earnings on your computer screens are in Experimental Dollars. These Experimental Dollars will be converted to real Dollars at the end of the experiment, at a rate of _____ Experimental Dollars = 1 real Dollar. Notice that the more Experimental Dollars that you earn, the more cash that you receive at the end of the experiment. Please pay careful attention to these instructions. You will take a 10-question quiz when we finish reading them and you will earn 50 cents for every correct answer.

We are going to conduct a number of periods. You will not learn the number of periods until the end of the experiment. Along with these instructions you should have received a sheet labeled Personal Record Sheet, which will help you keep track of your earnings based on the decisions you make. You are not to reveal this information to anyone. It is your own private information.

In today's experiment, each period you will chose a number between 0 and 20. You can also buy or sell "coupons." The rule in today's experiment is that the number you choose PLUS the coupons you hold should equal at least 20 every period.

Environmental Framing (EF) Alternative: In today's experiment you should think of yourself as the manager of a power plant that produces electricity. Your plant burns fossil fuel to produce electricity which pollutes the atmosphere. As a plant manager, you can either buy "pollution" permits that allow you to legally emit pollution, or you may invest in pollution control of your production process to reduce your amount of pollution.

The higher the number you choose, the greater your costs in experimental dollars. If you decide that choosing higher numbers is very costly then you may buy coupons which allow you to choose a lower number and still satisfy today's rule. At the end of each period, you must have enough coupons so that your coupons + your number choice $\geq$ 20. A computerized inspector enforces this rule in the following manner. First, you must report your number choice to the inspector. The inspector then adds your reported number to the number of coupons you possess. If the total of your number plus your coupons is 20 or higher, you are in compliance. If this sum is less than 20, the inspector fines you.

EF Alternative: For each ton of pollution you "control", you have to incur a cost. If you decide that pollution control is very costly then you may buy additional pollution permits which allow you to emit this pollution into the atmosphere legally. At the end of each period, you must have enough permits to cover your reported pollution level. An environmental regulator enforces this rule in the following manner. First, you must report your pollution level to the environmental regulator. The regulator then compares your reported pollution level to the number of permits you possess. If you have enough permits to cover your reported pollution, you are in compliance and the regulator simply collects one permit for each ton of pollution you reported. If you have fewer permits than the pollution you report to the regulator, the regulator fines you.

The inspector always knows how many coupons you have, and your reported number. But it does not initially know your actual number choice. There is some chance that the inspector may inspect your decision in a given period, however, to see what your **actual** number is. If the sum of your actual number plus your coupons is less than 20, and you are inspected, the inspector fines you. Thus, there are two ways to be fined in this system: for having the sum of your coupons plus your reported number be less than 20, OR for having the sum of your coupons plus your ACTUAL number be less than 20 and being inspected. In other words, either your reported or your actual number will be combined with your coupons to determine your compliance, depending on whether or not you are inspected.

*EF Alternative: Although the regulator always knows how many permits you have, she does not initially know your actual level of pollution—only your reported level. There is some chance that the regulator may inspect your plant in a given period, however, to see if your **actual** pollution level exceeds your number of permits. If you have actually polluted MORE than the number of permits you hold that period, and you are inspected, the regulator fines you. Thus, there are two ways to be punished in this system: for not holding enough permits to cover your reported pollution level, OR for not holding enough permits to cover your actual pollution level and being inspected by the regulator. In other words, either your reported or your actual pollution level will be compared to your number of permits to determine your compliance, depending on whether or not you are inspected. (Environmental Framing Alternative hereafter simply shown in italics in parentheses.)*

Your payoff depends on the decisions you make about three things: (1) buying/selling coupons *(permits)*, (2) what number you choose *(how much of your pollution to control)*, and (3) what number *(how much pollution)* you report to the inspector *(environmental regulator).* In addition, in every period you receive revenue that is fixed at a constant level for all periods. *(Note that you do not make any decisions about the amount of electricity you produce. In other words, in every period you produce the same amount of electricity and your sales revenue is fixed at a constant level for all periods.)* Your earnings each period are determined as follows:

Earnings = Fixed Revenue – Total Costs from Number Choice + Sale revenue from Selling Coupons – Amount Spent when Buying Coupons – Fines Paid to Inspector.

Your Fixed Revenue does not depend on any actions you take, and does not change throughout the experiment. (In fact, it is already written on your Personal Record Sheet). All other factors are determined by your choices each round, as well as the choices of other individuals in the experiment.

Trading Coupons *(Pollution Permits)*

At the start of every period, everyone starts with some initial endowment of coupons *(pollution permits)* and will have an opportunity to adjust their coupon *(permit)* holdings by trading coupons *(pollution permits)* with others. The initial endowment of coupons *(permits)* is not equal for everyone *(all firms).* Instead, some people are given a larger number of initial coupons and others get a smaller number. Which people receive a "higher" or "lower" endowment is decided at random. You will find out your initial endowment when you start the actual experiment (*Instead, the experiment "grandfathers" the permits based on variations in pollution control costs. Thus, some "dirtier" power plants are given a larger number of permits at the start of each period based on their higher pollution control costs, while other "cleaner" plants are given a smaller number of initial permits based on their lower pollution control costs. You will find out which kind of firm you are ("dirtier" or "cleaner") when you start the actual experiment)* (there will be a label in the corner of your screen indicating that you are getting a "higher" or a "lower" allocation). These initial allocations will be fixed throughout all rounds of the experiment.

Since the inspector *(regulator)* expects you to have one coupon for each unit your chosen number is below the required level (20), *(one pollution permit for each ton of pollution you emit)* these coupon *(permit)* trades will affect the number you need to choose *(the amount of pollution you need to control)* in that period in order to be in compliance. For example, if you buy an additional coupon in this period, you would then be able to reduce your number choice by one in order to be in compliance *(permit in this period, you would then need to control one fewer ton of pollution in order to be in compliance).* If you sell one of your coupons, by contrast, then you would need to increase your number choice by one for that round in order to be in compliance *(permits, by contrast, then you would need to control one additional ton of pollution for that round in order to be in compliance.).* Later in these instructions we explain the rules for buying and selling coupons *(permits)* in more detail.

Figure 1

Costs of Your Number Choice *(Pollution Control Costs)*

As shown in Figure 1, after you have completed the coupon *(permit)* trading phase you will choose your number *(pollution control level).* You must pay *(pollution control)* costs when you choose numbers *(reduce pollution).* Your marginal costs of choosing each higher number *(marginal pollution control costs)* are always shown on the left side of your computer screen, as illustrated in Figure 1 (the cost values on this example screen are different from the actual cost values used in the experiment, and you won't actually learn your cost values until the experiment begins). The maximum number choice for each person is 20. The cost of choosing each higher number is written separately. Note that the costs are not fixed; typically, choosing a higher number costs MORE than the previous number. In other words, it is usually more expensive to choose the 8^{th} number than the 7^{th}. Put more formally, the marginal costs of choosing a higher number are increasing. However, these costs are not necessarily the same for everyone. *(Everyone emits 20 tons of pollution if they do not control pollution, so the maximum each person can control is 20 tons. Every ton of pollution controlled reduces the amount emitted by one ton, so if you control T tons of pollution you emit 20-T tons of pollution. The cost of controlling each ton is written separately. Note that the costs are not fixed; typically, controlling each additional ton costs MORE than the previous ton. In other words, it is usually more expensive to clean up the 8^{th} ton of emissions than the 7^{th}. Put more formally, the marginal costs of pollution control for your firm are increasing. However, these costs are not necessarily the same for every firm.)*

For example, consider the numbers shown in the *example* in Figure 1 in the Marginal Number *(Pollution Control)* Cost column. It shows that your first number *(ton controlled)* would cost 25 experimental dollars, your second number *(ton controlled)* would cost 35 more dollars, etc. If, for example, these were your number *(pollution control)* costs and you chose the number 3 *(controlled 3 tons),* your **total** costs would be 25+35+47=107. So you must recognize that the costs shown on your marginal cost column are the **extra** costs associated with each **additional** number chosen *(ton controlled).*

Coupons *(Pollution Permits)*

Under the current rules, the following compliance rule applies to everyone *(every firm)*:

Compliance Rule: To be in compliance, your coupons plus your number must be equal to or greater than 20. ***(You must possess a pollution permit for every ton of pollution you do not control.)***

This rule means that you can reduce your required number choice by holding more coupons. These coupons are like a "license" to choose a lower number. If you hold 4 coupons, for example, you could choose the number 16 (instead of 20) and still be in compliance with the rule. *(This rule means that you can reduce your legally required pollution control efforts by holding pollution permits. These permits are like a "license" to legally emit one ton of pollution. If you currently hold 4 permits, for example, you can legally emit 4 tons of pollution and so you could control only 16 tons of pollution (instead of 20) and still be in compliance with the law.)*

As noted above, you have an opportunity each round to buy or sell coupons *(pollution permits)* BEFORE choosing your number *(setting your pollution level).* Buying or selling coupons *(permits)* will change your number choice required to satisfy the rule *(legally required pollution control efforts)*. Consider the example in Figure 1. To be in compliance without selling or buying coupons *(permits),* this person *(firm)* needs to choose the number 16 *(control 16 tons of pollution).* The marginal *(pollution control)* cost of the 16th number is 431 experimental dollars. If this person *(manager)* can buy a coupon *(permit)* on the market, however, for less than $431, she might decide to choose the number 15 *(control only 15 tons of pollution)* instead. If she buys a coupon *(permit)* for $200, for example, she would have saved herself $431 – 200 = $231 in expenses and she *(her firm)* will earn more money. Of course, if she buys a coupon *(permit)* for $500, then she has cost herself $431 – 500 = $-69 more money than she would have spent just choosing the higher number 16 *(controlling her own pollution).*

On the other hand, an individual *(firm manager)* might choose to sell coupons *(pollution permits)*. Consider again example in Figure 1, but let's say this person *(the manager)* is considering whether to choose the number 17 instead of 16 *(control 17 tons of pollution instead of 16)*. Then her *(the manager's)* costs will be $521 higher if she chooses 17 instead of 16 *(controlled 17 tons instead of 16 tons)*, but she will have more coupons *(permits)* than she needs to comply with the rule *(law).* If she *(the manager)* sells a coupon *(permit)* on the market for $550, and pays this extra *(pollution control)* cost of 521, she will make a $550 – 521 = $29 profit. If she sells a coupon for only $500, however, she will end up losing $500 – 521 = $-21 on the transaction. Thus, the net profit of selling or buying coupons *(permits)* depends in part on the

marginal costs of choosing specific numbers for that individual *(marginal costs of controlling a given ton of pollution for that firm).*

How to Buy and Sell

Each trading period will be open for trading for 2 minutes. At any time during the trading stage, everyone is free to make an offer to buy a coupon *(permit)* at a price they choose; likewise, everyone is free to make an offer to sell a coupon *(permit)* at a price they choose. Also at any time during the period, everyone is free to buy at the best offer price specified by someone wishing to sell, and everyone is free to sell at the best offer price specified by someone wishing to buy. (Of course, to sell a coupon *(permit)* or make a sales offer, you need to have a coupon *(permit)* to sell. And to buy a coupon *(permit)* or make a buy offer, you need to have enough cash to pay.)

You will enter offer prices and accept prices to execute transactions using your computer. Figure 2 shows the market trading screen. The time left in the period is shown on the upper right of the trading screen. Participants interested in buying can submit offer prices using the "Buy Offer" box in the right side of the screen, and then clicking on the "Make Offer" button in the lower right. This offer price is immediately displayed on all traders' computers on the upper right part of the screen, labelled "Buy Offers." Once this offer price has been submitted, it is binding in the sense that anyone wishing to sell can accept this price offer. Such an acceptance results in an immediate trade at that price. The previous trading prices in the current period are displayed in the "Trading Prices" list in the center of your computer screen.

If there are already Buy Offers displayed in the current period, then new buy offers submitted by anyone wishing to buy must provide better trading terms to the sellers. Sellers prefer higher prices, so any new buy offers must be higher than the current highest buy offer. Your computer will give you an error message if you try to offer a lower price than the best price currently available.

Anyone wishing to buy can accept the best (that is, lowest sell offer price) by simply clicking the "Buy Coupon *(Permit)*" button on the bottom of their computer screen. This results in an immediate trade at that price.

Participants interested in selling can submit offer prices using the "Sell Offer" box on the left side of the screen, and then clicking on the "Make Offer" button below this box. This offer

price is immediately displayed on all traders' computers on the left part of the screen, labelled "Sell Offers." Once this offer price has been submitted, it is binding in the sense that anyone wishing to buy can accept this price offer. Such an acceptance results in an immediate trade at that price.

If there are already Sell Offers displayed in the current period, then new sell offers submitted by anyone wishing to sell must provide better trading terms to the buyers. Buyers prefer lower prices, so any new sell offers must be lower than the current lowest sell offer. Your computer will give you an error message if you try to offer a higher price than the best price currently available.

Anyone wishing to sell can accept the best (that is, highest offer price) by simply clicking the "Sell Coupon *(Permit)*" button on the bottom of their computer screen. This results in an immediate trade at that price.

Figure 2

The upper left portion of your trading screen will display the number of coupons *(permits)* you currently hold, and your cash on hand, and these will be automatically adjusted after each sale or purchase you make. Please keep a careful eye on these, because it is not always obvious when you make a transaction if the transaction occurs from someone else accepting a sell offer or buy offer that you have previously submitted to the market.

Reporting and Fines

At the end of each period, after choosing your number *(pollution control level)*, you will make a report *(Pollution Report)* to the inspector *(environmental regulator)*, using a screen like that shown in Figure 3. What you must remember is the following:

The inspector *(environmental regulator)* always knows your coupon *(permit)* holdings.

The inspector *(environmental regulator)* does not know your actual number *(pollution level)* unless it inspects you *(she inspects your firm)* to verify your *(pollution)* report for accuracy.

You will choose what number to report to the inspector *(how much pollution to report to the regulator)*. If it does not inspect you, then it takes your *(pollution)* report as truthful and simply checks whether you hold enough coupons *(permits)* to cover your reported gap between 20 (required for compliance) and your number *(reported pollution)*. If you hold fewer coupons than necessary to reach the compliance level of 20, you must pay a fine based on how large the gap is. *(If you hold fewer permits than your reported pollution, you must pay a fine based on how many tons your reported pollution exceeds your number of permits.)*

However, the inspector *(regulator)* may inspect you *(your firm)* to determine your Actual number *(pollution levels)*. The probability (or, "likelihood") that it will inspect is 50%. To understand the chances of being inspected, imagine an urn (or the bingo cage the experimenter is holding) containing 4 total balls: 2 white balls and 2 red balls. One ball is drawn from this imaginary urn, and if we draw a red ball then you would be inspected; if we draw a white ball then you would not be inspected. A different ball draw is conducted for every different individual for every different period in the experiment. In other words, the random draws are all independent.

If the inspector *(regulator)* does inspect you and finds that your actual number plus your coupons is less than the required level of 20, you must pay a fine based on the size of the shortfall *(actual pollution level is greater than the number of permits you hold, you must pay a fine based on how many tons your actual pollution exceeds your number of permits)*.

Consider the following examples to illustrate this.

Example #1:

Your number *(pollution control)* choice = 13 *(tons)*.

Your coupons needed for compliance *(actual pollution)* = 20 – 13 = 7.

Your coupons *(permits)* = 5.

Your reported number *(pollution)* to the inspector *(regulator)* = 15.

You are inspected and the inspector sees that the sum of your actual number (13) and your coupons (5) is 18, which is 2 units below the compliance requirement of 20 *(sees that your actual pollution (7) is 2 tons higher than your number of permits (5)).*

Your fine (at 400 experimental dollars per unit the sum is < 20 *(at 400 experimental dollars per ton)*) = 400 × 2 = 800

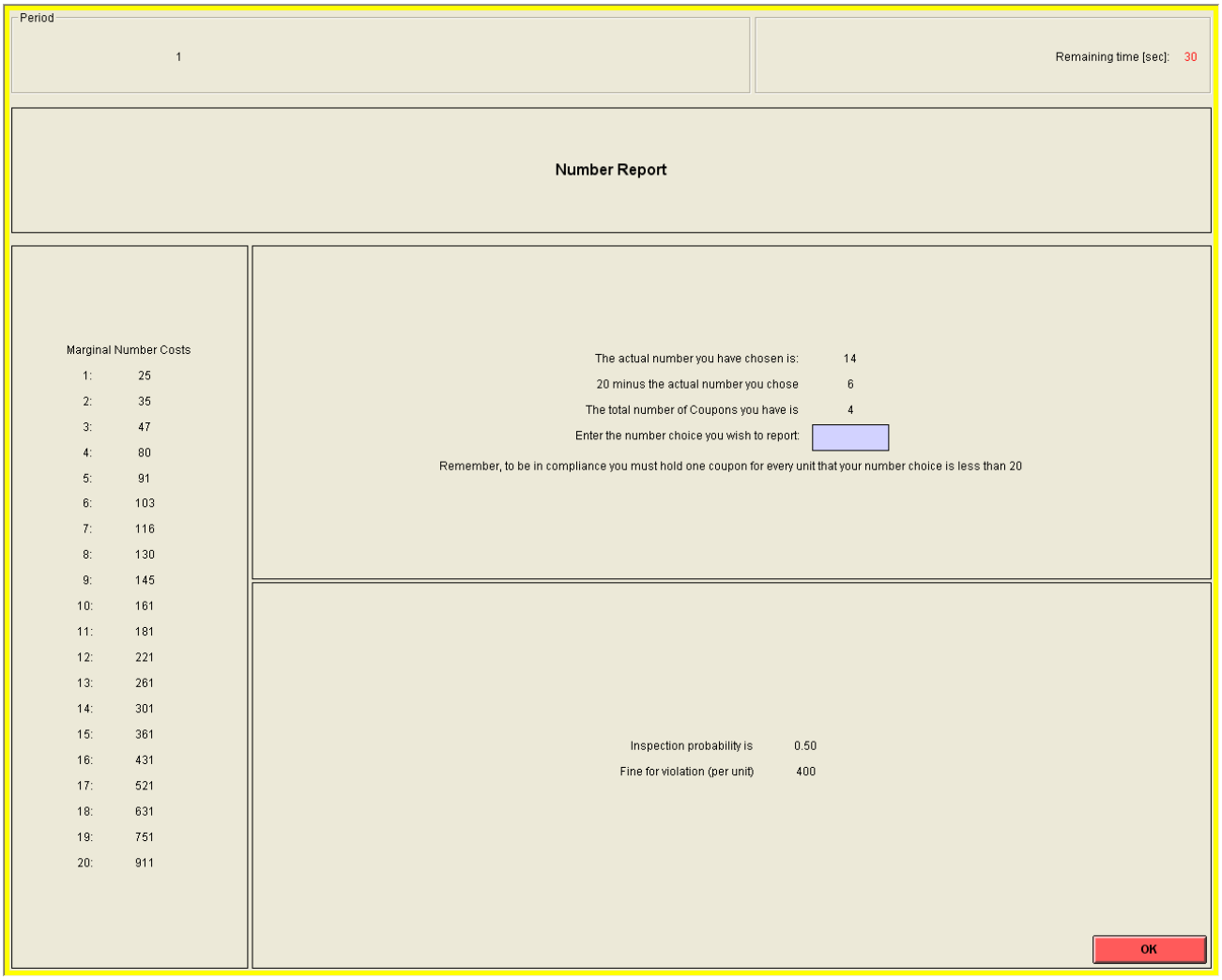

Figure 3

Example #2: *(Note: similar adjustments to following examples not shown)*

Your number choice = 4.

Your coupons needed for compliance = 20 – 4 = 16.

Your coupons = 12.

Your reported number to the inspector = 8.
You are not inspected, so the inspector believes your number choice is the number you reported (8). Since the sum of your reported number (8) and your coupons (12) is equal to the compliance requirement of 20, you are not fined.

Example #3:
Your number choice = 6.
Your coupons needed for compliance = 20 – 6 = 14.
Your coupons = 13.
Your reported number to the inspector = 6.
You are not inspected, so the inspector believes your number choice is the number you reported (6). Even though your report was truthful, the sum of your reported number (6) and your coupons (13) is 1 unit below the compliance requirement of 20. Thus, you are fined for not having enough coupons for your reported number.
Your fine (at 400 experimental dollars per unit the sum is < 20) = 400 × 1 = 400.

Note that you can therefore be fined *(be considered a violator and fined)* even if you are not inspected or are inspected and accurately report your coupons plus number that sums to less than 20 *(pollution level).* Any time you report a sum that is less than 20, you will be fined, because to follow the rule the sum of your coupons plus your number must be 20. *(Any time you report more pollution than you have permits, you will be fined, because to legally pollute you must hold a permit for every ton of pollution.)* In this case, the fine paid is the per-unit fine times the amount that your reported number plus coupon holdings is less than 20 *(reported pollution exceeds permit holdings).* In addition, you may be fined if you are inspected and found to have an actual number plus coupon holdings that is less than 20 *(actually emitted more pollution than your permit holdings)*, regardless of what you reported.

Period Results

Whether or not you are inspected and a summary of the results from the period are shown on the Period Results screen; Figure 4 presents an example. Your cash holdings are updated for the next period (and remember, these are the cash holdings that get converted into actual dollars

at the end of the experiment). You should copy this information onto your Personal Record Sheet at the end of each period, and then click "continue" to begin the next period.

Figure 4

Summary

- Your marginal costs for choosing each higher number *(pollution control costs)* are shown on your computer screen are the extra, additional costs incurred for each higher number choice *(ton of pollution that you control and do not emit).*
- To be in compliance, the sum of your number plus your coupons must equal 20 or more *(you must have one pollution permit for each ton of pollution you emit).*

- If you choose the number 0, you will need 20 coupons to be in compliance *(If you do not control any pollution, you will emit 20 tons of pollution each period)*.
- The inspector *(regulator)* always observes your coupon *(permit)* holdings and your reported number *(reported pollution level)*, but does not observe your actual number *(pollution level)* unless it chooses to inspect you at random.
- If the sum of your **reported** number plus your coupons is less than 20, you will be fined. If the sum of your **actual** number plus your coupons is less than 20, and you are inspected, you will be fined. *(If you hold fewer permits than your reported pollution level, you will be fined. If you hold fewer permits than your actual pollution levels, and you are inspected, you will be fined.)*
- Different people *(plants)* start each period with different numbers of coupons *(permits)*, depending on whether they are in the "higher" or "lower" endowment category *(their pollution control costs)*.
- Unused coupons *(permits)* do not carry over to the next period and are forfeited.

We will now conduct a short, 10-question quiz to test your understanding of these instructions. You will earn 50 cents for each correct answer, and you may refer to these instructions when taking the quiz. Also, before we begin making decisions for real money, we will conduct one practice period for you to get comfortable with the trading software. This practice period does not affect your experiment earnings. Once we begin the experiment you should be careful to maintain positive cash holdings, since anyone whose cash is below zero at the end will have these losses subtracted from earnings in other parts of the experiment (but not the Guaranteed Participation Payment).

Are there any questions now before we begin the quiz?

(Lottery Choice Instructions—Administered During Pre-Survey Phase Before Permit Trading)

For each line in the table in the next page, please state whether you prefer option A or option B.

Notice that there are a total of 15 lines in the table but just one line will be randomly selected for payment. You ignore which line will be paid when you make your choices. Hence you should pay attention to the choice you make in every line. After you have completed all your choices a token will be randomly drawn out of a bingo cage containing tokens numbered from 1 to 15. The token number determines which line is going to be paid.

Your earnings for the selected line depend on which option you chose:

If you chose option A in that line, you will receive $1.

If you chose option B in that line, you will receive either $3 or $0. To determine your earnings in the case you chose option B there will be second random draw. A token will be randomly drawn out of the bingo cage now containing twenty tokens numbered from 1 to 20. The token number is then compared with the numbers in the line selected (see the table). If the token number shows up in the left column you earn $3. If the token number shows up in the right column you earn $0.

Participant ID: ____

Deci-sion no.	**Option A**	**Option B**		Please choose A or B
1	**$1**	**$3** never	**$0** if 1,2,3,4,5,6,7,8,9,10,11,12,13,14,15, 16,17,18,19,20	
2	**$1**	**$3** if 1 comes out of the bingo cage	**$0** if 2,3,4,5,6,7,8,9,10,11,12,13,14,15, 16,17,18,19,20	
3	**$1**	**$3** if 1 and 2	**$0** if 3,4,5,6,7,8,9,10,11,12,13,14,15, 16,17,18,19,20	
4	**$1**	**$3** if 1,2 and 3	**$0** if 4,5,6,7,8,9,10,11,12,13,14,15, 16,17,18,19,20	
5	**$1**	**$3** if 1,2,3,4	**$0** if 5,6,7,8,9,10,11,12,13,14,15, 16,17,18,19,20	
6	**$1**	**$3** if 1,2,3,4,5	**$0** if 6,7,8,9,10,11,12,13,14,15, 16,17,18,19,20	
7	**$1**	**$3** if 1,2,3,4,5,6	**$0** if 7,8,9,10,11,12,13,14,15,16,17,18,19,20	
8	**$1**	**$3** if 1,2,3,4,5,6,7	**$0** if 8,9,10,11,12,13,14,15,16,17,18,19,20	
9	**$1**	**$3** if 1,2,3,4,5,6,7,8	**$0** if 9,10,11,12,13,14,15,16,17,18,19,20	
10	**$1**	**$3** if 1,2,3,4,5,6,7,8,9	**$0** if 10,11,12,13,14,15,16,17,18,19,20	
11	**$1**	**$3** if 1,2, 3,4,5,6,7,8,9,10	**$0** if 11,12,13,14,15,16,17,18,19,20	
12	**$1**	**$3** if 1,2, 3,4,5,6,7,8,9,10,11	**$0** if 12,13,14,15,16,17,18,19,20	
13	**$1**	**$3** if 1,2, 3,4,5,6,7,8,9,10,11,12	**$0** if 13,14,15,16,17,18,19,20	
14	**$1**	**$3** if 1,2, 3,4,5,6,7,8,9,10,11,12,13	**$0** if 14,15,16,17,18,19,20	
15	**$1**	**$3** if 1,2,3,4,5,6,7,8,9,10,11,12,13,14	**$0** if 15,16,17,18,19,20	