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Framing Effects in an Emissions Trading Experiment with Voluntary Compliance*

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Abstract

This paper reports a laboratory emissions trading experiment with imperfect enforcement that introduces environmental framing as a treatment variable. Subjects self-reported their "emissions" at the end of each trading period, and were inspected probabilistically and fined when they underreported. Market prices did not vary across framing treatments, but compliance was lower in the low enforcement treatments as expected. Transaction volume and compliance rates were significantly lower in the environmentally-framed condition, compared to the more standard neutrally-framed control. The latter result suggests that environmental framing reduced subjects' incentives to honestly report "pollution" to the experimental "regulator."

Keywords: emissions trading; compliance; laboratory experiment; framing effects

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1. INTRODUCTION

Emissions trading is an important part of the broad set of strategies regulators employ to address pollution problems ranging from climate change to local air and water quality protection. Experimental research on emissions trading has had a long history, one that actually precedes implementation of the first large scale trading schemes in the field such as the SO_2 trading system in the U.S. and the Greenhouse Gas emissions trading system in Europe (see Muller and Mestleman (1998) and Cason (2010) for surveys, and Holt and Isaac (1999) and Cherry et al. (2008) for collections of contributions). Experimental research is useful to inform policy design because alternative design details can be "testbedded" at low cost to identify the most promising approaches, and the experiments can also highlight to regulators how the markets may operate differently depending on what rules are implemented.

Most laboratory experiments studying emissions trading present the decision environment to subjects using a neutral, non-environmental context, although a few exceptions exist (e.g. Bohm and Carlén 1999). The conventional use of neutral, abstract frames in economics experiments distinguishes the methodology from psychology experiments, which more often employ natural and meaningful contexts. Economists frequently justify the experimental design choice of a neutral frame as a way to improve experimental control. The researcher does not observe the environmental policy attitudes of subjects, and these attitudes might influence behavior in the experiment if an environmental frame is used. Moreover, since economists' research hypotheses typically do not rely on the market having a particular environmental interpretation, the environmental frame is not necessary and has the potential to increase noise due to unobserved subject heterogeneity. Framing effects can matter, however, in behavioral economics models such as those that include reference dependence (e.g., Köszegi and

Rabin, 2006), as well as in models that can incorporate the influence of context (e.g., Jehiel, 2005). This contrasts with standard neoclassical models that do not generate interesting hypotheses regarding framing effects, since the underlying market incentives typically do not depend on the labels applied to the items being traded or quantities reported.

To evaluate whether environmental framing influences behavior on pollution control and reporting in an experimental context, this paper reports a laboratory experiment that manipulates environmental framing as a treatment variable, in the context of an emissions trading system with voluntary reporting of emissions and imperfect enforcement. Enforcement policies are likely to grow in importance as emissions trading programs spread to emissions that are more difficult to measure directly. Some early emissions trading programs, most prominently the 1990 U.S. acid rain program to reduce SO_2 emissions, have achieved very high levels of compliance (EPA, 2009), in part because they have controlled a relatively small number of sources and required 24-hour continuous emissions monitoring. Other emissions trading programs, including early stages of the EU ETS, have adopted a higher level of self-reporting common in other regulatory reporting systems, including for corporate and individual income tax. In the experiment imperfect enforcement is modeled as random inspections to determine whether pollution reports were accurate, with monetary fines imposed for under-reporting. This is similar to existing research on compliance with self-reported emissions and imperfect enforcement (e.g. Murphy and Stranlund 2007; Cason and Gangadharan 2006; Stranlund et al. 2005; Stranlund et al. 2002).

If subjects have some concern for environmental protection, non-neutral framing that describes the item being traded as an emissions permit and requires subjects to report a pollution of greenhouse gas emissions at the end of each period could influence compliance behavior in

several ways. Our initial conjecture was that compliance would be greater in the environmentally framed treatment compared to the standard neutral frame treatment in which subjects traded "coupons" and reported a "number," because subjects would be more reluctant to misrepresent "pollution levels" than a simple "number" with little to no moral content.

An alternative conjecture (suggested by an insightful referee) is that the environmental frame would discourage honest reporting of "pollution" due to the negative connotation of being a (larger) polluter. Because honest compliance in the framed context requires subjects to report higher levels of "pollution," instead of a higher "number," according to this conjecture the environmental frame would actually reduce compliance. This conjecture is consistent with the recent work of Pevnitskaya and Ryvkin (2010), who find that environmental framing in a two-player dynamic public goods game is associated with lower pollution levels and higher payoffs compared to a neutral context treatment.

Our experiment provides support for a similar framing effect, with subjects exhibiting substantially *lower* compliance in the environmentally framed treatment, by reporting lower than actual levels of pollution. (Notice though that in our experiment subjects in the framed treatments are actually emitting higher levels of pollution, but not admitting to the fact—an important contrast with the Pevnitskaya and Ryvkin results). This result persists even when controlling for factors such as subjects' self-reported attitudes toward the environment and climate change, motivations for compliance with rules, as well as demographic controls. Subjects in the experiment do not learn others' pollution or compliance decisions, indicating that if shame were the driving factor in the framing effect, our participants sought to hide pollution levels from the experimenter rather than from their peers. Alternatively, this result is also consistent with a framing effect driven by the suggestion that subjects imagine themselves as managers of a power

plant, priming them to think more about profit-maximization and less about environmental impacts.

While this study is the first emissions trading experiment to consider environmental framing as a treatment variable, the focus on regulatory compliance is similar to previous laboratory research examining tax reporting compliance. Like the experimental literature on emissions trading, most of that research has also employed a neutral frame. Alm (1999) recommends neutral framing for such compliance experiments, noting that neutral terms obscure the experiment's context and purpose, thereby increasing experimental control by not inducing subjects to invoke mental scripts. This view is not universally shared, of course. Other researchers, particularly advocates of field experiments, argue that neutral framing can reduce control since subjects might develop their own context for use in 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 in other contexts is limited and has produced mixed results. Barr and Serra (2009) 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, framing does not affect the level of honest reporting by student subjects (Alm et al. 1992; Wartick et al. 1999). Cooper and Kagel (2009) find that a natural economic context promotes cross-game learning in a signaling game studying limit pricing and entry deterrence.

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 (Cooper et al. 1999; Alatas et al. 2009). Consequently, this previous research documents that non-neutral context

influences experts' behavior more than student subjects' behavior. This leads to the natural conjecture that environmental framing could influence experts more than it influences student subjects, and if so the framing effects we observe in our student subject pool might actually underestimate the influence of framing for experts such as firms' environmental managers.

2. EXPERIMENTAL DESIGN

In this computerized laboratory emissions trading market subjects traded permits that allowed them to avoid incurring costs of emissions abatement. Subjects traded permits for 11 periods of stationary repetition, although the exact number of periods was not announced. Trading occurred through the continuous double auction institution. In this trading institution, which is widely used in market experiments to approximate relatively competitive conditions with a small number of traders, traders submit public buy and sell price offers and trades occur when a counterparty accepts another trader's offer. These offers and acceptances can occur at any time during the 2-minute trading period.

Initial Permit Allocations	→	Permit Market Conducted	→	Choose Abatement Levels	→	Report Pollution to Regulator	→	Inspections and Possible Fines

The timeline above summarizes the steps that occurred in each of the 11 periods. Subjects received an exogenous initial allocation of permits at the start of every period, and this endowment remained unchanged across periods. In the environmentally framed treatment each subject was instructed to consider him or herself as the manager of an electricity power plant, whose power production was fixed at a particular level. If the subject left pollution uncontrolled, the plant would emit 20 "tons" of pollution. Each subject could incur costs to abate this pollution, and marginal abatement costs increased for higher abatement levels. These marginal

costs varied across subjects so that gains from trade existed from reallocating pollution control responsibility through tradable emission permits.

Figure 1 shows the individual marginal abatement cost schedules for the four types of permit traders: Types A and B, who had relatively high marginal abatement costs, and Types C and D, who had much lower marginal abatement costs. Two subjects were assigned to each type in each treatment. In equal endowment treatments, all traders were initially given 8 permits. A permit is required for every ton of pollution and 20 tons are emitted if pollution is uncontrolled, so to be in compliance this required traders to abate 12 tons of pollution (20 minus the 8 units legally emitted) if they did not engage in permit trading and merely retained their 8 initial permits.

Figure 1: Marginal Abatement Costs for Each Type of Trader

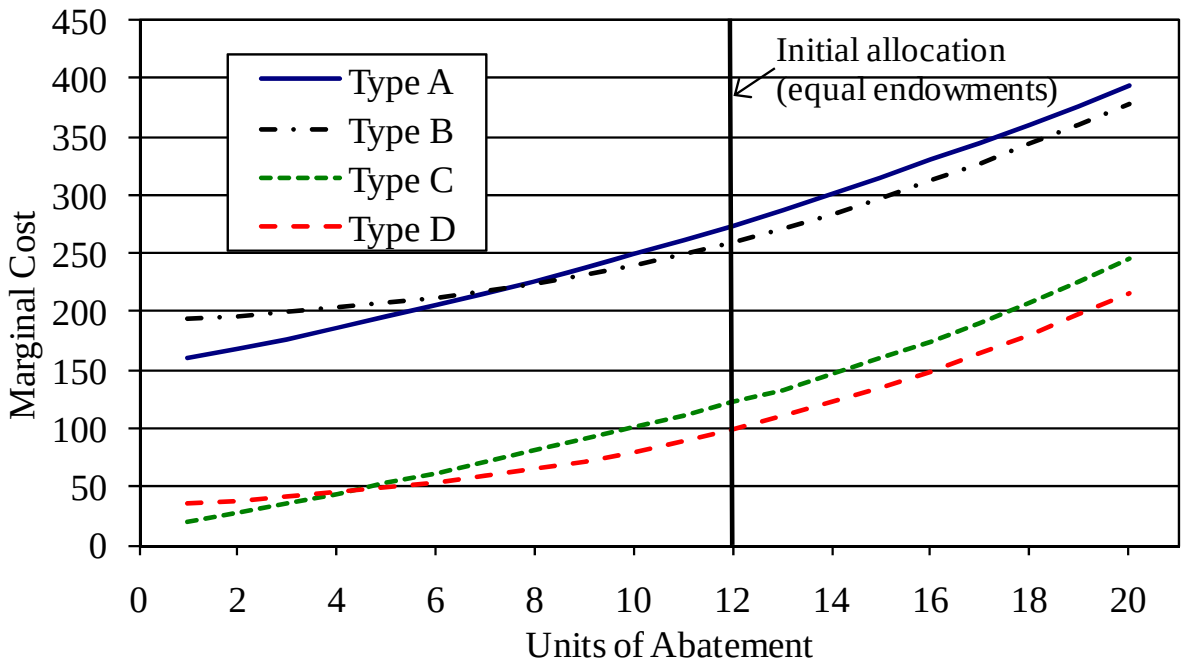


Figure 1 displays the required abatement at the initial allocation with a vertical line at 12 units of abatement. At this permit endowment level the high abatement cost traders have

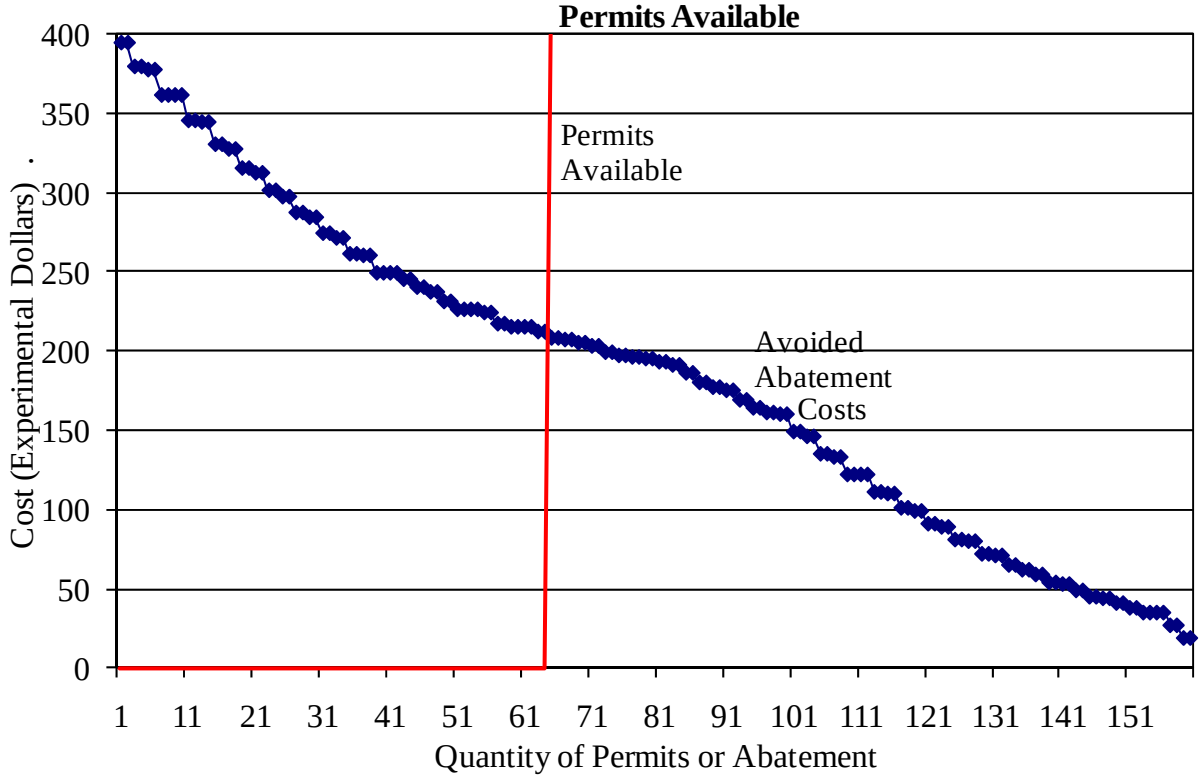
marginal abatement costs of 274 (for Type A) and 260 (for Type B). These costs are more than double those of the low abatement cost traders: 122 for Type C and 99 for Type D. This heterogeneity in abatement costs leads to gains from trade when subjects with high abatement costs buy permits from subjects with low abatement costs, moving the abatement responsibility to a subject who can reduce emissions more efficiently. In efficient competitive permit markets, aggregate emissions are reduced at their lowest total social cost, which requires traders to equalize the marginal abatement costs. To achieve this efficient outcome, each type A trader must buy 6 permits, each type B trader must buy 7 permits, and each type C and D trader must sell 6 and 7 permits, respectively. Thus, the total trade volume required to reach the efficient, competitive equilibrium in the permit market is 26 transactions.

Figure 2 displays the aggregate marginal abatement cost schedule pooled across subjects, along with the total allocation of 64 permits. At the benchmark of full compliance, prices in the range 208-212 experimental dollars should clear the market. Under-reported emissions cause total emissions to exceed the initial cap, effectively expanding the permit "supply" outward and exerting downward pressure on the market-clearing price.

In the unequal endowment treatment, each high abatement cost trader (Types A & B) received 11 permits and each low abatement cost trader (Types C & D) received 5 permits at the start of the trading period. These unequal endowments approximate the grandfathering policies that have been employed in some permit markets, where large emitters are initially allocated more permits than small emitters. The different endowment levels do not change the equilibrium prices, but they do change the net permit demand. In equilibrium each of the type A traders should buy 3 permits, each of the type B traders should buy 4 permits, and the type C and D traders should each sell 3 and 4 permits, respectively. Because the unequal endowments are

closer to the efficient distribution of permits, only 14 permit trades are required to reach the competitive equilibrium allocation.

Figure 2: Avoided Aggregate Marginal Abatement Costs and Total Permits Available



After the permit market closed for the period and subjects finalized their permit holdings, each subject chose a level of costly pollution abatement. This abatement action determined their pollution level for the period. Finally, subjects reported their level of pollution (after abatement) to the regulator. These reports did not need to be accurate, but if subjects under-reported their pollution they failed to comply and risked being fined. A random draw determined if subjects were "inspected" at the end of each period by an experimental "regulator," and if they were found to have under-reported 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.

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 (low) monitoring treatment, each subject had a 50 (25) percent chance of being inspected. The random inspection draws were independently and identically distributed. An inspection resulted in a private, computerized notification to the subject, indicating that an inspection had occurred and the amount of the fine if non-compliance was detected.

As noted above, in the environmental frame subjects 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, and must report their total pollution amounts to a "regulator." 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." The instructions and computer screens for the neutral context removed all references to pollution, the environment, or any other feature of emissions trading.[1] Details regarding the framing are highlighted in the experiment instructions appendix.

The experiment included 5 sessions (40 subjects total) in each of the 8 treatment cells shown in Table 1, and an extra session in one cell, employing a total of 328 subjects. Subjects were recruited online using a large database of Purdue University undergraduates. In addition to this emissions trading and reporting exercise, they also completed computerized pre- and post-

[1] 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.

trading surveys (including both open and closed-ended questions) to assess their beliefs about and stated motivations for complying with rules, their attitudes toward the environment and environmental regulations, and their perceptions of the fairness of their permit allocations and the legitimacy of emissions trading more generally. Responses to those survey questions are reported in a companion paper (Raymond and Cason, 2010) that focuses on comparing so-called "affirmative" and "negative" motivations for compliance.[2] 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).

Table 1: Number of subjects and sessions in each treatment condition

	Neutral Frame		Environmental Frame	
	Unequal Allocation	Equal Allocation	Unequal Allocation	Equal Allocation
Low Monitoring	40 subjects 5 sessions	40 subjects 5 sessions	40 subjects 5 sessions	40 subjects 5 sessions
High Monitoring	40 subjects 5 sessions	40 subjects 5 sessions	48 subjects 6 sessions	40 subjects 5 sessions

Data were collected from 16 or 24 subjects simultaneously in the laboratory, corresponding to two or three 8-person sessions with identical treatment conditions. The experimenter read the instructions aloud while subjects followed along on their own copies. In lieu of a "show-up" fee, subjects completed a 10-question, computerized quiz to confirm their

[2] The companion paper concentrates on the relationship between various measures of "affirmative" motivations to comply, based on subjects' perceptions of the legitimacy and fairness of a policy's requirements, and compliance behavior. Consistent with the emerging literature on affirmative motivations, we found significantly more compliance than predicted by the expected value of non-compliance, calling "negative" motivation-based models of compliance driven by the threat of punishment into question. We also found statistically significant association between perceptions of a policy's fairness and legitimacy with more honest levels of emissions reporting, consistent with models of a positive relationship between "affirmative motivations" for compliance and compliance behavior.

understanding of key features of the instructions. They 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. Subjects scored slightly better on the comprehension quiz in the neutral context (79 percent correct) than in the framed context (76 percent correct). A practice period followed to further familiarize subjects with the double auction trading interface. Sessions lasted for about two hours (including sign-in, instructions, questionnaires and payment distribution), and total earnings averaged US$29 per subject.

3. RESULTS

We present the results in two subsections, following the order of the two phases of decisions that subjects made each period. The first subsection reports the permit market performance, specifically transaction prices and quantities. The second section analyzes the reporting compliance choices of subjects.

3.1 Permit Market Performance

Subjects were not allowed to bank permits, and their abatement costs and permit endowment did not change across periods, so all periods had identical and stationary economic incentives. Price volatility was large in some sessions, so we employ the median transaction price in each period as a summary statistic for the central tendency of prices because it is less sensitive to outliers. Figure 3 displays the average of these median prices across sessions within the high and low monitoring treatments and for the neutral and environmental framing treatments, separately for each of the eleven periods. Panel A shows that this price average is within or slightly below the full-compliance benchmark (208-212 experimental dollars) in the high monitoring treatment. Prices were lower, and fell over time, in the low monitoring

Figure 3A: Average Median Permit Transaction Prices for Low Monitoring and High Monitoring Treatments

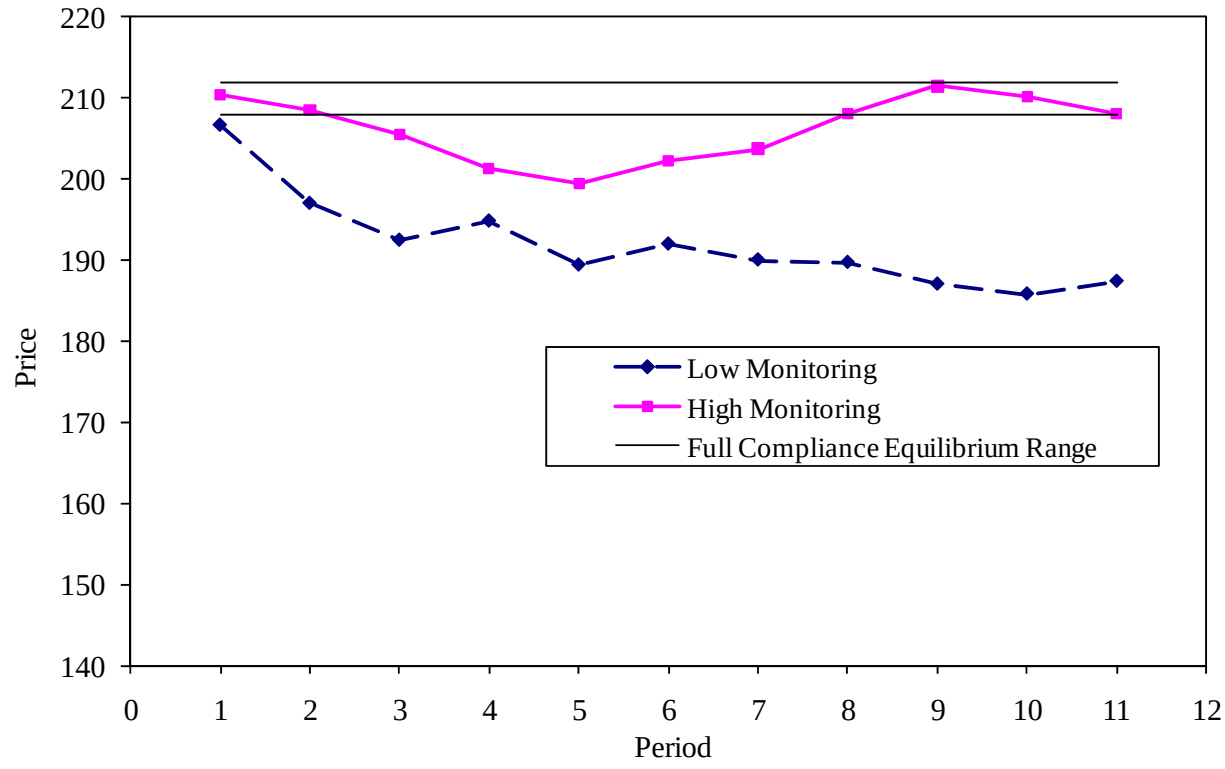
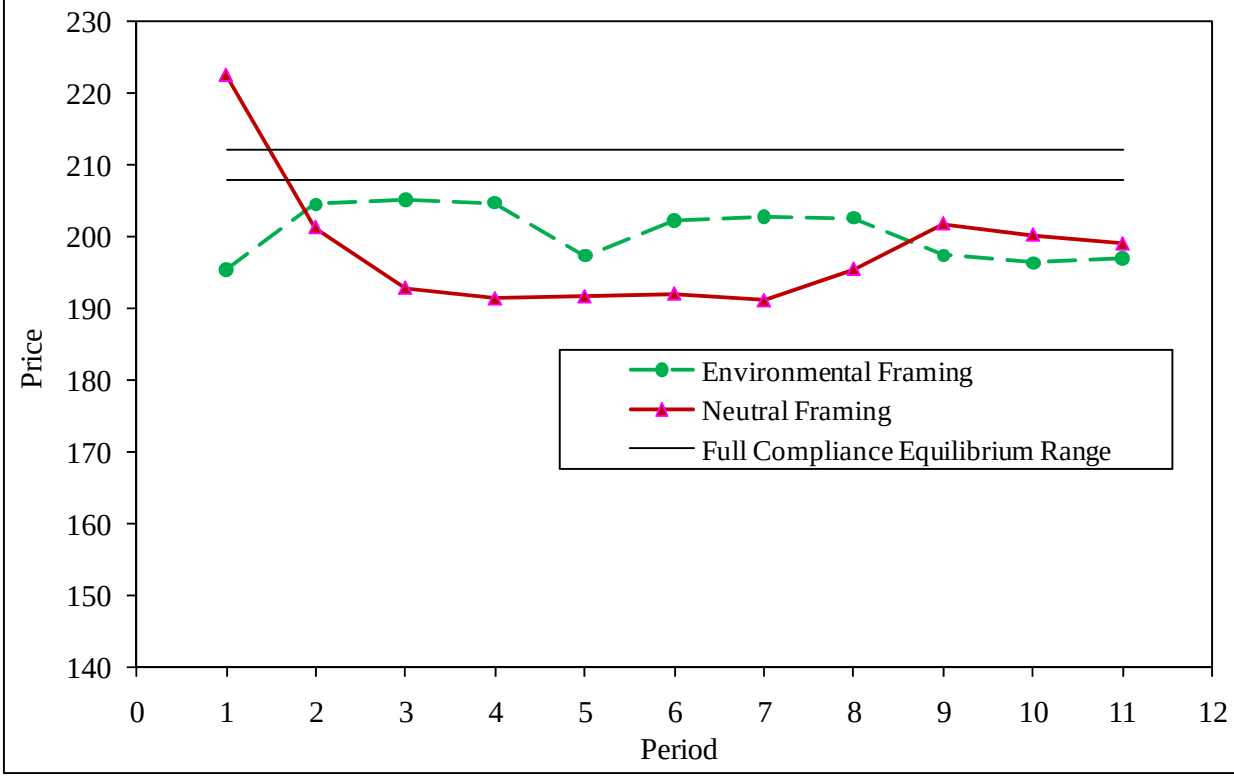


Figure 3B: Average Median Permit Transaction Prices for Neutral and Environmental Framing Treatments



treatment. This is consistent with the lower compliance rate for the low monitoring treatment documented below in Subsection 3.2. Panel B indicates that prices were lower in the neutral context than the environmental context treatment in a majority of the periods. This difference is not as systematic as in Panel A, however, and higher prices are expected in the neutral context due to the greater compliance observed in this treatment.

Standard performance measures of experimental markets include transaction prices and quantities, which can be compared to the theoretical benchmarks and across treatments. Table 2 reports linear OLS regression models of the median transaction price and transaction quantity in each period, using treatment dummies and a nonlinear time trend (1/period) as independent variables. This 1/period specification for the time trend is common in market experiments because it allows for larger adjustments in early periods and smaller changes in later periods as prices and quantities converge to equilibrium levels. The intercept of 198 for the price regression in column 1 is not significantly different from the equilibrium range of 208-212 discussed in Section 2 above. The monitoring and framing treatment dummy variables do not have a significant influence on prices, although the positive sign of the high monitoring dummy is consistent with the higher prices for this treatment shown in Figure 3A.

These modestly (but insignificantly) higher prices in the high monitoring treatment may be due to the greater compliance and amount of emissions control in this treatment, documented in the next subsection, and the estimates shown in column 2 include emissions control as an explanatory variable to quantify this indirect effect. We use previous period emissions control rather than the current period control because subjects determine the current control choices at the same time that they determine their transaction prices and quantity. If we had instead used current period emissions control, endogeneity of this variable would lead to biased coefficient

estimates. The estimates indicate that the amount of (lagged) emissions control has a strong positive influence on prices. More control and less pollution are associated with greater compliance, and these activities raise permit prices.

Table 2: OLS Models of Median Transaction Prices and Trading Volume

Variable	Dependent Variable: Median Transaction Price		Dependent Variable: Trading Volume	
=1 if High Monitoring	13.71	-1.06	0.27	2.19†
(0 otherwise)	(13.83)	(13.74)	(1.40)	(1.26)
=1 if Equal Endowments	-20.75	-20.68†	3.46*	3.67**
(0 otherwise)	(13.73)	(12.12)	(1.39)	(1.18)
=1 if Environmental	1.57	19.32	-2.68†	-4.64**
Frame (0 otherwise)	(13.60)	(12.72)	(1.39)	(1.14)
Previous Period Total		1.28**		-0.17**
Emissions Control		(0.41)		(0.04)
1/Period	12.21	-6.82	-4.27**	-2.36
	(15.22)	(27.47)	(1.15)	(2.68)
Intercept	198.26**	97.85**	17.22**	30.50**
	(12.61)	(30.64)	(1.36)	(3.31)
R-squared	0.06	0.15	0.16	0.25
Number of Observations	451	410	451	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 10%, 5% and 1% levels, respectively (two-tailed tests).

The transaction quantity models shown in columns 3 and 4 indicate 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 only 14 required trades with unequal endowments. Transaction volume is also lower in the environmentally framed treatment, although this is only marginally significant in the specification without the previous period emission control. Table 3 displays the average number of trades for the two endowment treatments, separately for the neutral and environmental framing conditions.

Transaction volume is too low for the market to reach the competitive equilibrium in the equal endowments treatment for both framing conditions, but is approximately at equilibrium levels for both unequal endowment treatments. Note, however, that for both endowment conditions the transaction volume is about three units lower per period with the environmental frame, indicating that subjects are less inclined to trade "emissions permits" compared to neutrally-framed "coupons." This suggests that in the environmental frame some subjects may have preferred not to trade "pollution" rights, and this lower transaction volume could be one of the reasons for the weaker compliance in the environmentally framed condition, which we document next.

Table 3: Average Number of Transactions Per Period

	Equal Endowments (26 trades needed to reach competitive equilibrium)	Unequal Endowments (14 trades needed to reach competitive equilibrium)
Environmental Context	16.8 (*n*=110)	13.6 (*n*=121)
Neutral Context	19.8 (*n*=110)	16.1 (*n*=110)

3.2 Compliance

Recall that after the permit trading market closed for the period subjects next chose a level of pollution abatement, which determined their actual pollution level, and then reported their actual pollution (honestly or not) to the regulator. To be in compliance they had to hold one emission permit for every "ton" of pollution emitted that period. They could misreport their pollution, however, and were only inspected probabilistically to check their reported emissions against their actual pollution levels. Table 4 indicates that subjects were frequently noncompliant in the experiment, in both the low and high monitoring treatments. As expected, honest reporting was more common when inspections occurred with a 50-percent chance in the high monitoring treatment. Nevertheless, many subjects honestly reported their emissions even when the

probability of inspection was only 25-percent, which was too low to make compliance optimal even if they were highly risk averse. We analyze how this result relates to theories of affirmative motivations for compliance in our companion paper (Raymond and Cason 2010).

Table 4, Panel A: *Percentage* of noncompliant emissions reports, by treatment condition*

	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.

Table 4, Panel B: *Average amount* of underreported emissions, by treatment condition†

	Neutral Frame		Environmental Frame	
	Unequal Endowments	Equal Endowments	Unequal Endowments	Equal Endowments
Low Monitoring	1.53	2.42	3.54	3.37
High Monitoring	0.58	0.45	2.11	1.67

†Mean difference between actual and reported emissions in "tons," by treatment condition. (Each "ton" of emissions required one emissions permit to satisfy compliance rules.)

This table also indicates that environmental framing has a large and negative influence on reporting compliance. In the condition with the greatest compliance (High Monitoring and the Neutral Frame), about 11 to 13 percent of emissions reports were untruthful. Noncompliance increases by roughly the same amount when switching from the neutral to the environmental frame (to 31-36 percent dishonest reports) as it does by switching from high to low monitoring (to 32-39 percent). Moreover, Low Monitoring and Environmental Framing interact to generate the greatest overall noncompliance (53-54 percent of all reports). Subjects in the framed, low monitoring condition were noncompliant at least *4 times more frequently* than in the strongest

compliance condition, and they underreported *6 to 7 times more units of emissions* on average. Obviously, these are very large differences in compliance behavior across treatments.

Since we manipulated the three treatment variables in a 2×2×2 design, to test whether these differences are statistically significant we employ a multivariate analysis to control for potential treatment interactions. Table 5 reports a series of cross-sectional tobit models to test if compliance varies with enforcement conditions and environmental framing. In these models the subject is the unit of observation. We provide estimates for all treatments pooled, as well as separate estimates for the high and low monitoring treatments. The dependent variable is the total amount of misreported emissions for each subject across all periods. This variable ranges from 0 to 220, because the maximum level of noncompliance is 20 units of unreported pollution in each of the 11 periods.[3] These models also include demographic controls and controls for a variety of subjects' survey responses concerning perceptions of fairness regarding permit allocations, motivations for obeying rules, and attitudes towards the environment and environmental regulation (not shown in the table). These other factors are discussed in detail in Raymond and Cason (2010).

Row 1 of Table 5 shows that compliance was much greater in the neutral, unframed context and this difference is statistically significant ($p < .01$). This finding is consistent across both the low and high monitoring treatments respectively, as shown in columns (2) and (3). The point estimates in these columns indicate that the environmental frame increases non-compliance by almost 14 tons in the low monitoring condition and by more than 32 unreported tons of emissions in the high monitoring condition over the 11 periods of the experiment. Differences in

[3] 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, so we do not report them here.

task understanding across frames cannot explain this difference, given that subjects scored similarly on the instructions quiz in both contexts.

Table 5: Tobit Models of Noncompliance (Total Amount of Misreporting)

	All Treatments	Low Monitoring	High Monitoring
	(1)	(2)	(3)
Indicator=1 if	27.98**	13.88†	32.56**
environmental context	(4.81)	(7.12)	(6.34)
Indicator=1 if	-23.39**		
monitoring is high	(5.12)		
Indicator=1 if subject	-23.22**	-29.25**	-17.93*
has high permit endowment	(6.48)	(8.98)	(7.36)
Indicator=1 if subject	11.84†	18.81	2.93
has low permit endowment	(7.00)	(11.87)	(6.31)
Indicator=1 if subject considers	6.16	14.79†	-0.97
herself an "environmentalist"	(5.61)	(8.75)	(7.09)
Indicator=1 if subject believes	0.90	0.10	4.62
that global warming is an important issue	(5.73)	(8.89)	(6.36)
Indicator=1 if subject correctly identifies statement	4.53	11.18	-7.69
describing emissions trading and supports it as policy	(10.76)	(16.09)	(8.86)
Indicator=1 if subject's lottery choices	10.76	-1.27	13.15†
indicate risk seeking preferences	(8.08)	(11.98)	(8.01)
Indicator=1 if subject's lottery choices	-13.95**	-19.61*	-10.25†
indicate strongly risk averse preferences	(5.30)	(8.82)	(6.13)
Intercept	-29.16	-28.07	7.97
	(17.38)	(24.41)	(27.49)
Number of Observations	326	160	166
Observations censored at 0	119	46	73
Log pseudolikelihood	-1133.81	-619.09	-494.84

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 10, 5 and 1-percent levels (all two-tailed tests). Regressions also include demographic controls and controls for other questionnaire responses (not shown).

This result is inconsistent with the conjecture that concern for the environment would strengthen motivations to comply in a framed context related to environmental protection, rather

than a neutral context where maximizing monetary gain through deception might be considered more acceptable. Instead, the result is consistent with the alternative interpretation that an environmental frame may discourage subjects from reporting high levels of "pollution" to the regulator given its negative connotation, or even to acquire sufficient permits to maintain compliance at high pollution levels. Note that subjects who consider themselves "environmentalists" fail to comply at a (marginally significantly) higher rate in the low monitoring condition, which is consistent with this interpretation.

Table 5 also shows that more risk averse subjects comply to a greater extent. This is expected since non-compliance carries a greater risk of relatively large losses. Other control variables derived from subjects' questionnaire responses, such as subjects beliefs about whether global warming is an important policy issue or whether they understand and support the concept emissions trading as a policy option, are not correlated with compliance behavior.[4] We found little support for emissions trading as a policy option among our subjects, consistent with recent public opinion research (e.g. Maibach et al. 2009; Rabe and Borick 2008). Relatively few subjects (33 percent) correctly understood what emissions trading was prior to our instructions and only a small minority of subjects (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 decrease in compliance and transaction volume when the market was framed as a pollution permit market could also be due, in part, to subjects' negative perceptions of emissions trading.

[4] In order to avoid priming subjects about the environmental aspect of this research, in the neutral, unframed treatment subjects answered these questions after the trading and reporting experiment was completed. Subjects answered these questions before the emissions trading experiment in the environmental framed treatment.

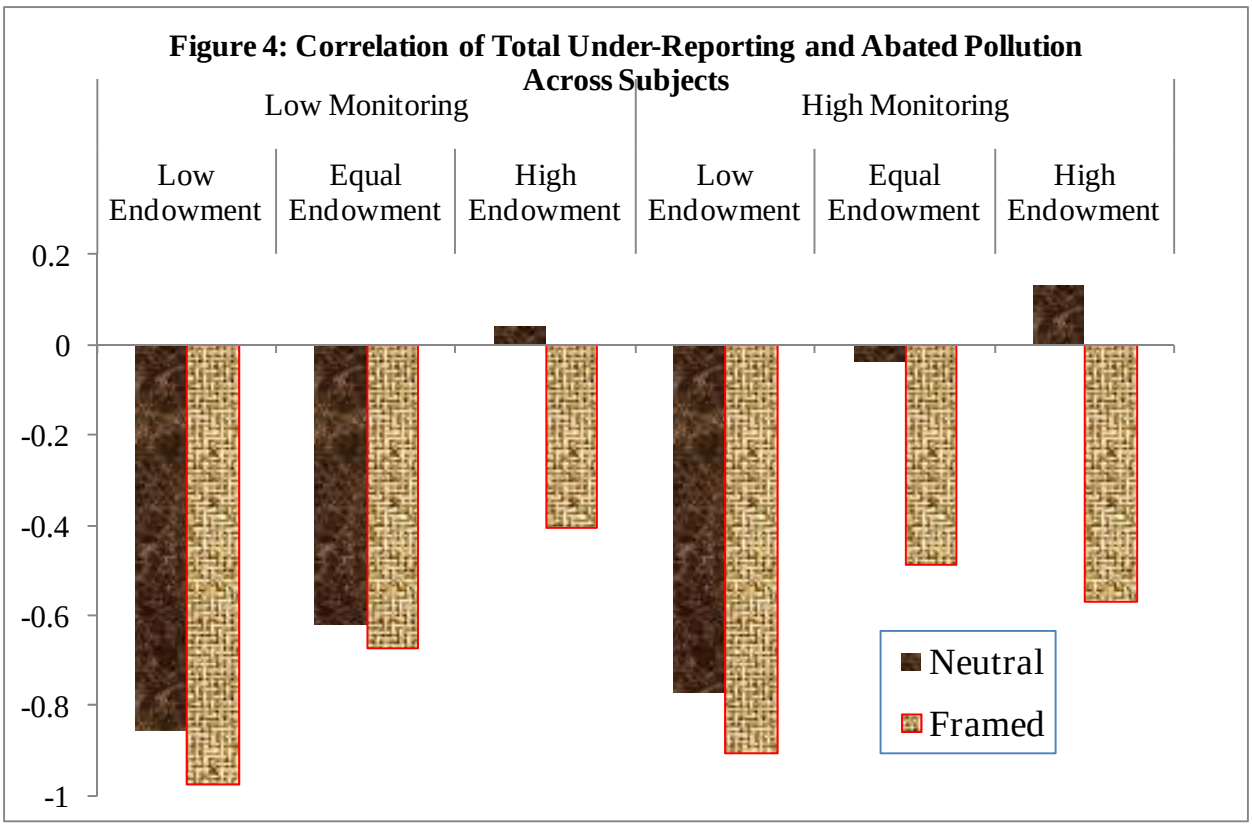


Figure 4 provides further evidence consistent with the view that subjects' under-reporting is due in part to greater guilt or shame and a desire to cover-up "dirty" actions like pollution, as primed by the environmental framing. Subjects chose how much costly pollution abatement to undertake, and whether and how much to under-report pollution to the regulator. Not surprisingly, these two choices are negatively correlated, since greater abatement lowers pollution and so it naturally decreases the potential and need for under-reporting. Figure 4 shows that this negative correlation is stronger for the environmentally framed than the neutrally framed treatment, particularly among those subjects who received a high permit endowment. This suggests that subjects were more likely to incur costs to abate pollution, but still under-report actual pollution levels, when these choices were described in environmental terms. The correlation is weaker when these decisions are described neutrally as "number" choices.

4. CONCLUSION

We manipulated the environmental framing of this emissions trading experiment as part of a broader study to determine why compliance occurs more than expected based only on economic motivations. For example, the expected value of cheating on one's tax returns predicts greater noncompliance than is observed in countries such as 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). Consistent with our larger expectations, we found that framing had a significant effect on compliance – an effect commensurate with changes from high to low monitoring. We did not find support for the conjecture that environmental framing would increase compliance by triggering stronger motivations to comply honestly with regulations that protect the environment compared to reporting a simple "number" in context not unlike a game of chance. Instead, environmental framing increased noncompliance by a large and statistically significant amount. Confusion is an unlikely explanation for this result given that subjects scored similarly on comprehension tests in the framed and unframed treatments and responded strongly to variations in the economic incentives for compliance through changes in the enforcement rate. Rather, it appears that subjects complied less honestly in the framed context because of their general disapproval of emissions trading, or because they sought to avoid the shame of reporting higher actual "pollution" levels honestly because of the negative connotation of pollution—both effects that are unlikely to be triggered by reporting a "number" in the neutrally-framed treatment.

Of course, subjects in the framed sessions understood that their pollution choices and decisions to under-report emissions would not actually affect the environment. An alternative design could strengthen the saliency of the environmental framing by manipulating the

environmental consequences of emissions and under-reporting choices. For example, at the end of each experimental session the researchers could purchase a variable number of "carbon offset" credits that is smaller when subjects in that session had a greater amount of unreported emissions, or undertake other activities to increase actual greenhouse gas emissions following noncompliance or increases in subjects' chosen pollution levels (e.g., Boyce et al. 1992). This would increase the external validity of the experiment and would also shed more light on whether it was embarrassment in reporting higher pollution levels, general disdain for emissions trading policies, or some other factor that was primarily driving the framing effect.

The substantially reduced compliance observed in the environmental framing treatment could have also occurred (as we noted in our introduction) because we instructed subjects to 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 help isolate the origins of this framing effect. Regardless of its motivational source, it is important to reiterate that the framing effect was as large as the impact of doubling the monitoring rate from 25 to 50 percent. This should be of concern to experimental economists 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. As experimenters employ more "framed field experiments" outside the lab, it may be important to evaluate such pure framing effects in the lab if a main research goal is to compare lab and field experiment outcomes.

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Appendix: Sample Experiment Instructions (High Monitoring, Neutral Framing, Unequal Endowment) – ***Key alternative phrasing from Environmental Framing treatment shown in italics, and screens from the Environmental Framing treatment are shown at the end.***

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.

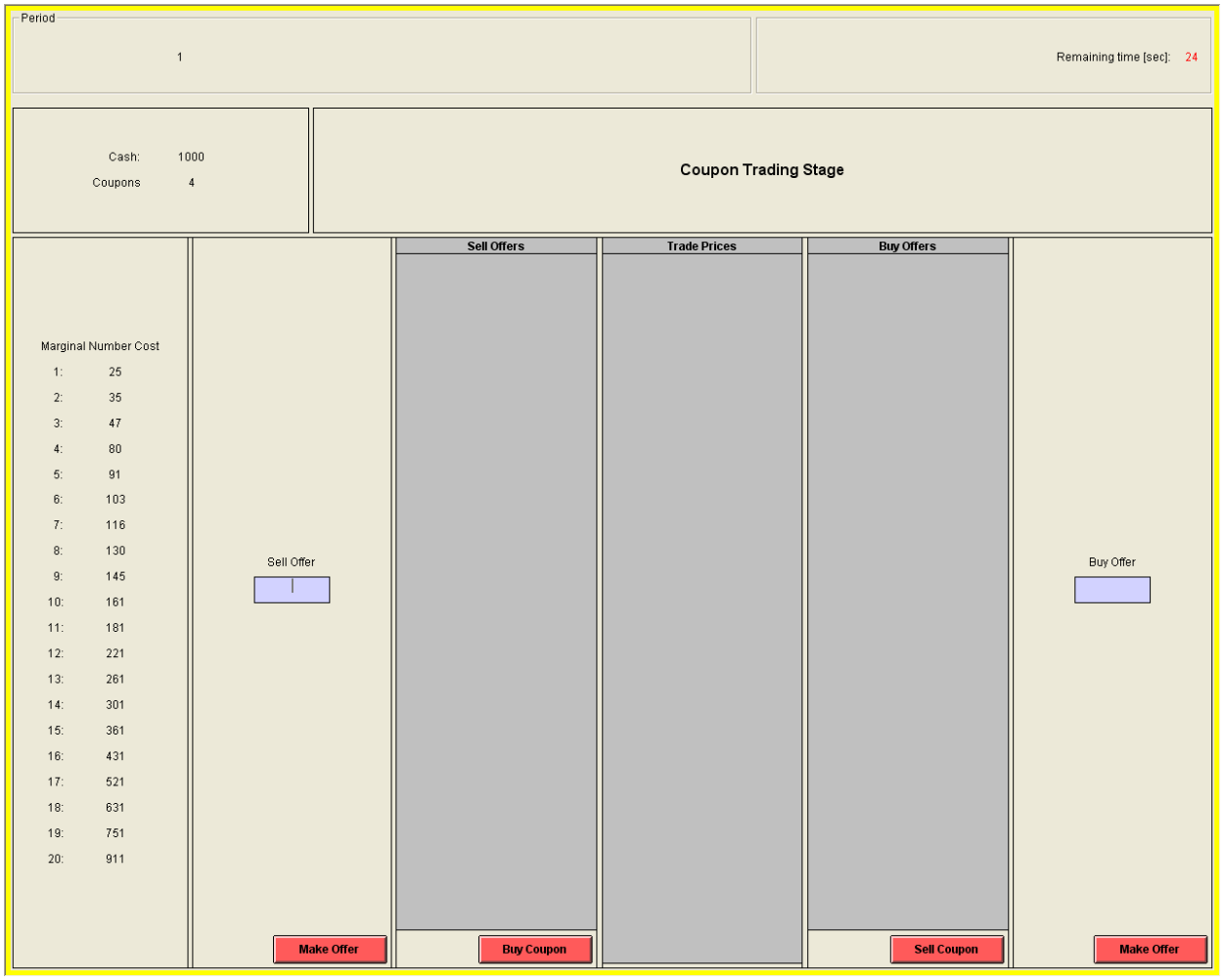

Figure 2

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.

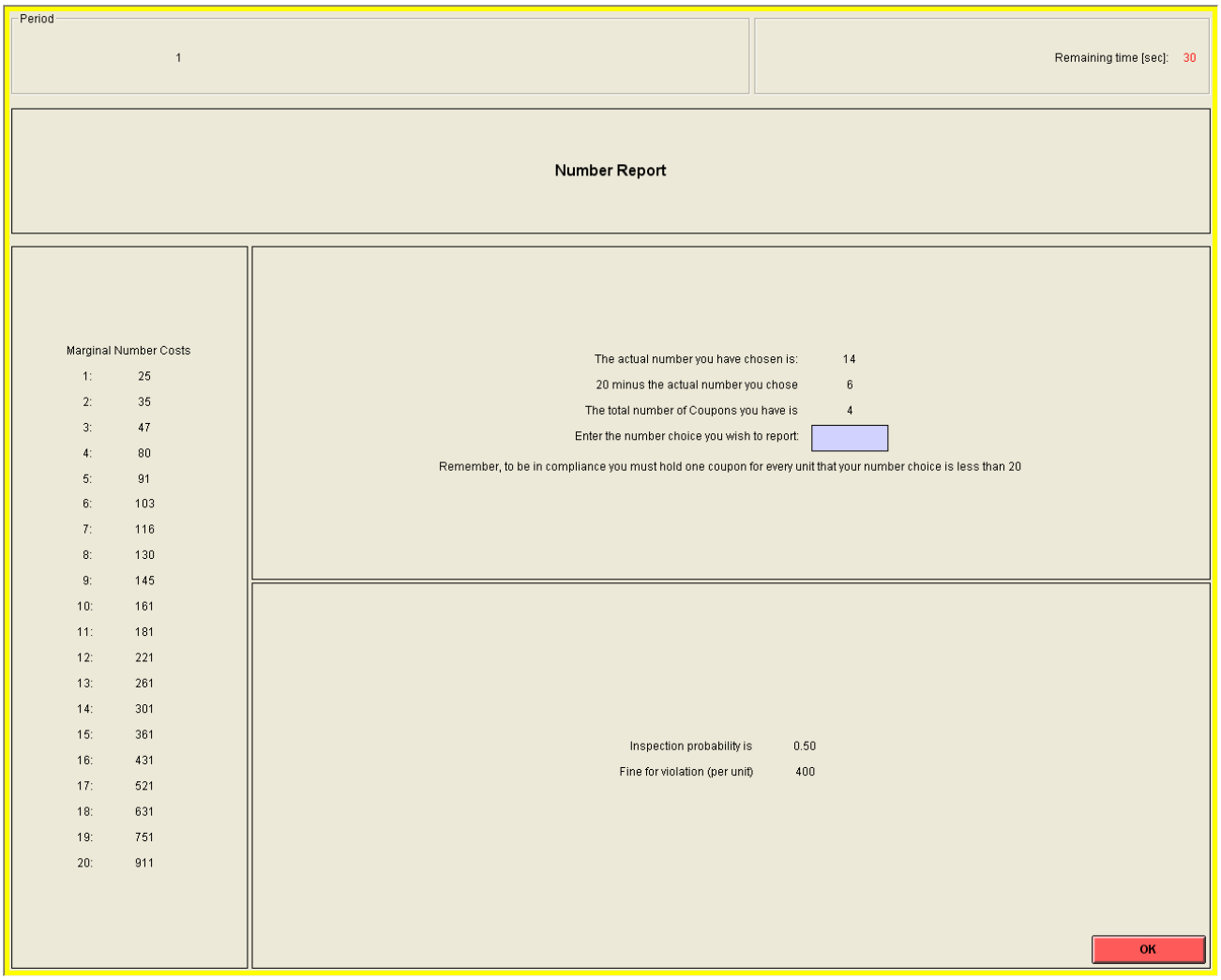

Figure 3

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

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.

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.

Figure 4

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?

Screens for Environmental Framing Treatment

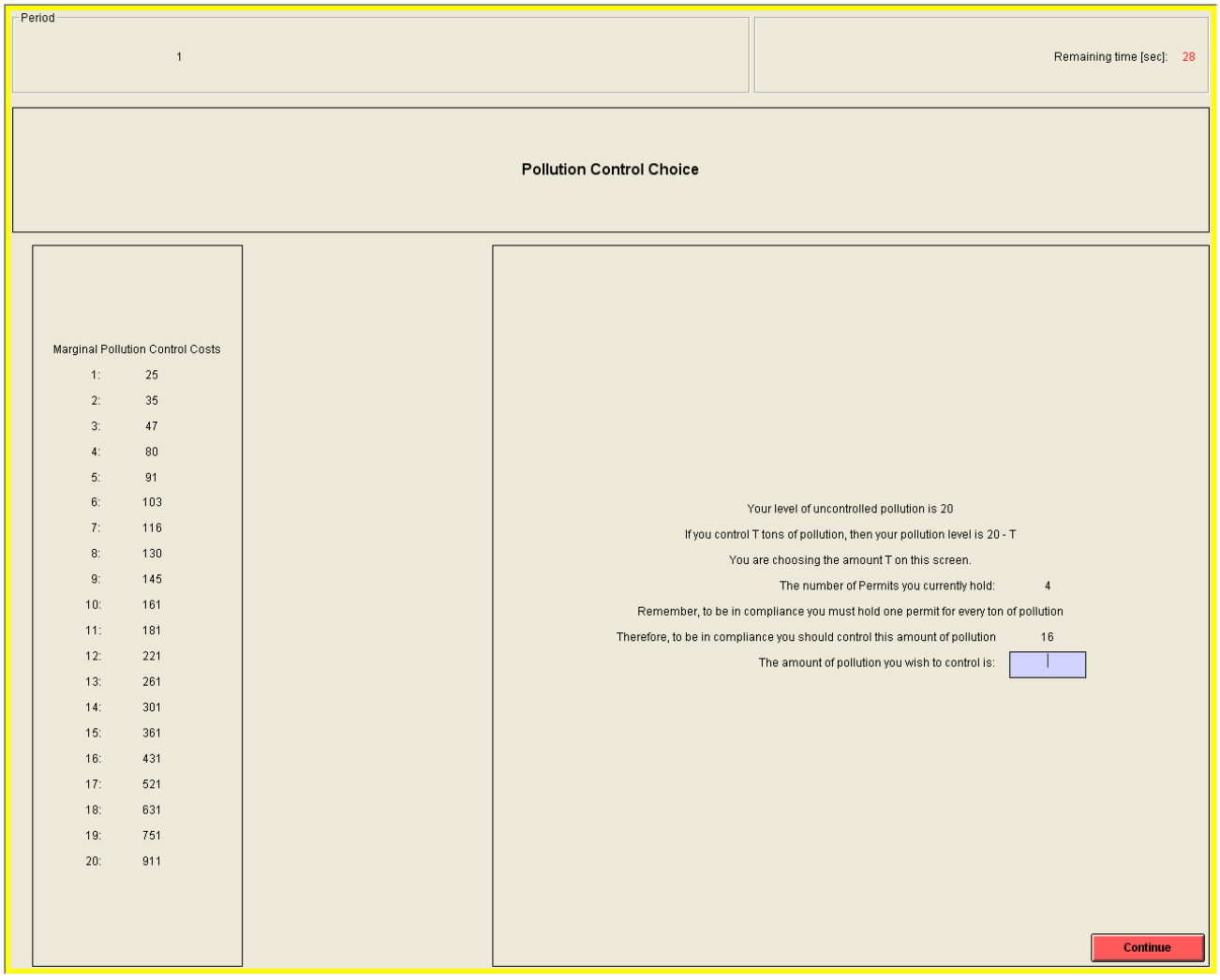

Figure 1

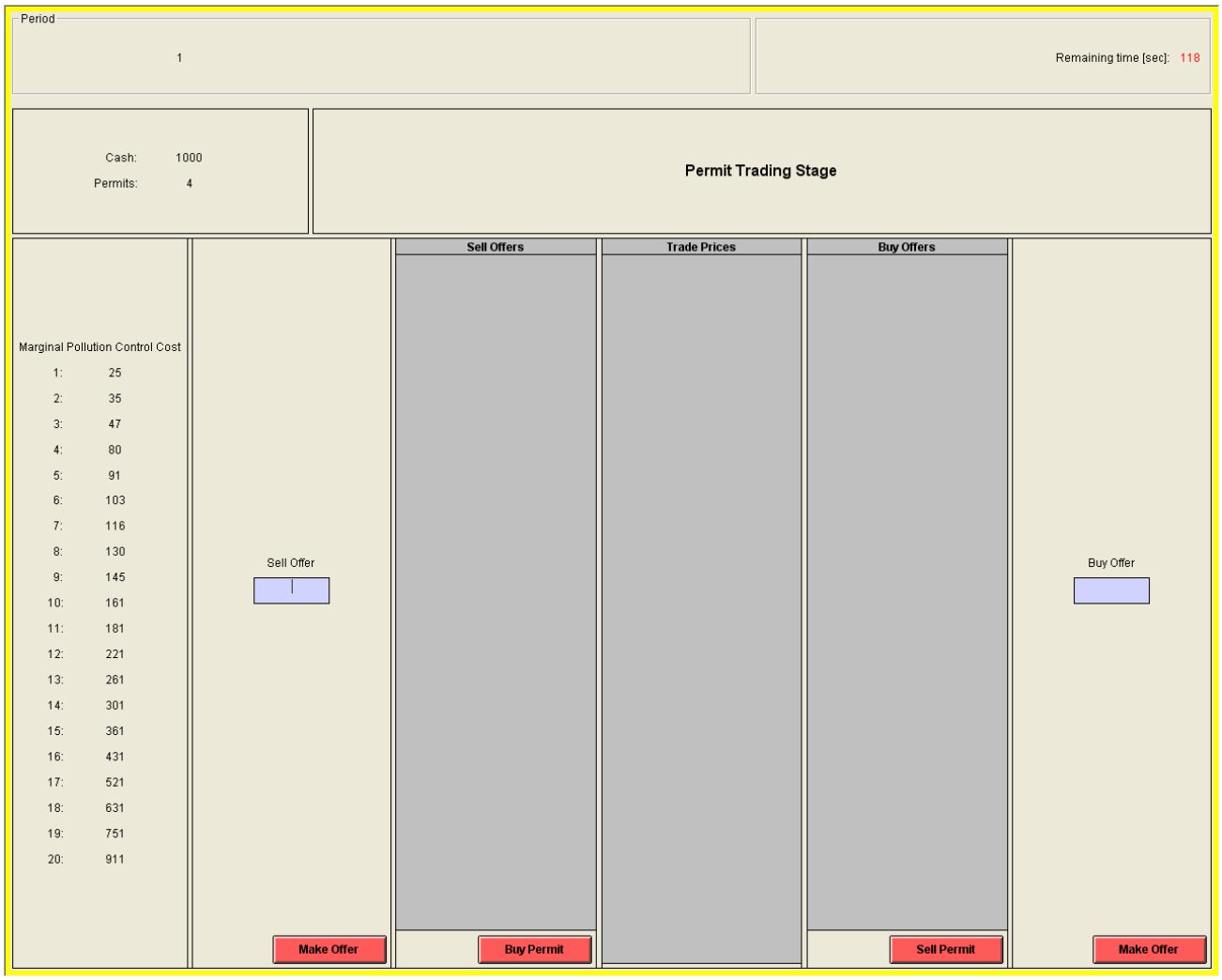
Period
1
Remaining time [sec]: 118
Cash: 1000
Permits: 4
Permit Trading Stage
Marginal Pollution Control Cost
1: 25
2: 35
3: 47
4: 80
5: 91
6: 103
7: 116
8: 130
9: 145
10: 161
11: 181
12: 221
13: 261
14: 301
15: 361
16: 431
17: 521
18: 631
19: 751
20: 911
Sell Offer
Make Offer
Sell Offers
Buy Permit
Trade Prices
Buy Offers
Sell Permit
Buy Offer
Make Offer

Figure 2


Period
1
Remaining time [sec]: 27
Pollution Report
Marginal Pollution Control Costs
1: 25
2: 35
3: 47
4: 80
5: 91
6: 103
7: 116
8: 130
9: 145
10: 161
11: 181
12: 221
13: 261
14: 301
15: 361
16: 431
17: 521
18: 631
19: 751
20: 911
Your total amount of uncontrolled Pollution is 20 tons
The amount of pollution you have controlled is: 12
Your level of pollution: 8
The total number of permits you have is 4
Enter the pollution amount you wish to report:
Remember, to be in compliance you must hold one permit for every ton of pollution
Inspection probability is 0.50
Fine for violation (per ton) 400
OK

Figure 3


Period
1
Remaining time [sec]: 43
Period Results
Marginal Pollution Control Costs
1: 25
2: 35
3: 47
4: 80
5: 91
6: 103
7: 116
8: 130
9: 145
10: 161
11: 181
12: 221
13: 261
14: 301
15: 361
16: 431
17: 521
18: 631
19: 751
20: 911
Your total amount of uncontrolled pollution is 20
The amount of pollution you have controlled is: 14
Your level of actual pollution you have after controlling is: 6
The number of permits you hold is: 4
Your pollution report was: 4
You were not inspected
Fixed period revenue: 1000
Total pollution control costs: 1897
Total fines: 0
New cash for upcoming period: 103
Permits to start next period: 4
continue

Figure 4