Can Affirmative Motivations Improve Compliance in Emissions Trading Programs?*

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Abstract

Early emissions trading programs have obtained a very high rate of compliance, in part by using continuous emissions monitors (CEMS) that automatically record emissions data on a 24 hour basis. As they expand into a wider range of pollutants and sources, policy designers will have to rely on less automated forms of self-reporting. The cost of verifying these self-reported emissions is an important concern. This paper asks if improved "affirmative motivations" (Tyler 2006; May 2005) for compliance among emitters could reduce the likelihood of under-reporting, thereby reducing costly external audits without unduly jeopardizing environmental integrity. Using a computerized laboratory emissions trading market, we find that many subjects reported honestly in situations where dishonest reporting would have been more profitable, as well as a statistically significant association between perceptions of a policy's fairness and honest reporting. These results suggest that designing an emissions trading program to increase its perceived fairness among users has the potential to increase honest emissions reporting and reduce monitoring costs.

Keywords: emissions trading; cap and trade; compliance; affirmative motivations

INTRODUCTION

Also known as "cap and trade," emissions trading policies allow 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, national, and regional programs to reduce greenhouse gas emissions. As they have gained popularity, however, these policies have also been criticized as vulnerable to compliance and enforcement problems (e.g., Stranlund et al. 2002). This is ironic given that emissions trading programs, such as the 1990 U.S. acid rain program, have attained some of the strongest compliance records of any environmental policy to date. The acid rain program has achieved a high level of compliance (greater than 99% of all affected sources annually) in part by requiring automated continuous emissions monitors (CEMS) on most sources, making false reporting of emissions difficult (EPA 2009a).

CEMS were feasible for the 1990 SO_2 program because of the relatively limited number of stationary sources affected and then-recent improvements in technology (Cole 2002). Emissions trading programs will have to use less reliable forms of 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 refineries, mines, or importers of carbon-based energy (Stavins 2008). Continuous emissions monitoring is inappropriate or too expensive for many of these reporting settings, so self-reporting based on fuel consumption or other metrics will be necessary, as was done in the early stages of the EU Emissions Trading System (EU ETS) (Ellerman and Joskow 2008). This less automated form of reporting has led to worries about fraud and dishonest reporting among emitters (e.g., Green et

al. 2007; Pearlstein 2009; Peeters 2006).

How to maintain sufficiently honest reporting of emissions at the lowest cost is therefore an important policy design question. Although self-reporting of emissions based on fuel-consumption formulas or other information can be verified externally, such audits are costly. As with many traditional command and control regulations, finding a way to ensure sufficient compliance at the lowest cost is desirable for emissions trading programs. Referred to as "imperfect enforcement" by economists, the threat of irregular inspection and verification of self-reports is a common approach to enforcing policies from taxation and financial reporting to many environmental regulations (see Ellerman and Joskow 2008).

This study examines affirmative motivations as a mechanism for improving compliance in emissions reporting under imperfect enforcement. Negative motivations—fear of costly punishments for detected violations—are frequently cited as a primary reason for legal obedience (following Becker 1968), and experimental research on emissions reporting has emphasized their role (e.g., Cason and Gangadharan 2006; Murphy and Stranlund 2007). Yet other research suggests that less well-understood affirmative motivations can also affect regulatory compliance (Tyler 2006; May 2005; Torgler 2003; Winter and May 2001). Affirmative motivations rely on belief in a law's legitimacy or fairness as a determinant of compliance. Because imperfect monitoring may make under-reporting of emissions profitable (Tietenberg 2006: 65; Harrington 1988), depending on the inspection frequency and penalty structure, affirmative motivations could be important to the design of current and future trading schemes.

To explore the potential influence of these affirmative motivations, we conducted an experiment using a computerized laboratory emissions trading market combined with survey questions to assess subjects' affirmative motivations for compliance. Our experiment employed a

full factorial design with 8 treatment cells and 328 total subjects to test the effect of different factors on compliance: 2 enforcement conditions (high and low probability of inspection) × 2 permit allocations (equal or unequal) × 2 frames (environmental or neutral). Our expectation was that affirmative motivations would lead to more honest reporting than was economically "rational" in all treatments, and that this costly honest reporting would be significantly greater when subject affirmative motivations were strongest. In particular, we expected affirmative motivations to be strongest when subjects rated their initial allocation as "fair," and also when the experiment was framed in terms of complying with rules to protect the environment.

Our results confirm the importance of affirmative motivations in several ways. Many subjects reported honestly in situations where dishonest reporting was obviously more profitable. In addition, most subjects rated affirmative motivations as an important reason for complying with laws in general, and those subjects were significantly more likely to report honestly when they also rated their initial allocations as fair. Environmental framing also significantly affected reporting, although in the opposite direction of our expectations: dishonest reporting was more common in the framed treatments. These results suggest that negative motivations alone are inadequate to explain reporting compliance, and that judgments of fairness and legitimacy by regulated individuals are another important factor explaining compliance with emissions trading rules.

The paper proceeds as follows. First, we discuss our hypotheses as they emerge from existing research on emissions trading and regulatory compliance. After describing our experimental methods in more detail, we present and discuss our results. Finally, we conclude with a few thoughts about the implications of our findings for emissions trading policy design and for theories of compliance more generally, as well as directions for future research.

HYPOTHESES AND EXISTING RESEARCH

Grounded in the work of Coase (1960) and Dales (1969), emissions trading policies seek to reduce the social cost of meeting an environmental standard by increasing flexibility and equalizing marginal costs of compliance. Rather than forcing firms to install a given piece of pollution control equipment, as required for instance under the Clean Air Act's "Best Available Control Technology" requirement, emissions trading programs set an overall limit (or "cap") on pollution and give firms more freedom to find cheaper ways of reducing their emissions. The policy enforces the cap by creating a limited number of "quasi-property rights" to emit a unit of pollution, often called "allowances" or "permits," and requires regulated sources to surrender one allowance for every unit of pollution they emit. Firms may trade allowances, in order to encourage emissions reductions at sources with the lowest emissions abatement costs.

Promoted by environmental economists in the 1970s and 1980s, emissions trading principles gradually percolated through federal air pollution regulation via policies such as "netting" and "offsetting" requirements for new sources in non-attainment areas (Hahn 1989). On the heels of a more intensive trading program for lead additives in gasoline in the 1980s, emissions trading became the centerpiece of a major pollution control regime for the first time under Title IV of the 1990s Clean Air Act Amendments. Title IV created a new cap and trade program for Sulfur Dioxide (SO_2) emissions from the utility sector, in order to address concerns about acid precipitation.

Under the 1990 policy, SO_2 emissions from large power plants are capped just below 9 million tons annually. Allowances are given largely for free to existing utilities in rough proportion to their historic emission levels. The law requires most sources to install CEMS in order to provide the most accurate emissions data (EPA 2009b). Utilities surrender allowances to

the EPA annually, once they have reported their total emissions for the previous calendar year. Failure to surrender sufficient allowances for reported emissions results in both substantial fines and a requirement to surrender additional allowances in future years. Based on this nearly automated reporting regime, as well as the relatively low cost of allowances, near-perfect compliance has led many to declare the policy a major success (EPA 2009a; Burtraw and Palmer 2003).

The SO_2 program reveals how compliance with an emissions trading program consists of two important elements: 1) *honest reporting of emissions* and 2) *surrendering a sufficient number of "allowances"* to cover those emissions (see Stranlund et al. 2002). The use of CEMS in the SO_2 program helps ensures honest reporting at relatively low cost, thereby explaining the first part of the program's high compliance rate. EPA's computerized allowance tracking system, high fines for allowance shortfalls, and a liquid market for allowances, has made surrendering a sufficient number of allowances relatively easy as well, thereby explaining the second element of the high degree of compliance. In general, high fines can almost entirely prevent noncompliance through surrendering too few allowances (Stavins 2008; Stranlund et al. 2002). Non-compliance through dishonest emissions reporting, however, may pose a greater risk in some contexts. While CEMS data could be manipulated, in theory, the automated stream of emissions data combined with rigorous internal quality assurance reports and occasional third party verification that the equipment is functioning properly makes false reporting difficult (EPA 2009b). Other forms of self-reporting based on self-reports of fuel consumption or average emission rates, by contrast, would be easier to misrepresent and might require more frequent external auditing and verification.

Unfortunately, the CEMS used for SO_2 emissions from power plants are inappropriate for more broad-based GHG emissions. Many GHG programs propose to regulate several pollutants that are emitted from highly dispersed sources (e.g. automobile tailpipes) or otherwise defy simple "end of pipe" monitoring through CEMS. Therefore, self-reporting based on fuel consumption or other proxy measures has already been used extensively in the EU ETS (Ellerman and Joskow 2008; Peeters 2006), and will likely be required in other GHG programs (Stavins 2008). U.S. states have also created "climate registries" of self-reported emissions where issues of third party verification have arisen, and such registries could easily play a role in a future federal cap and trade program (Rabe 2004, 100; Rich 2008). Similar reporting issues confront tracking offset credits for emissions reductions "outside the cap" (e.g., Trexler et al. 2006; Woodward and Kaiser 2002).

Given that verification of any reporting system is costly, the question becomes what degree of inspection and verification is required to ensure *sufficient* compliance. While inspecting and verifying every tax return, for example, would increase honest reporting and tax revenue, governments obtain reasonably high compliance with tax laws at lower cost through more limited forms of auditing (Rothstein 2000). Current emissions trading programs vary widely in this regard. All EU ETS emissions reports are subject to required third party verification before being submitted to the government (Pew 2005). CEMS data, as noted above, require more infrequent outside inspections to confirm the proper functioning of the equipment (EPA 2009b). One could imagine other forms of verification of emissions reports, including spot inspections or selected audits of self-reported emissions based on fuel consumption or other non-CEMS data (see generally, Ellerman and Joskow 2008).

In light of the growing importance of self-reporting for compliance, researchers have begun to explore which factors generate more honest reporting under imperfect enforcement (e.g., Murphy and Stranlund 2007; Cason and Gangadharan 2006; Stranlund et al. 2005; Stranlund et al. 2002). These studies have concentrated on economic incentives, including variations in enforcement regimes, marginal abatement costs, and permit banking opportunities. Yet empirical evidence based on field and laboratory data has shown that individuals often comply with laws where economic incentives favor noncompliance. For example, the expected value of falsifying a tax return predicts greater noncompliance than observed in countries such as the United States or Sweden (Rothstein 2000; Scholz and Lubell 1998). Results from laboratory experiments reveal similar "over-compliance" of this nature in tax reporting (Torgler 2002; Alm and McKee 1998). In light of these findings, it is important to investigate the role of non-economic factors in shaping honest reporting in emissions trading programs.

Non-economic factors have gained prominence as explanations of human behavior in recent work by economists, sociologists, and political scientists. Political science in particular has recognized the importance of moral judgments and norms as explanatory factors for collective action and political choice (e.g., Ostrom 1998). Work in behavioral economics has recently drawn similar conclusions about the influence of morals and honesty on economic choices (e.g., Gneezy 2005; Charness and Dufwenberg 2006). While economic incentives are important, it is evident that individuals frequently organize to provide collective goods despite free-riding problems and often behave in a manner inconsistent with basic economic incentives (e.g., Sen 1977). This line of research has increased awareness of the importance of institutional design—shaping decision-making rules in order to make the best use of these non-economic incentives in providing public goods (March and Olsen 1984; Ostrom 2007).

In the realm of compliance and policy implementation, non-economic factors have gained prominence under the idea of "affirmative motivations" for compliance. Affirmative motivations stem from personal sense of a law's fairness and legitimacy (Tyler 2006). Thus May (2004) has found that a contractor's belief that building code standards are "legitimate" is an important predictor of compliance beyond the financial risk of being cited for a violation, while Torgler (2003) has found that "tax morale" (public support for government and the taxation system) is an important predictor of tax compliance beyond the threat of penalties for under-reporting. In another study, Winter and May (2001) found affirmative motivations to be at least as influential as the threat of fines in predicting farmers' compliance with environmental regulations. These examples are consistent with a larger body of work documenting how perceptions of "fairness" drive public compliance with policies ranging from military conscription (Levi 1997) to the conservation of natural resources (Lubell 2004; Libecap 1989).

Applying this research to emissions trading, our core hypothesis (H1) is that *subjects will report emissions more honestly calculations of economic self-interest would dictate, due to affirmative motivations*. Building on the larger literature discussed above, as well as recent work showing that honest reporting decreases for individuals who believe they were treated unfairly (Houser et al. 2001), we theorize that beliefs about the *fairness* of the initial allocation will be an important determinant of affirmative motivations to comply. Thus, we also hypothesize (H2) that *subjects perceiving the program rules as more fair, especially with respect to their personal allocations, will be more likely to report honestly.*

The perceived fairness of the initial allowance allocation is vital to a cap-and-trade policy's political acceptability (Ellerman et al. 2007; Raymond 2003), yet research on attitudes toward allocation remains limited. Governments continue to experiment with a growing range of

allocation mechanisms, including distributions based on previous levels of resource use (grandfathering), equal per capita shares, and auctions. Although policy analysts have assessed the efficiency of different allocation methods, including multiple forms of auction design (e.g., Porter et al. 2009; Burtraw et al. 2009), there has been little research on the perceived legitimacy of different allocation rules. Previous work in other distributive contexts suggests a tendency to view egalitarian distributions as more fair than inequalities based on morally arbitrary criteria (e.g., Raymond 2008; Yamamori et al. 2008; Miller 1992). Thus, we hypothesize (H3) that *subjects in treatments with equal allocations will report more honestly due to greater affirmative motivations*.

Finally, we expect that different treatment frames will be an important determinant of subjects' affirmative motivations and compliance. Framing is known to have an important effect on public attitudes (Chong and Druckman 2007; Clawson and Waltenburg 2003), but has not (to our knowledge) been applied to the issue of compliance or affirmative motivations. To test the influence of framing on affirmative motivations, we gave half our subjects instructions describing the items being traded as emissions permits for pollution they were emitting as power plant operators. This framed treatment differs from the unframed approach we provided in other treatments, using neutral terminology to avoid activating value judgments. (See Appendix for full instructions for both framed and unframed treatments). We expected that framed treatments would trigger norms of honesty and fairness more strongly than unframed treatments, which were described more like a game of chance in which dishonesty is simply a calculated risk without ethical implications (not unlike bluffing in poker). Thus, our final hypothesis (H4) is that *subjects will report more honestly in environmentally-framed treatments due to stronger affirmative motivations*, because they will be more reluctant to misrepresent pollution levels than

a simple “number” with no morally-loaded content.

METHODS

The centerpiece of this experiment was a computerized laboratory emissions trading market constructed following standard methods 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 subjects’ cash earnings, thereby creating a real market—albeit one that is stylized and controlled (Smith 1982). In our experiment, permit trading continued for 2-minute periods through the continuous double auction institution, which is widely used in laboratory markets and is similar to standard rules governing securities trading. Subjects submitted public buy and sell price offers and trades occurred when a subject clicked a button to accept another subject’s offer. These offers and acceptances could occur through the computer network at any time during a trading period. Also following standard methods, subjects traded using “experimental dollars” that were converted via a fixed, pre-announced exchange rate into actual U.S. dollars paid to subjects at the end of the experiment.

All treatments consisted of 11 periods of trading, with each trading period followed by a decision on pollution abatement and then emissions reporting. Thus, there were eleven opportunities to report honestly or dishonestly in each experiment for each subject. Subjects’ initial allocation of permits remained constant across all eleven periods. Marginal abatement costs rose with the level of abatement and varied across subjects to create gains from trade between subjects with lower and higher marginal abatement costs, consistent with basic

emissions trading theory. At the benchmark of full compliance, prices in the competitive equilibrium range of 208-212 experimental dollars cleared the market.

Prior to the permit market opening, subjects reviewed their initial allocation of permits, their budget of experimental dollars, and their maximum, unabated pollution level (see Figure 1). This gave subjects a sense of the initial "compliance gap" they would need to close by some combination of purchasing permits and reducing emissions in order to be in full compliance. Subjects then bought and sold permits on the market, according to whatever strategy they planned for compliance or non-compliance. After the permit market closed and subjects finalized their permit holdings for the period, each then chose a level of costly pollution abatement. To be in compliance, subjects had to reduce their emissions to a level equal to the number of permits they held. As noted above, emissions reductions were increasingly costly for each additional unit of pollution avoided.

**** Insert Figure 1 about here ****

Finally, subjects reported their level of pollution (after abatement) to the regulator. Subjects who held fewer permits than their self-reported emissions automatically paid a fine of 400 experimental dollars per unit of pollution reported over their permit quota (approximately double the average cost of a permit on the market). If subjects did not report their emissions above their permit holdings *and were not inspected*, they paid no fine. If subjects under-reported emissions and were inspected, however, they were fined 400 experimental dollars for every unreported unit of pollution over their permit quota. Because this fine for noncompliance was the same whether subjects reported honestly or not, virtually every subject who chose not to reduce

emissions to their number of permits held also chose to underreport their emissions.[1] Thus, we will sometimes speak of noncompliance as synonymous with "underreporting of emissions," because this is the primary type of noncompliance feared in self-reporting systems, and the only plausible form of noncompliance in this experimental design.

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 on his or her computer, indicating the inspection had occurred and the amount of the fine, if any under-reporting of emissions 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 reduce emissions. In the neutral frame, subjects traded "coupons" and had to choose a "number" (this corresponded to the level of emissions after abatement) that they reported to an "inspector." The instructions and computer screens for the neutral context removed all references to pollution, the environment, or any mention of emissions trading. Instructions in both frames provided only factual information about the possible consequences of reporting choices, avoiding morally-loaded terms such as "lying," "punishment," or even "dishonesty." The framed context with unequal endowments included a brief explanation that some participants received larger allocations based on their higher pollution control costs (similar to actual emissions trading

[1] Of more than 3,600 reports across all treatments and experiments, only 32 were honest reports of emissions at a level higher than permits held. This represents less than 1% of all reports.

policies relying on "grandfathering" as an allocation rule), while others received smaller allocations because they represented "cleaner" facilities. In the neutral context, unequal allocations were presented to subjects without additional explanation.

We conducted 5-6 sessions of 8 subjects each in every treatment cell, employing a total of 328 subjects (Table 1). 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 as a policy. We also measured subjects' risk preferences using a simple lottery choice problem prior to the trading exercise (Holt and Laury 2002).

**** Insert Table 1 about here ****

Subjects were recruited from the general student population at a large public university. No subject participated in more than one session. Although all subjects were students, they otherwise reflected a diverse socio-demographic mix. 61 percent 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 broad pool of student participants (rather than a cohort of freshmen, say, from a 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 other experimental 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 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, and total earnings averaged US$29 per subject.

RESULTS

Figure 2 presents the average of the median transaction price across sessions within the high and low monitoring treatments, separately for each of the eleven periods. The average price was 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. Permit prices were lower, and fell over time, in the low monitoring treatment. This is consistent with the higher noncompliance rate (which should drive permit demand and prices downward) for the low monitoring treatment. These economic results confirm that subjects understood the experiment's incentive structures and that the permit market was operating in an economically rational manner, confirming the experiment's internal validity.

**** Insert Figure 2 about here ****

Table 2 indicates that most subjects reported emissions honestly even when realized median permit prices far exceeded the expected value of the fine for dishonest reporting—making compliance economically irrational for those who were risk neutral or in many cases even for those who were risk averse.[2] Overall, less than 20 percent of all emissions went unreported, a figure well below the economically rational level of false reporting. By contrast, subjects honestly reported nearly 75 percent of all emissions even in the low monitoring treatment, where compliance costs far exceeded the expected penalty for non-compliance. 98 percent of the median transaction prices in the low monitoring treatment exceeded the expected cost of non-reporting (100 experimental dollars), and most permit prices exceeded 150 experimental dollars. Nevertheless, most subjects reported honestly even when this form of compliance was economically irrational for all but the most risk averse.

**** Insert Table 2 about here ****

This behavior cannot be attributed to confusion, given that 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 2 shows that subjects' were sensitive to differences in monitoring risks, as compliance was better in the high monitoring condition. Another indication of task understanding is that subjects who were classified as more risk-averse in the preliminary lottery choice problem consistently cheated less (as discussed in Table 3 below). Thus, something beyond negative motivations influenced subjects who complied

[2] Because traders can buy and sell permits at the market price regardless of their abatement costs, in emissions trading the permit price is the marginal compliance (opportunity) cost measure for all sources, making it the appropriate benchmark for economically "rational" decision-making about compliance (Murphy and Stranlund, 2007).

more than was economically rational. This economically "irrational" compliance by many subjects is consistent with behavior driven by affirmative motivations for compliance, per our primary hypothesis H1.

Table 3 reports a series of cross-sectional multivariate tobit regression models testing the effect of specific treatment conditions and subject attitudes and characteristics on compliance. 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 ("neutral") treatments. The dependent variable is the total amount of misreported emissions for each subject across all 11 reporting periods.[3] This variable ranges from 0 to 220, as the maximum amount of noncompliance was 20 units of unreported pollution for each of 11 periods.

The regression models are consistent with several findings already discussed. Row 2 shows that high monitoring had a significant and large effect on reducing misreporting. Row 3 indicates that subjects with larger initial permit allocations also underreported less frequently. Because these subjects had more allowances at the beginning of each round, they often had excess allowances to sell or fewer allowances to purchase while still maintaining compliance.

****Insert Table 3 about here ****

Rows 5-7 of Table 3 represent variables designed to measure the effect of affirmative motivations on reporting behavior. Rows 6 and 7 are the simplest tests of these motivations: we

[3] In terms of measuring compliance, the total misreporting variable is the most appropriate because it captures the full amount of surplus emissions in a given session and treatment, which is the factor most relevant to preserving the environmental integrity of the emissions cap. We also ran models using the number of periods a subject was noncompliant as the dependent variable, as well as a series of panel regressions that considered individual compliance decisions for each period. These alternative specifications provided similar results, so we do not report them here.

asked subjects after the experiment to indicate what motivations best described their reasons for accurately reporting or misrepresenting their emissions. 64 subjects selected the choice "personal belief that misreporting in not appropriate behavior in this context," suggesting affirmative motivations were most important to their honest reporting. These subjects were significantly less likely report dishonestly, as indicated in row 6. Similarly, 24 subjects indicated that "personal belief that misreporting is justifiable in this context" was the motive that best described their reason for misreporting, and those subjects tended to underreport their emissions by a significantly greater margin as indicated by row 7. These tests provide initial support for the role of affirmative motivations in generating higher than expected levels of honest reporting, as per H1.

Although the post-hoc, self-identification of affirmative motivations as most important in shaping reporting choices is a first step, there is a risk of subjects "rationalizing" their compliance behavior after the fact. In addition, the questions required subjects to choose affirmative or negative motivations as "most important," when in fact such motivations can reinforce one another. Thus, we created another measure of affirmative motivations that addresses both these concerns.

Before the trading and compliance exercise, we asked subjects to rate the importance of different personal motivations for obeying laws in general, including the option: "personal belief that this particular law is fair or just." Subjects who rated this motivation as important or extremely important (on a 5-point Likert scale) were considered to weigh affirmative motivations for compliance strongly. More than two-thirds of our subjects rated this affirmative motivation as important for obeying laws. If H2 is correct, subjects expressing these more general affirmative

motivations to comply based on fairness *who also judged the experimental rules as fair* should be more likely to comply by reporting honestly.

To test this, we interacted a dummy variable for individuals who indicated the importance of this affirmative motivation with a question asking subjects to evaluate the fairness of their own allocations in the experiment. Row 5 of Table 3 shows the results, which support the importance of judgments of fairness. Individuals who based their compliance decisions on perceptions of a law's fairness, and who judged their own allocation as fair, were significantly more likely to report honestly, an effect that was strongest in the framed treatments.[4]

We tested our third hypothesis—that subjects would find equal allocations fairer, and therefore report more honestly in such treatments—in two ways. First, Row 4 of Table 3 indicates that subjects receiving equal allocations had significantly greater compliance, although this effect is not statistically significant in the neutral frame. This is consistent with the pattern of noncompliance in Table 2, where the percentage of unreported emissions was lower for equal endowment treatments in the environmental frame only.

Of course, the effect of the initial allocation on compliance could be due to other factors besides affirmative motivations, including the relatively larger or smaller initial "compliance gap" faced by subjects with different initial endowments. We can better connect the effect of equal endowments on compliance to subject perceptions of fairness, however, in two ways. First, 68% of those receiving an equal allocation rated it as "fair" compared to 57% of those receiving a higher allocation, and 45% of those receiving a lower allocation in an unequal endowments treatment—differences that are statistically significant ($p < 0.01$). Thus, subjects' evaluations of their own allocations are consistent with this egalitarian norm—even subjects who *benefited*

[4] We also tested the role of judgments of an allocation's fairness even without the interaction with the reported importance of following fair or just laws. These alternative coefficient estimates were similar in size to those shown in Table 3, and were also significant in predicting more honest reporting for the framed treatments and in aggregate.

from a larger allocation justified by "higher historic emissions levels" were less likely to rate their allocations as fair.

In addition, subjects in the framed treatments also rated several common allocation rules on a 5-point scale from "very unfair" to "very fair." Table 4 shows that significantly ($p < 0.01$) more subjects considered an equal per capita allocation (defined as "giving permits to existing polluters free of charge in proportion to the number of citizens they serve") as the fairest option compared to "grandfathering" permits based on prior use (the explanation given in the unequal treatments condition), as well as auctioning permits. While the idea of equal per capita allocation is not the same as giving an equal number of allowances to each power plant, it is a more egalitarian option than grandfathering rules favoring dirtier facilities. Thus, there is reason to think that the effect of the equal distribution of allowances on compliance is driven at least partially by these judgments of the greater fairness of more egalitarian distributions in general.

**** Insert Table 4 about here ****

Our findings in terms of affirmative motivations from the environmental framing of the experiment are more complicated. Consistent with our expectation that the neutral frame would inspire weaker affirmative motivations and thus lower compliance, row 5 of Table 3 indicates that affirmative motivations related to judgments of the initial allocation's fairness were not significant in the "morally arbitrary" neutral frame. In addition, row 7 of Table 3 shows that subjects attributing noncompliance to "personal beliefs" cheated at significantly higher levels in the neutral context only, while row 6 indicates that subjects who identified personal beliefs as an important motivation for compliance reported significantly more honestly in the framed context,

but not the neutral context, where the rules were designed to appear more arbitrary and game-like. These relationships are consistent with our hypothesis (H4) that subjects would find false reporting more personally acceptable behavior in the neutral context.

On the other hand, Table 2 shows that compliance was better across all treatments in the neutral, unframed context, contrary to H4. Nor was this a trivial effect: Row 1 of Table 3 confirms that framing had a large impact on non-compliance. This finding contradicts our expectation that affirmative motivations to comply would be stronger when framed as related to environmental protection, rather than a neutral context resembling a game of chance. Differences in task understanding cannot explain this difference: Subjects scored better on the comprehension quiz in the neutral context (79% correct) than in the framed context (76% correct). Nor does a general lack of support for emissions trading: Although our subjects were largely opposed to the idea of emissions trading (only 16% "supportive"), those attitudes were not significantly associated with reporting behavior.[5]

It is possible that because our environmental frame described subjects as managers of a power plant, this context could have triggered a stronger motivation to maximize profits rather than protect the environment. Along these lines, it would be interesting to see if alternative instructions that stressed the reduced compliance costs for polluters from emissions trading weakened this framing effect.[6] Alternatively, "pollution framing" could have created greater reluctance among subjects to admit higher levels of "emissions" rather than simply a higher "number" as in the neutral frame. Other explanations are possible as well, but impossible to

[5] Unlike the evaluations of the fairness of one's allocation, these judgments about emissions trading in general did not affect compliance behavior as a standalone variable, nor when interacted with the dummy for subjects expressing the importance of affirmative motivations for compliance based on personal judgments that a law is fair or just. Details of these unreported regression models are available upon request.

[6] We are grateful to an anonymous reviewer for this suggestion.

verify without further research (for more discussion of possible explanations for this surprising framing effect, see Cason and Raymond 2011).

The powerful influence of framing, however, is consistent with our primary hypothesis that affirmative motivations can influence compliance decisions. Although the directionality of these motivations is surprising in terms of this framing effect, the degree of influence of these alternatives to "negative motivations" from economic factors is both undeniable and substantial.

CONCLUSION

This study strongly suggests that affirmative motivations substantially affect compliance behavior in the new and important policy context of emissions trading. Much of the compliance behavior in our experiment cannot be explained by negative motivations or economic incentives. Most subjects honestly reported emissions when the expected value of such reporting was negative, despite the significant impact on their cash earnings. Confusion is an unlikely explanation for this behavior given that subjects passed 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.

Self-reported measures of affirmative motivations, especially those related to judgments of allocation fairness, were significantly associated with greater compliance through honest reporting. It is worth highlighting the greater perceived fairness of more egalitarian allocations versus "grandfathering" based on prior emissions in this regard. The results of this study indicate that *even affected emitters* may rate grandfathered allocations as less fair than other options, and that those perceptions appear to affect overall compliance. Finally, the surprising but powerful effect of environmental framing is also consistent with the need for greater attention to non-

economic motivations on compliance. Taken together, these results indicate that affirmative motivations, especially related to the perceived fairness of initial allocations, could play an important role in future emissions trading policies.

External validity is always a concern for experimental laboratory research, and environmental compliance officers for regulated firms face a different set of professional incentives than subjects in our experiment. In particular, a skeptic might argue that the larger financial rewards for false reporting in the field would overwhelm affirmative motivations such as those documented in the laboratory. This is an important critique that should be addressed in future research, such as by recruiting experimental subjects from the general population, or from managers in energy and manufacturing industries. As new cap-and-trade programs come on-line, one could also survey and interview a sample of environmental managers on their relevant beliefs, and then compare those data with public inspection results of reporting compliance.

Nevertheless, there is a reasonable argument that our experiment represents a more challenging set of conditions for demonstrating the influence of affirmative motivations than the real world. Although the financial stakes were smaller, they were substantial relative for the subject population (some of whom profited more than US$75 over the 2 hour experiment, which represents a high hourly income for most students). More importantly, the experiment tested the influence of “real” negative motivations in terms of monetary gains against “imaginary” affirmative motivations grounded in imaginary environmental or political outcomes. In other words, subjects in the framed experiments understood that underreporting their “emissions” would have no real environmental impact, and that the rules about allocation were only stylized representations of actual policy situations. Thus, one might expect affirmative motivations to be weaker in this setting than in practice, where compliance decisions are driven by actual policy

processes and have important environmental effects. (Future experiments could include realistic environmental consequences based on subject decisions to under-report, through the purchase of a variable number of carbon offsets, for example, based on total *actual* emissions for all subjects in the experiment or some other mechanism). The fact that many subjects still reported honestly at some cost to their profits even in this "artificial" experimental context suggests how influential affirmative motivations to comply may be in the field.

We conclude with a few thoughts about the theoretical and policy design implications of our findings. First, our results provide additional and original evidence that affirmative motivations play an important role in policy compliance. Although negative motivations will almost always influence emissions reporting behavior, affirmative motivations are also relevant. Therefore, we suggest that experimental or other field research on the design and implementation of emissions trading programs should better attend to the role of affirmative motivations in shaping and encouraging compliance under imperfect enforcement. In particular, understanding how perceptions of the initial allocation affect compliance deserves more attention. In addition, these results are timely for those designing new emissions trading programs that will likely rely on self-reporting. Some have expressed concern about fraud and dishonest reporting in future GHG cap and trade systems. The results reported here can help identify ways of encouraging greater compliance with lower enforcement costs, through enhancing affirmative motivations.

In sum, these findings suggest important new 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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Figure 1: Subject Emissions Reporting Process in Each Period

Step 1: **Compare initial permit endowment with maximum (unabated) pollution level**.

Step 2: **Buy or sell emissions permits from other subjects** (2 minute period)

Step 3: **Decide how much to invest in limiting emissions that period**

Step 4: **Report emissions to regulator**.
If reported emissions are greater than permits held, pay fine of $400 per unit of emissions lacking a permit. If reported emissions are lower than actual emissions and subject is inspected, pay fine of $400 per unreported unit of emissions lacking a permit.

Example:

Step 1: Subject starts period with 8 permits and a facility that emits 20 units of pollution. Subject is short 12 permits and will either have to reduce emissions or buy permits to be in compliance.

Step 2: Based on the permit market, subject decides to buy 5 more permits from other subjects during the transaction period, giving him 13 total permits.

Steps 3 & 4: Subject now holds 13 permits and must reduce emissions from 20 to 13 units in order to be in compliance. Subject has three options:

(1) **Full compliance**: Reduce emissions by the remaining seven units and report 13 units of pollution honestly.

(2) **Non-compliance with honest reporting**: Reduce emissions by less than 7 units, and report honestly. *Subject will be fined $400 for each unit of emissions reported above 13*. (As noted in text, this option was almost never taken in experiment).

(3) **Non-compliance with dishonest reporting**: Reduce emissions by less than 7 units, but dishonestly report 13 units of emissions. *Subject has 25% or 50% chance of being inspected and then being fined $400 for each unit of emissions above 13 that was not reported*.

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

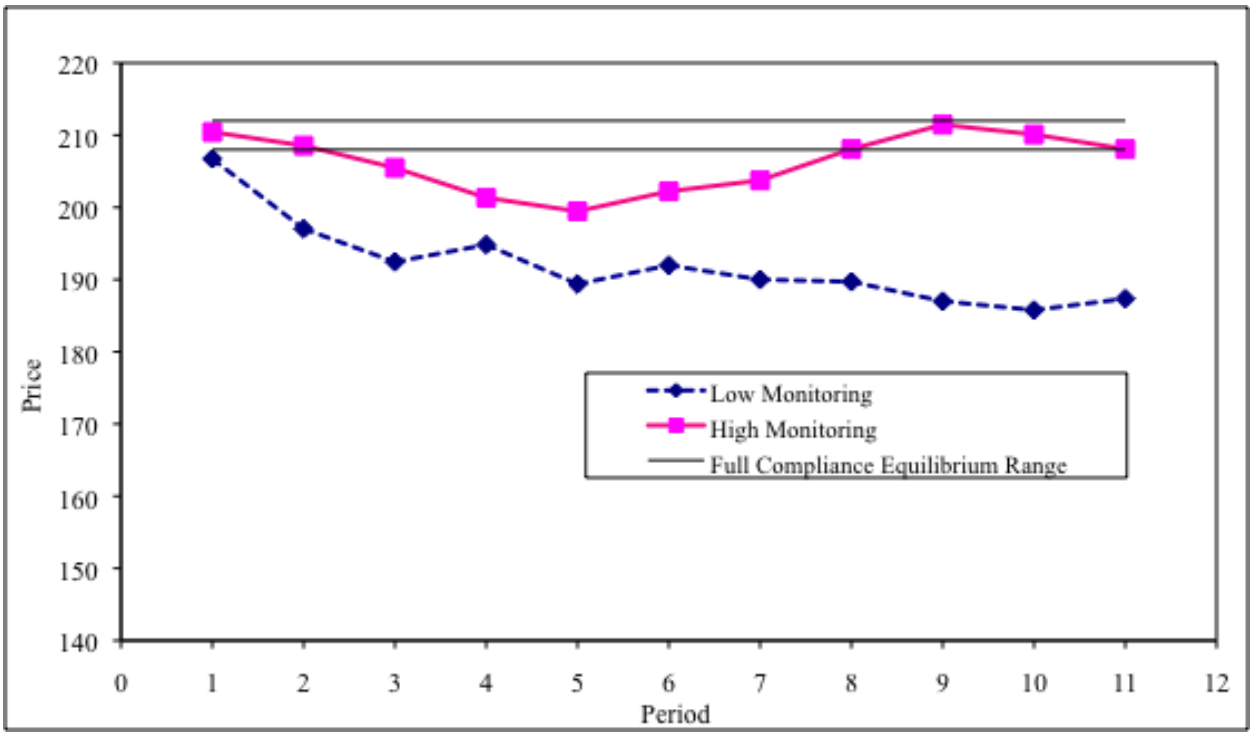

Table 1: Number of subjects in each treatment condition

	Neutral Frame		Environmental Frame		
	Unequal Endowments	Equal Endowments	Unequal Endowments	Equal Endowments	Total
Low Monitoring	40	40	40	40	160
High Monitoring	40	40	48	40	168
Total	80	80	88	80	328

Table 2: Percentage of total emissions not reported, by treatment conditions

	Neutral Frame		Environmental Frame		
	Unequal Endowments	Equal Endowments	Unequal Endowments	Equal Endowments	Total
Low Monitoring	16.1	23.1	30.3	29.4	25.2
High Monitoring	6.7	5.3	20.8	17.1	13.4
Total	11.6	15.1	25.5	23.8	19.6

*Expressed as percentage of all emissions for each treatment condition or group of conditions.

Table 3: Tobit Models of Noncompliance
Dependent variable = Number of underreported emissions by subject

	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	27.07**		
	context	(0.50)	(5.50)		
2	Indicator=1 if monitoring	0.51	-24.39**	-31.38**	-20.32**
	intensity is high	(0.50)	(5.28)	(8.75)	(6.62)
3	Indicator=1 if subject has a	0.26	-36.47**	-38.28**	-37.94**
	high permit endowment	(0.44)	(8.56)	(13.80)	(10.94)
4	Indicator=1 if subject has a	0.48	-14.14*	-10.45	-18.01*
	equal permit endowment	(0.50)	(7.10)	(9.35)	(8.45)
	Measures of Affirmative Motivations				
5	Indicator=1 if subject viewed own permit endowment as	0.42	-14.39**	-4.31	-22.53**
	fair and believes in importance of following fair or just laws	(0.49)	(4.49)	(5.85)	(6.44)
6	Indicator=1 if subject indicated personal beliefs as main	0.20	-20.41**	-17.72	-20.75*
	motivation for accurately reporting emissions	(0.40)	(7.63)	(11.00)	(9.63)
7	Indicator=1 if subject indicated personal beliefs as main	0.07	33.90**	55.08**	12.73
	motivation for misrepresenting emissions in reporting	(0.26)	(9.46)	(11.17)	(10.64)
	Demographic and Risk Preference Controls				
8	Indicator=1 if subject is considers him/herself	0.39	7.53	-0.73	10.76
	an "environmentalist"	(0.49)	(5.52)	(7.16)	(7.83)
9	Indicator=1 if	0.61	8.71	16.44*	3.64
	subject is male	(0.49)	(5.44)	(8.14)	(7.31)
10	Indicator=1 if subject has	0.79	-22.78**	-31.92**	-21.31**
	lived in US for more than 5 years	(0.41)	(6.11)	(9.09)	(7.38)
11	Indicator=1 if subject's lottery choices	0.48	-15.43**	-14.38*	-17.71**
	indicate very risk averse preferences	(0.50)	(4.68)	(6.51)	(6.03)
	Intercept		46.86**	49.68**	80.68**
			(8.84)	(14.45)	(10.13)
	Number of Observations		327	159	168
	Observations censored at 0		119	77	42
	Log pseudolikelihood		-1148.35	-452.03	-688.22
	Robust standard errors shown in parentheses, which are adjusted for clustering at the session level. * and **				
	indicate estimates that are significantly different from zero a the 5 and 1-percent levels (all two-tailed tests).				

Table 4: 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)