

Online Appendix for
“Truth-telling by Third-party Auditors and the Response of
Polluting Firms: Experimental Evidence from India”

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A. Tables

Table 1: PROBIT OF AUDIT SUBMISSION ON PLANT CHARACTERISTICS

	Dependent variable: audit submitted			
	(1)	(2)	(3)	(4)
Treatment group (=1)	0.014 (0.037)		0.0089 (0.037)	0.086 (0.104)
Textiles plant (=1)		0.258*** (0.055)	0.259*** (0.055)	0.361*** (0.076)
In industrial estate (=1)		0.083** (0.040)	0.083** (0.040)	0.077 (0.059)
Effluent flows to CETP (=1)		0.012 (0.040)	0.019 (0.040)	-0.0060 (0.059)
Waste water (billion l/day)		-16.4 (65.6)	-17.3 (65.7)	-10.6 (99.1)
Audit submitted in 2008 (=1)		0.291*** (0.044)	0.290*** (0.044)	0.317*** (0.060)
Citation in 2008 (=1)		0.084* (0.044)	0.083* (0.044)	0.091 (0.064)
Year 2010 (=1)		-0.057** (0.024)	-0.057** (0.024)	-0.128*** (0.037)
Treatment × Textiles plant				-0.184* (0.111)
Treatment × In industrial estate				0.018 (0.081)
Treatment × Effluent flows to CETP				0.055 (0.081)
Treatment × Waste water				-0.819 (136.1)
Treatment × Audit submitted in 2008				-0.043 (0.088)
Treatment × Citation in 2008				-0.017 (0.088)
Treatment × Year 2010				0.135*** (0.049)
Pseudo R2	0.0002	0.166	0.166	0.177
Observations	946	946	946	946

The dependent variable is submission of audit reports to GPCB. We report marginal effects at mean for continuous variables, and the 0-1 effect for binary variables. Pollution samples are from the final-stage effluent outlet for water and boiler-stack for air. Pollutants included are $Water = \{NH_3-N, BOD, COD, TDS, TSS\}$ and $Air = \{SO_2, NO_x, SPM\}$ with $All = Water \cup Air$. Standard errors clustered at the plant level are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 2: AUDIT TREATMENT EFFECTS ON AUDITOR REPORTING,
SELECTION CORRECTED

	All pollutants		Water pollutants		Air pollutants	
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A. Dependent variable: Compliance</i> (Dummy for pollutant in audit report at or below regulatory standard)						
Treatment group (=1)	-0.150*** (0.027)	-0.155*** (0.032)	-0.202*** (0.035)	-0.192*** (0.043)	-0.035 (0.026)	-0.068** (0.029)
Auditor fixed effects	No	Yes	No	Yes	No	Yes
Control mean	-0.291	-0.291	-0.350	-0.350	-0.194	-0.194
Observations	13170	13170	8373	8373	4797	4797
<i>Panel B. Dependent variable: Level of pollutant in audit report</i>						
Treatment group (=1)	0.230** (0.114)	0.219** (0.099)	0.314* (0.168)	0.283* (0.157)	0.064** (0.025)	0.093*** (0.022)
Auditor fixed effects	No	Yes	No	Yes	No	Yes
Control mean	-0.291	-0.291	-0.350	-0.350	-0.194	-0.194
Observations	13170	13170	8373	8373	4797	4797
<i>Panel C. Dependent variable: Level of pollutant in audit report minus level of pollution in backcheck</i>						
Treatment group (=1)	0.165 (0.119)	0.068 (0.125)	0.117 (0.152)	0.061 (0.153)	0.241 (0.165)	0.084 (0.191)
Auditor fixed effects	No	Yes	No	Yes	No	Yes
Control mean	-0.304	-0.304	-0.354	-0.354	-0.225	-0.225
Observations	1118	1118	689	689	429	429

Regression include region fixed effects in all Panels and year fixed effects in Panels A and B only. Pollution samples, pollutants collected and outcome variables are as in Table V; the only difference is an alternate weighting scheme to account for selection into audit submission. The method is from DiNardo et al. (1996), and uses administrative data from before the experiment to reweight observations so that the distribution of audit submitters' observables resembles that of all plants. The reweighting is based on the results of the estimation of a probit for submission as a function of baseline plant characteristics, shown in column 2 of Online Appendix Table 1. Standard errors clustered at the plant level are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 3: AUDIT - BACKCHECK DIFFERENCES ON BACKCHECK EXPERIENCE,
FOR CONTROL AND TREATMENT FIRMS

	control (1)	treatment (2)
Any backchecks on auditor before audit	0.182** (0.082)	-0.076 (0.275)
Observations	566	552

The dependent variable is audit reports less pollution in backchecks. Pollution samples are from the final-stage effluent outlet for water and boiler-stack for air, and regressions include region fixed effects. Pollutants included are *Water* = {NH₃-N, BOD, COD, TDS, TSS} and *Air* = {SO₂, NO_x, SPM} with *All* = *Water* ∪ *Air*. Standard errors clustered at the plant level are in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

B. Body of Letter to Treatment Firms

Dear Sir,

«Company» has been selected by GPCB for a modified third-party environment audit scheme. As part of this scheme, the audit firm «Auditor» has been assigned to audit «Company» by GPCB. The audit performed by «Auditor» will consist of three audit visits to «Company» and an accompanying audit report. This audit will substitute in full for any pre-existing audit arrangements to meet «Company»'s legal obligations under the environment audit scheme for the year 2009, and «Company» is directed to replace any currently engaged auditor with the herein assigned auditor. «Company» will not be responsible for payment to «Auditor» for services rendered under this scheme. «Auditor» will contact you shortly to decide acceptable dates for audit visits.

You are hereby directed to cooperate in full with the environment audit of «Auditor» and with any follow-on visits by accredited external auditors. This cooperation will include agreeing to three seasonal visit dates in accordance with auditor directions, allowing entry to industry grounds, allowing collection of water effluent and air emissions samples and providing details of effluent treatment plant operation and general environment management as requested by the auditor or accredited external auditors.

Your cooperation will be a valuable contribution to save the environment.

Yours Faithfully,

Member Secretary
GPCB, Gandhinagar

C. Benefit-Cost Analysis

In the paper, we analyze the effects of the audit treatment but in light of data limitations, do not present a comprehensive benefit-cost analysis. Nevertheless, we sketch out an approximate calculation below. While the results are tentative, the steps clarify what data would be needed to fully carry out the exercise. We make the following assumptions on the costs and benefits of the intervention.

1. Benefits (from reduced pollution): On the side of social benefits, there are few comprehensive estimates of the marginal damages of any pollutant. As a best guess at marginal damages, we looked for cases where developing-country governments had applied taxes per unit of pollution for the pollutants measured in our sample, as a measure of the social willingness to pay to avert pollution. We found such marginal charges for all of our pollutants from China, which has a pollution levy system, and Colombia. Summing the total value of the pollution reductions, we estimate the total value at \$7,274 per plant on average, at current prices, with \$4,537 of these benefits due to reductions in suspended particulate matter in air and much of the balance, \$1,663, due to reductions in total dissolved solids in water.
2. Cost of auditor effort: Auditors shirking in the status quo scheme reduced their costs. To do a proper audit, the additional cost of travel and sample collection and analysis is about \$400 per plant-year, if we assume, quite conservatively, that all auditors were shirking in the control and no auditors shirked in the treatment. This calculation turns out about the same as the difference between the market price paid to auditors in the control and what they were paid in the treatment, which was meant to reflect the technical cost plus a modest profit margin.
3. Backcheck: 20% of audit visits (an audit consists of three visits) were backchecked in year one. At this rate backchecks add a cost of \$180 per plant year.
4. Administrative costs: There are likely to be some administrative costs associated with the government running the treatment audit program, such as randomizing auditors, collecting audit fees from plants, and coordinating payment to auditors. We estimate our own administrative costs during the experiment to be \$60,000, but do not have any precise estimate of what this would cost the government—which already has staff responsible for administering the audit scheme—and so leave it blank in the table.
5. Plant pollution abatement: On the plant side, there are additional costs of pollution abatement and any changes in production in response to the increased scrutiny from audits. We have collected data on abatement costs in the endline survey. We use only estimates of investment in abatement capital, or fixed costs, as our measures of abatement costs such as operations and maintenance are poor. The average treatment plant spent \$670 more on abatement capital than the average control plant.

The reductions in pollution at the plant level are suggestive that the system may have had net social benefits, as seen in the Online Appendix Table 4 below. However, the estimates of both costs and benefits are at best tentative. In particular, we are uncertain about the appropriate values of marginal damages in urban Gujarat and our estimates of abatement costs are incomplete, accounting only for fixed costs.

Table 4: Benefit-Cost Analysis of Audit Intervention

	Pollution per plant (kg)			Benefit (USD)		Per kg	Valuation Source
	Treatment	Control	Reduction	Per plant	Total		
<i>Panel A. Benefits of Reduced Pollution</i>							
<i>Water pollution</i>							
Biochemical oxygen demand (BOD)	29,930	34,303	4,373	159	37,058	0.04	Colombia, 2002
Chemical oxygen demand (COD)	111,713	114,266	2,554	439	102,239	0.17	China, 2003
Total suspended solids (TSS)	19,349	21,378	2,029	32	7,453	0.02	Colombia, 2002
Total dissolved solids (TDS)	762,716	868,244	105,528	1,663	387,563	0.02	Assume ~TSS
<i>Air pollution</i>							
Suspended particulate matter (SPM)	34,625	41,441	6,816	4,537	1,057,169	0.67	China, 1997
Nitrogen oxides (NOx)	3,800	3,790	-10	-4	-858	0.38	China, 1997
Sulfur dioxide (SO ₂)	14,315	15,494	1,179	448	104,461	0.38	China, 1997
<i>Total benefits</i>				<u>7,274</u>	<u>1,695,085</u>		
<i>Panel B. Additional Costs of Treatment Audits</i>							
<i>Auditors</i>							
Cost of auditor effort				-400	-93,200		
<i>Regulator</i>							
Cost of backchecks, 20% of audits				-180	-41,490		
Administrative costs					-		
<i>Plants</i>							
Plant abatement capital				-670	-156,110		
<i>Total costs</i>				<u>-1,250</u>	<u>-291,250</u>		
<i>Benefits less costs</i>				<u>6,024</u>	<u>1,403,835</u>		