Online Appendix

Does the Squeaky Wheel Get More Grease? The Direct and Indirect Effects of Citizen Participation on Environmental Governance in China

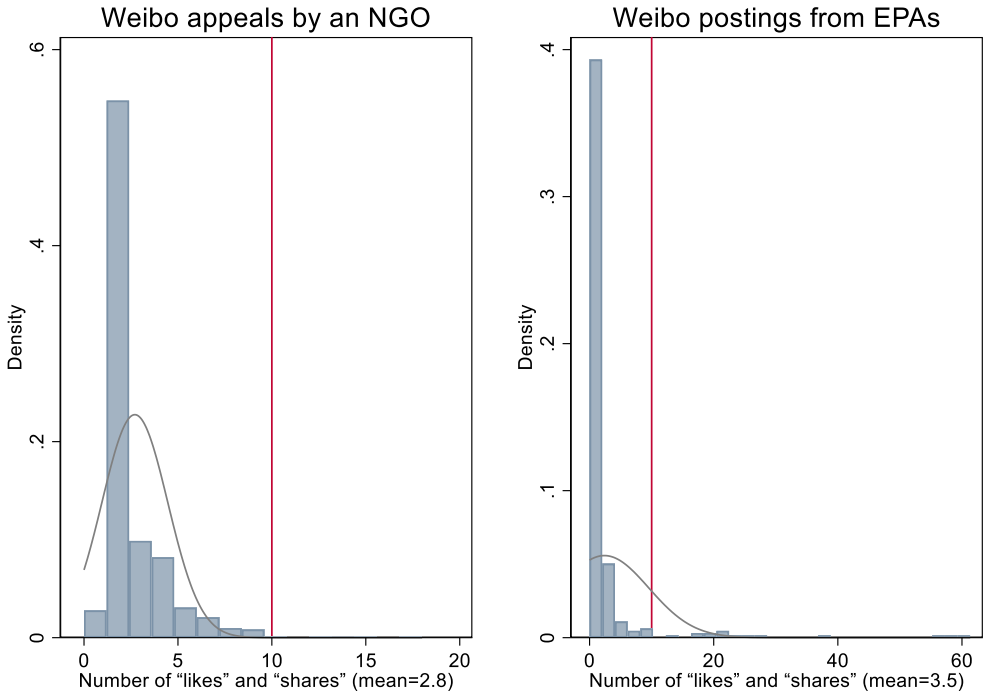
Mark Buntaine, Michael Greenstone, Guojun He,

Mengdi Liu, Shaoda Wang, and Bing Zhang*

*Buntaine: University of California, Santa Barbara; buntaine@bren.ucsb.edu. Greenstone: University of Chicago and NBER; mgreenst@uchicgao.edu. He: University of Hong Kong; gjhe@hku.hk. Liu: University of International Business and Economics; liumengdi@uibe.edu.cn. Wang: University of Chicago and NBER; shaoda@uchicago.edu. Zhang: Nanjing University; zhangb@nju.edu.cn. We thank Martina Bjorkman-Nyqvist, Robin Burgess, Fiona Burlig, Jiahua Che, Kim Fe Cramer, Richard DiSalvo, Hanming Fang, Eyal Frank, Matthew Gordon, Chang-Tai Hsieh, Kelsey Jack, Ruixue Jia, Panle Jia Barwick, Ryan Kellogg, Jing Li, Shanjun Li, Mushfiq Mobarak, Ben Olken, Nancy Qian, James Robinson, Nicholas Ryan, Joseph Shapiro, Venkat Bhargav Sreedhara, Reed Walker, Ye Wang, Daniel Xu, David Yang, Noam Yuchtman, and numerous seminar and conference participants for insightful suggestions. The research described in this article was approved by the IRB at the University of Chicago and University of California, Santa Barbara. Jiaying Chen, Xun Fan, Yue He, Neil Himwich, Chenye Liu, Zifu Liu, Ziyi Liu, Matthew Neils, Wenwei Peng, Fan Sun, Yue Tang, Fanyu Wang, Xurui Wang, Jiaqi Zhang, Yimeng Zhang, Runren Zhou, and Ziao Zhu provided excellent research assistance. Financial support from the National Science Foundation of China (Grant No. 71825005 & 72161147002) and the Energy Policy Institute at UChicago (EPIC) is gratefully acknowledged. The AEA RCT registry ID is AEARCTR-0005601.

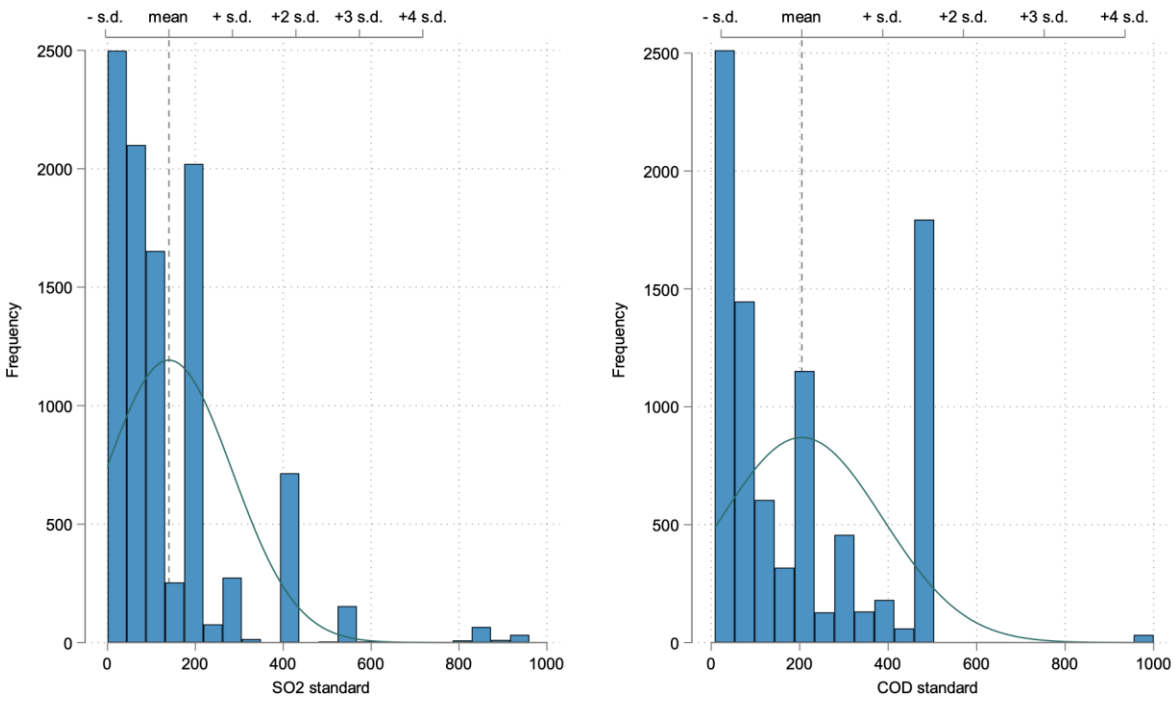
APPENDIX A: FIGURES AND TABLES

Figure A1. Distribution of Weibo's Number of "Likes" and "Shares"



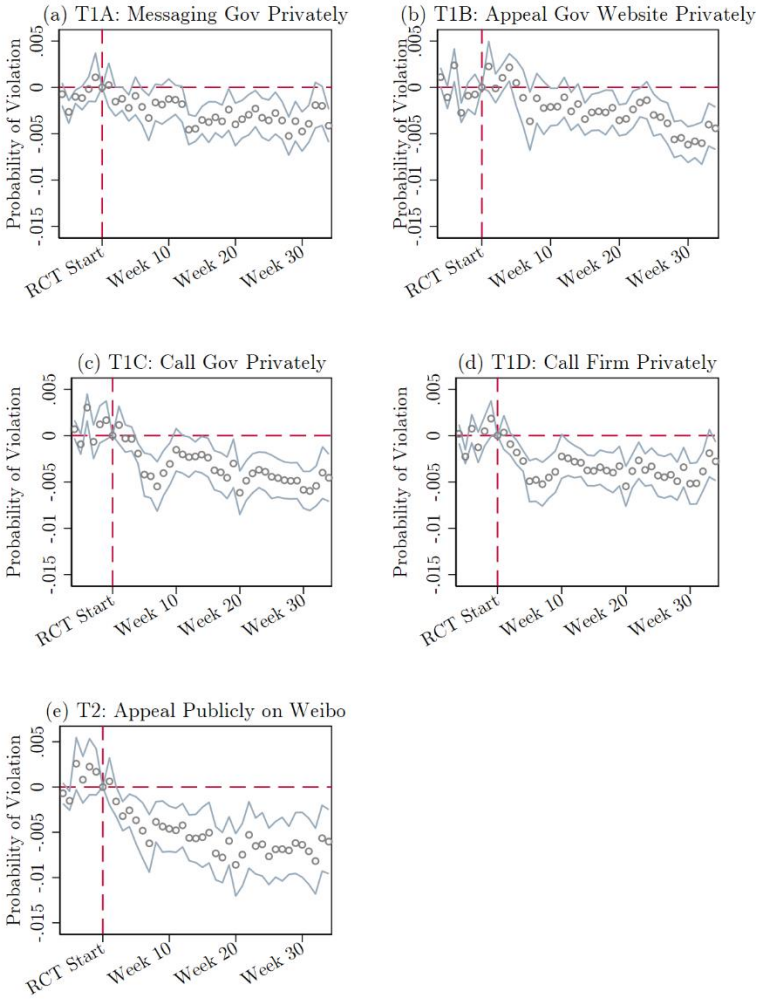
Note: This figure presents the distributions of the average likes/shares for the two types of Weibo accounts, i.e. accounts of NGOs and each prefectural city's environmental protection agency (EPA).

Figure A2. Distribution of Pollution Emission Standards



Note: This figure presents the distribution of SO_2 and COD emission standards. The units for SO_2 standards are mg/m3, and the units for COD standards are mg/L.

Figure A3. Event Studies



Note: This figure presents coefficients and 90% confidence intervals on Treatment*Week interactions from regressions of violation on Treatment*Week, firm FE, and week FE. Standard errors are clustered two-way by prefecture and week.

Figure A4. Event Studies for Public and Private Appeals on Emission Concentrations

Note: This figure presents coefficients and 90% confidence intervals on Treatment*Biweek interactions from regressions of concentration on Treatment *Biweek, firm FE, and biweek FE. Standard errors are clustered two-way by prefecture and biweek.

Table A1. Industry Distribution

	(1)	(2)	(3)	(4)	(5)	(6)
	Control	Private Appeals				Public Appeals
		Messaging	Website	Call Gov	Call Firm	Weibo
	C	T1A	T1B	T1C	T1D	T2
Water production and sewage treatment plant (46)	16.55%	15.00%	17.07%	16.80%	17.03%	17.40%
Electricity and heat production and supply (44)	12.00%	11.93%	11.88%	12.18%	11.26%	12.26%
Chemical raw materials and products (26)	6.20%	6.89%	9.16%	9.87%	8.64%	9.99%
Textile printing and dyeing (17)	9.68%	9.34%	9.16%	8.50%	8.44%	8.55%
Non-metallic mineral products (30)	6.63%	7.18%	7.64%	8.32%	7.79%	7.98%
Agri-food processing (13)	3.48%	3.57%	5.03%	4.16%	3.65%	4.27%
Paper products (22)	4.79%	5.67%	4.56%	4.62%	4.84%	4.22%
Ferrous metal smelting and rolling processing (31)	4.99%	4.79%	3.30%	3.76%	4.07%	3.40%
Pharmaceutical manufacturing (27)	2.86%	2.44%	2.88%	3.02%	3.27%	3.09%
Petroleum, coal and other fuel processing (25)	2.47%	2.39%	2.72%	3.20%	2.67%	2.99%
Metal products (33)	3.73%	2.54%	3.51%	2.94%	3.32%	2.73%
Liquor, beverage and refined tea manufacturing (15)	1.31%	2.20%	2.41%	2.49%	2.60%	2.47%
Food manufacturing (14)	1.36%	1.76%	2.04%	1.85%	1.67%	1.65%
Coal mining and washing (6)	1.40%	1.52%	1.26%	1.60%	1.42%	1.60%
Electronic equipment manufacturing (39)	1.65%	1.03%	1.20%	1.12%	1.10%	1.60%
Leather, fur, feathers and their products (19)	2.23%	2.49%	1.20%	1.57%	1.82%	1.34%
Total	81.3%	80.7%	85.0%	86.0%	83.6%	85.5%

Note: This table presents the industries that make up the highest percentage of T2. Other industries are also included in the sample.

Table A2. Pollution Appeals and Verified Environmental Violations

	(1a) Violation	(1b) Violation
Panel A. Impacts of Private and Public Appeals		
Private Appeals (T1*Post)	-0.002	-0.002
	(0.001)	(0.001)
Public Appeals (T2*Post)	-0.005	-0.004
	(0.001)	(0.001)
H0: T1<T2	P=0.009	P=0.005
Panel B. Impacts of Private and Public Appeals		
Messaging Gov Privately (T1A*Post)	-0.002	-0.002
	(0.001)	(0.001)
Appeal Gov Website Privately (T1B*Post)	-0.003	-0.002
	(0.001)	(0.001)
Call Gov Privately (T1C*Post)	-0.002	-0.001
	(0.001)	(0.001)
Call Firm Privately (T1D*Post)	-0.001	-0.001
	(0.001)	(0.001)
Call Gov*Call Firm (T1C*TID*Post)	-0.001	-0.001
	(0.001)	(0.001)
Appeal Publicly on Weibo (T2*Post)	-0.005	-0.004
	(0.001)	(0.001)
H0: T1A=T1B=T1C=T1D	P=0.25	P=0.48
Control Mean	0.007	0.007
Control SD	0.083	0.083
Firm FE	Yes	Yes
Day FE	Yes	
Province by Day FE		Yes
Observations	7,100,881	7,100,881

Note: This table reports the regression results from estimating Equation (1), excluding cases with minimal levels of measured air flows as these may be instances when the plant is not operating. Violation is a dummy variable that equals 1 if the firm violates an emission standard on that day, and zero otherwise. In Column (1a), we control for firm FE and day FE. In Column (1b), we control for firm FE and province-by-day FE. Standard errors are clustered two-way by prefecture and week.

Table A3. Robustness Checks using Alternative Clusters

	(1a) Violation	(1b) Violation	(2a) SO_2	(2b) SO_2	(3a) COD	(3b) COD
Panel A. Prefecture by Arm Cluster						
Private Appeals (T1*Post)	-0.003 (0.000)	-0.002 (0.000)	-5.6 (1.8)	-5.9 (2.0)	-0.3 (0.0)	-0.4 (0.1)
Public Appeals (T2*Post)	-0.006 (0.000)	-0.006 (0.000)	-15.8 (0.4)	-16.2 (1.5)	-2.1 (0. 0)	-2.2 (0.3)
H0: T1<T2	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00	P=0.00
Panel B. Prefecture Cluster						
Private Appeals (T1*Post)	-0.003 (0.001)	-0.002 (0.001)	-5.6 (3.7)	-5.9 (3.8)	-0.3 (0.9)	-0.4 (0.9)
Public Appeals (T2*Post)	-0.006 (0.002)	-0.006 (0.001)	-15.8 (4.6)	-16.2 (4.8)	-2.1 (1.3)	-2.2 (1.2)
H0: T1<T2	P=0.01	P=0.00	P=0.02	P=0.02	P=0.04	P=0.04
Control Mean	0.009	0.009	132.5	132.5	59.1	59.1
Control SD	0.096	0.096	539.5	539.5	78.8	78.8
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Day FE	Yes		Yes		Yes	
Province by Day FE		Yes		Yes		Yes
Observations	7,100,881	7,100,881	2,216,208	2,216,208	2,459,622	2,459,622

Note: This table reports the regression results from estimating Equation (1). In Columns (1a) and (1b), we use firm-day level data, and the outcome variable is a dummy variable that equals 1 if the firm violates an emission standard on that day, and zero otherwise; in Columns (2a) and (2b), we use pipe-day level data, and the outcome variable is the daily average emission concentration of SO_2 (mg/m3); in Columns (3a) and (3b), we use pipe-day level data, and the outcome variable is the daily average emission concentration of COD (mg/L). For each outcome, in the column "a", we control for firm FE and day FE; in the columns "b", we control for firm FE and province-by-day FE. In panel A, standard errors are clustered two-way by prefecture and arm. In panel B, standard errors are clustered at the prefecture level.

Table A4. Robustness Checks using Aggregated Data

	(1a) Weekly Violations	(1b) Monthly Violations
Private Appeals (T1*Post)	-0.309	-0.289
	(0.101)	(0.102)
Public Appeals (T2*Post)	-0.552	-0.537
	(0.113)	(0.119)
H0: T1<T2	P= 0.000	P=0.000
Control Mean	0.066	0.244
Control SD	0.508	1.728
Firm FE	Yes	Yes
Week FE	Yes	
Month FE		Yes
Observations	322,241	86,453

Note: This table reports the regression results from estimating Equation (1) using firm-month level data and firm-week level data. Weekly Violations measure the number of violations of the firm violates an emission standard within a week. Monthly Violations measure the number of violations of the firm violates an emission standard within a month. In Column (1a), we control for firm FE and week FE. In Column (1b), we control for firm FE and month FE. Standard errors are clustered at the prefecture level.

Table A5. Pollution Appeals and Air Flow

	(1a) log(Flow)	(1b) log(Flow)
Panel A. Impacts of Pooled Private and Public Appeals		
Private Appeals (T1*Post)	-0.027 (0.052)	-0.024 (0.059)
Public Appeals (T2*Post)	-0.022 (0.047)	-0.022 (0.063)
H0: T1<T2	P=0.54	P=0.51
Panel B. Impacts of the Sub-Treatments		
Messaging Gov Privately (T1A*Post)	-0.008 (0.062)	-0.010 (0.062)
Appeal Gov Website Privately (T1B*Post)	-0.117 (0.071)	-0.040 (0.076)
Call Gov Privately (T1C*Post)	0.005 (0.096)	-0.017 (0.091)
Call Firm Privately (T1D*Post)	0.088 (0.079)	0.072 (0.070)
Call Gov*Call Firm (T1C*TID*Post)	-0.203 (0.143)	-0.193 (0.114)
Appeal Publicly on Weibo (T2*Post)	-0.022 (0.051)	-0.028 (0.063)
H0: T1A=T1B=T1C=T1D	P=0.00	P=0.41
Control Mean	5.747	5.747
Control SD	4.452	4.452
Firm FE	Yes	Yes
Day FE	Yes	
Province by Day FE		Yes
Observations	3,979,180	3,979,180

Note: This table reports the regression results of replacing the dependent variables of Equation (1) with the logged volume of air flows using pipe-day level data. We place missing values for flow for any firms that are responsible for all flows in a province in Column (1a). In Column (1a), we control for firm FE and day FE. In Column (1b), we control for firm FE and province-by-day FE. Standard errors are clustered two-way by prefecture and week.

Table A6. Pollution Appeals and Firm Violations and Emission Concentrations by Arms

	(1a) Violation	(1b) Violation	(2a) SO_2	(2b) SO_2	(3a) COD	(3b) COD
Messaging Gov Privately	-0.002	-0.002	-3.0	-3.4	-0.1	-0.1
(T1A*Post)	(0.001)	(0.001)	(8.1)	(8.0)	(1.1)	(1.1)
Website Appeal Privately	-0.002	-0.001	-4.8	-4.7	-0.3	-0.4
(T1B*Post)	(0.001)	(0.001)	(5.6)	(5.6)	(1.1)	(1.0)
Call Gov Privately (T1C*Post)	-0.003	-0.002	-4.0	-4.6	-0.7	-0.6
	(0.001)	(0.001)	(5.8)	(5.6)	(0.8)	(0.8)
Call Firm Privately (T1D*Post)	-0.001	-0.001	-4.7	-5.1	-0.6	-0.6
	(0.001)	(0.001)	(4.3)	(4.4)	(1.2)	(1.2)
Call Gov*Call Firm	-0.001	-0.001	-1.9	-1.5	1.4	1.3
(T1C*TID*Post)	(0.002)	(0.001)	(7.8)	(7.7)	(1.4)	(1.4)
Appeal Publicly on Weibo	-0.006	-0.006	-15.8	-16.3	-2.1	-2.2
(T2*Post)	(0.002)	(0.001)	(4.4)	(4.5)	(1.23)	(1.2)
H0: T1A=T1B=T1C=T1D	P=0.35	P=0.46	P=1.00	P=1.00	P=0.94	P=0.93
Control Mean	0.009	0.009	132.5	132.5	59.1	59.1
Control SD	0.096	0.096	539.5	539.5	78.8	78.8
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Day FE	Yes		Yes		Yes	
Province by Day FE		Yes		Yes		Yes
Observations	7,100,881	7,100,881	2,216,208	2,216,208	2,459,622	2,459,622

Note: This table reports the regression results from estimating Equation (1). In Columns (1a) and (1b), we use firm-day level data, and the outcome variable is a dummy variable that equals 1 if the firm violates an emission standard on that day, and zero otherwise; in Columns (2a) and (2b), we use pipe-day level data, and the outcome variable is the daily average emission concentration of SO_2 (mg/m3); in Columns (3a) and (3b), we use pipe-day level data, and the outcome variable is the daily average emission concentration of COD (mg/L). For each outcome, in the column "a", we control for firm FE and day FE; in the columns "b", we control for firm FE and province-by-day FE. Standard errors are clustered two-way by prefecture and week.

Table A7. Violations and Political Incentives

Panel A. Pre-treatment Violations

	(1a) Pre-treatment Violation (one month prior)	(1b) Pre-treatment Violation (three months prior)
Strong	0.021	0.027
	(0.008)	(0.011)
Control Mean	0.019	0.044
Control SD	0.137	0.205
Observations	25,969	25,969

Panel B. Heterogeneity by Political Incentives

	(1) Violation	(2) SO_2	(3) COD
Private Appeals (T1*Post)*Strong	-0.003	-4.8	1.4
	(0.002)	(8.2)	(1.8)
Public Appeals (T2*Post)*Strong	-0.007	-8.7	2.9
	(0.003)	(9.3)	(2.5)
Private Appeals (T1*Post)	-0.001	-0.1	-1.5
	(0.001)	(6.4)	(1.4)
Public Appeals (T2*Post)	-0.003	-11.4	-4.3
	(0.001)	(7.8)	(2.3)
Post*Strong	0.003	1.5	-1.7
	(0.002)	(6.6)	(1.6)
Firm FE	Yes	Yes	Yes
Province by Day FE	Yes	Yes	Yes
Observations	5,728,548	1,655,730	1,995,792

Note: Panel A reports the results of regressing whether a firm had any violations during a period before the experiment on whether the promotion incentive of local regulator is strong, which is a dummy variable. In Column (1a), the time range covers one month prior to the experiment; and in Column (1b) it covers three months prior to the experiment. Control Mean and SD are statistics of the pre-treatment violations. Standard errors are clustered at the prefecture level. Panel B reports the results for heterogeneity analyses. In Column 1, we use firm-day level data, and the outcome variable is a dummy variable that equals 1 if the firm violates an emission standard on that day, and zero otherwise; in Column 2, we use pipe-day level data, and the outcome variable is the daily average emission concentration of SO_2 (mg/m3); in Column 3, we use pipe-day level data, and the outcome variable is the daily average emission concentration of COD (mg/L). Strong is a dummy variable that equals 1 if the promotion incentive of local regulators is strong, which is defined as being in the last three years of their terms. We control for firm FE and province-by-day FE. Standard errors are clustered two-way by prefecture and week.

Table A8. Social Media Publicity and Firm Violations

	(1a) Total violations	(1b) Total violations	(2a) Any future violation	(2b) Any future violation
1st Violation Received Promoted Weibo Appeal	-0.333	-0.350	-0.088	-0.082
	(0.174)	(0.203)	(0.049)	(0.053)
Pre-violations	0.031	0.033	0.002	0.002
	(0.010)	(0.011)	(0.002)	(0.002)
Control Mean	0.703	0.703	0.319	0.319
Control SD	2.001	2.001	0.468	0.468
Month FE	Yes	Yes	Yes	Yes
Province FE		Yes		Yes
Observations	337	332	337	332

Note: This table reports the regression results for public Weibo appeals on firm violations. We use the sample of firms in the public Weibo appeal to government arm, and keep only the first-time appeals. The unit of analysis is the initial Weibo appeal of each firm. Specifically, we compare the subsequent violation patterns for firms that randomly received promoted vs. non-promoted Weibo appeals for their *first* violations. "Any future violation" is a dummy variable that equals 1 if there is another violation committed by this firm during our experimental period, and 0 otherwise.

Table A9. Impacts on Other Citizen Appeals

	(1a)	(1b)
	Other Citizen Appeals	Other Citizen Appeals
Panel A. Impacts of Private and Public Appeals		
Private Appeals (T1*Post)	-0.0000	-0.0000
	(0.0001)	(0.0001)
Public Appeals (T2*Post)	-0.0000	-0.0001
	(0.0001)	(0.0001)
H0: T1<T2	P=0.50	P=0.42
Panel B. Impacts of the Sub-Treatments		
Messaging Gov Privately (T1A*Post)	0.0000	0.0000
	(0.0001)	(0.0001)
Appeal Gov Website Privately (T1B*Post)	0.0000	-0.0000
	(0.0001)	(0.0001)
Call Gov Privately (T1C*Post)	-0.0001	-0.0001
	(0.0002)	(0.0002)
Call Firm Privately (T1D*Post)	-0.0001	-0.0001
	(0.0001)	(0.0001)
Call Gov*Call Firm (T1C*TID*Post)	0.0002	0.0002
	(0.0002)	(0.0002)
Appeal Publicly on Weibo (T2*Post)	-0.0000	-0.0001
	(0.0001)	(0.0001)
H0: T1A=T1B=T1C=T1D	P=0.74	P=0.70
Control Mean	0.001	0.001
Control SD	0.027	0.027
Firm FE	Yes	Yes
Day FE	Yes	
Province by Day FE		Yes
Observations	7,100,881	7,100,881

Note: This table reports the regression results of replacing the dependent variables of Equation (1) with the number of appeals made by other citizens. In Column (1a), we control for firm FE and day FE. In Column (1b), we control for firm FE and province-by-day FE. Standard errors are clustered two-way by prefecture and week.

Table A10. Social Media Publicity and Other Citizen Appeals

	(1a)	(1b)
	Other Citizen Appeals	Other Citizen Appeals
Visibility Promotion (T2B)	-0.011	-0.007
	(0.017)	(0.018)
Control Mean	0.041	0.041
Control SD	0.200	0.200
Day FE	Yes	Yes
Province FE		Yes
Observations	408	403

Note: This table reports the regression results for visibility promotion on other citizen appeals. We use the sample of firms in the public Weibo appeal to government arm. The unit of analysis is each Weibo appeal. Other Citizen Appeals is a dummy variable that equals 1 if there were any appeals filed by other citizens after the Weibo appeal, and 0 otherwise. In column (1a), we control for month FE; in column (1b), we control for month FE and province FE.

Table A11. Effects of Multiple Private Appeals

	(1) SO_2 Concentration Diff	(2) SO_2 Violation Diff	(3) COD Concentration Diff	(4) COD Violation Diff
Multiple Appeals	4.8	-0.001	1.1	-0.002
	(3.9)	(0.006)	(1.6)	(0.007)
Baseline Concentration	-0.0	-0.000	-0.1	-0.000
	(0.0)	(0.000)	(0.0)	(0.000)
Control Mean	-1.4	-0.005	-1.3	-0.022
Control SD	62.8	0.093	27.8	0.110
Day FE	Yes	Yes	Yes	Yes
Province FE	Yes	Yes	Yes	Yes
Observations	1,731	1,731	2,187	2,187

Note: This table reports the effects of multiple private appeals using real-world appeal information. In Columns (1), the outcome variable is the change in emission concentration of SO_2 (mg/m3); in Column (2), the outcome variable is the change in violation probability of SO_2; in Column (3), the outcome variable is the change in emission concentration of COD (mg/L); in Column (4), the outcome variable is the change in violation probability of COD. Multiple Appeals equals 1 if there are more than one citizen filing the appeal, and 0 otherwise. We control for day FE and province FE.

Table A12. Pollution Appeals and Abnormal Concentrations

	(1a)	(1b)	(2a)	(2b)
	CEMs Operated <20 Hours in a Day	CEMS Operated <20 Hours in a Day	Abnormally Low Recorded Concentration	Abnormally Low Recorded Concentration
Panel A. Impacts of Private and Public Appeals				
Private Appeals (T1*Post)	-0.003	-0.005	0.000	-0.001
	(0.005)	(0.004)	(0.005)	(0.005)
Public Appeals (T2*Post)	-0.006	-0.012	0.002	-0.001
	(0.006)	(0.006)	(0.006)	(0.006)
H0: T1<T2	P=0.23	P=0.03	P=0.68	P=0.45
Panel B. Impacts of the Sub-Treatments				
Messaging Gov Privately (T1A*Post)	0.002	0.003	0.002	0.002
	(0.005)	(0.005)	(0.005)	(0.005)
Appeal Gov Website Privately (T1B*Post)	-0.005	-0.009	-0.005	-0.006
	(0.007)	(0.006)	(0.007)	(0.006)
Call Gov Privately (T1C*Post)	-0.004	-0.007	0.001	0.000
	(0.006)	(0.005)	(0.007)	(0.006)
Call Firm Privately (T1D*Post)	-0.006	-0.006	-0.001	-0.000
	(0.006)	(0.005)	(0.006)	(0.006)
Call Gov*Call Firm (T1C*TID*Post)	0.009	0.007	0.002	0.001
	(0.007)	(0.007)	(0.009)	(0.009)
Appeal Publicly on Weibo (T2A*Post)	-0.006	-0.012	0.002	-0.001
	(0.006)	(0.006)	(0.006)	(0.006)
H0: T1A=T1B=T1C=T1D	P=0.36	P=0.11	P=0.54	P=0.44
Control Mean	0.092	0.092	0.093	0.093
Control SD	0.289	0.289	0.291	0.291
Firm FE	Yes	Yes	Yes	Yes
Day FE	Yes		Yes	
Province by Day FE		Yes		Yes
Observations	3,367,352	3,367,115	3,367,352	3,367,115

Note: This table reports the regression results from estimating Equation (1) using firm-day level data. Abnormal Hour is a dummy variable that equals 1 if the firm's hourly records are fewer than 20 on that day, and zero otherwise. Abnormal Concentration is a dummy variable that equals 1 if the firm's daily average emission concentration of SO_2 (mg/m3) or COD (mg/L) is smaller than 1/10 annual average level, and zero otherwise. In Columns 1 and 3, we control for firm FE and day FE; in Columns 2 and 4, we control for firm FE and province-by-day FE. Standard errors are clustered two-way by prefecture and week.

Table A13. Threats and Government Responsiveness

	(1a) Whether Respond	(1b) Whether Respond	(2a) Response Length	(2b) Response Length	(3a) Onsite Audit	(3b) Onsite Audit
Threat to Tell Upper-Level Government	0.01	0.02	-5.6	-8.4	-0.02	-0.02
	(0.03)	(0.03)	(19.3)	(19.2)	(0.02)	(0.02)
Threat to Tell Media	0.04	0.05	22.9	19.3	-0.00	-0.00
	(0.03)	(0.03)	(21.9)	(21.8)	(0.03)	(0.03)
Control Mean	0.59	0.59	161.3	161.3	0.21	0.21
Control SD	0.49	0.49	329.0	329.0	0.40	0.40
Month FE	Yes	Yes	Yes	Yes	Yes	Yes
Province FE		Yes		Yes		Yes
Observations	1,579	1,578	1,579	1,578	1,579	1,578

Note: This table reports the regression results for private appeals on local government responsiveness. We use the sample of firms in the private appeals to government arm. The unit of analysis is each private appeal. Whether respond is a dummy variable that equals 1 if the government formally replies to our private appeal, and 0 otherwise; response length is the word count of the government's reply to our appeal, which is counted as zero if there is no response; onsite audit is a dummy variable that equals 1 if the government replies to our private appeal with proof of an onsite investigation, and 0 otherwise. For each outcome, in the column "a", we control for month FE; in the columns "b", we control for month FE and province FE.

Table A14. Treatment Effects of Appeals

Panel A. First stage				
	(1a) Private Appeal	(1b) Public Appeal	(2b) Private Appeal	(2b) Public Appeal
T1*Post	0.086		0.086	0.000
	(0.007)		(0.008)	(0.001)
T2*Post		0.099	0.001	0.100
		(0.009)	(0.005)	(0.009)
Firm FE	Yes	Yes	Yes	Yes
Day FE	Yes	Yes		
Province by Day FE			Yes	Yes
Kleibergen-Paap rk Wald F statistic	75.21		58.06	
Observations	7,100,881	7,100,881	7,100,881	7,100,881

Panel B. Second stage: IV estimates						
	(1a) Violations	(1b) Violations	(2a) SO_2	(2b) SO_2	(3a) COD	(3b) COD
Private Appeal	-0.032	-0.026	-48.5	-48.5	-3.5	-4.3
	(0.011)	(0.011)	(31.4)	(31.5)	(10.7)	(10.3)
Public Appeal	-0.062	-0.057	-141.7	-137.1	-21.5	-23.0
	(0.017)	(0.015)	(45.0)	(43.0)	(13.1)	(12.3)
H0: T1<T2	P=0.01	P=0.01	P=0.02	P=0.03	P=0.05	P=0.05
Control Mean	0.009	0.009	132.5	132.5	59.1	59.1
Control SD	0.096	0.096	539.5	539.5	78.8	78.8
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Day FE	Yes		Yes		Yes	
Province by Day FE		Yes		Yes		Yes
Observations	7,100,881	7,100,881	2,216,476	2,216,208	2,459,671	2,459,622

Note: This table reports the regression results from estimating the 2SLS equations. Panel A reports the first stage of violation analysis. In Columns (1a) and (1b) of Panel B, we use firm-day level data, and the outcome variable is a dummy variable that equals 1 if the firm violates an emission standard on that day, and zero otherwise; in Columns (2a) and (2b) of Panel B, we use pipe-day level data, and the outcome variable is the daily average emission concentration of SO_2 (mg/m3); in Columns (3a) and (3b) of Panel B, we use pipe-day level data, and the outcome variable is the daily average emission concentration of COD (mg/L). We control for firm FE and province-by-day FE. Standard errors are clustered two-way by prefecture and week.

Appendix B. Sample Templates for Each Arm

T1A: sending direct message to regulator on social media

Hello, I found that the daily average concentration of chemical oxygen demand of Xinxing Paper Co., Ltd. from Youxi County exceeded the standard value on December 25. Please refer to the attached screenshot and check the issue, thank you.

您好，我观察到尤溪县鑫兴纸业有限公司 12 月 25 日化学需氧量日均浓度超越标准值。详情见截图，请您关注并核查，谢谢。

T1B: appealing to the regulator on government website

The Fujian online monitoring platform shows that on September 15, the daily average concentration of ammonia nitrogen in the total sewage discharge outlet and the wastewater discharge outlet of Quanzhou Kaiying Power Supply Appliance Co., Ltd. exceeded the emission standard. Please refer to the attached screenshot. Please check and reply.

福建省在线监测平台显示 9 月 15 日泉州市凯鹰电源电器有限公司的污水总排放口、生产废水排放口氨氮日均浓度超标。详情见附件。请核查并说明原因。

***T1C:* appealing to the regulator by calling government hotline**

Hello, the Jiangsu Enterprise Automatic Monitoring Information Platform showed that the daily average concentration of total phosphorus in the sewage discharge outlet of Jiangyin Biyue Wastewater Treatment Co., Ltd. exceeded the standard on June 22. Please investigate and give feedback.

您好，江苏省企业自动监测信息平台显示 6 月 22 日江阴碧悦污水处理有限公司污水排放口总磷日均浓度超标。请调查并给予反馈。

T1D: appealing to the firm by phone call

Hello, I am an environmental protection enthusiast. I noticed that on May 29th, the daily average value of smoke and dust from your company's No. 1 exhaust gas discharge outlet exceeded the standard. Please pay attention to it and investigate, thank you.

您好，我是环保热心群众。我留意到 5 月 29 日贵公司的 1#废气排放口烟尘日均值超标，请您关注并进行调查，谢谢。

T2: publicly appeal to the government on Weibo

No threat

The industrial waste gas discharge outlet of Hengrun Coal Chemical Co., Ltd. located in Shenmu County exceeded the emission standard on May 29th. Please refer to the attached screenshot. Please check and provide feedback on the emission violation in time @ Yulin Ecological Environment Bureau

位于神木县的恒润煤化工有限公司的工业废气排放口 5 月 29 日烟尘日均在线数据超标，见附图，请及时核查并反馈超标原因@榆林市生态环境局

Media threat

Zhejiang Qunzhan Precision Fasteners Co., Ltd. in Jiashan County exceeded the standard value of daily average chemical oxygen demand emission at its wastewater discharge outlet on October 9. Please refer to the attached screenshot. Please check and give feedback @ Jiaxing Ecological Environment Bureau @ Jiashan Ecological Environment Bureau, if there is no response in time, I will contact the media about this matter.

嘉善县的浙江群展精密紧固件股份有限公司 10 月 9 日废水排放口化学需氧量日均值超越标准值，见附图，请核查并作出反馈@嘉兴生态环境 @嘉善环保，若未及时回复将进行媒体公开。

Upper-level government threat

The waste incinerator at discharge outlet No. 1 of Zhejiang Chunhui Environmental Energy Co., Ltd, located in the Shangyu Economic and Technological Development Zone, exceeded the daily standard value of sulfur dioxide emissions on August 16. Please refer to the attached screenshot. Please check and reply @Shaoxing Ecological Environment Bureau. If there's no reply in time, I will report this issue to the upper-level environmental protection department.

上虞经济技术开发区的浙江春晖环保能源有限公司 1#排放口 1#垃圾焚烧炉于 8 月 16 日出现二氧化硫日均值超标情况。详见附图。请核查并作出说明@绍兴生态环境，如未回复将向上级环保部门反映。

Screenshots of Experiment Implementation Details

Sample CEMS Violation Screenshot:

Screenshot for T1:

T1A: sending direct message to regulator on social media

- Find the official Weibo account of the city/county's environmental bureau

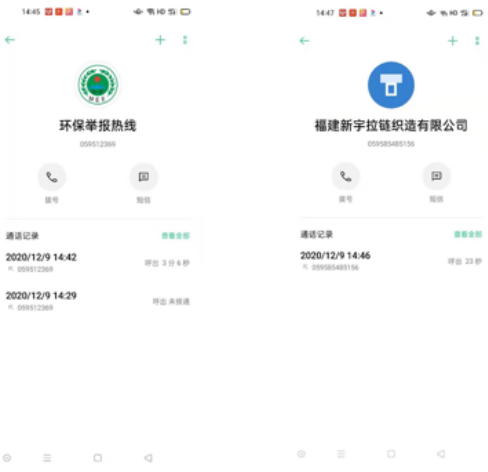
- We send pollution violation information to the government through the private messages
- Testing the information barrier hypothesis

T1B: appealing to regulator on government website

On the 12369 websites, we describe the appeals and upload the screenshot.

After submitting an appeal, we will get a search code, and then we can use it to check the responses.

T1C/T1D: appealing to regulator and/or firm by phone call



Screenshot for T2:

T2: public appeal to government on Weibo

- On Weibo, we publish the company's violation information and relevant screenshots
- Use the @ function of Weibo to remind the official accounts of relevant local environmental protection bureaus to pay attention to this complaint and respond

Appendix C. Ethical Considerations

Overview

This field experiment involved working with a team of graduate students in environmental science to verify the compliance of firms with environmental standards using publicly available data from the Continuous Emissions Monitoring System (CEMS) set up under the "Measures for the Self-Monitoring and Information Disclosure of National Key Monitoring Enterprises (Trial)". We identified violations on a daily basis and, upon observing violations, we generated private or public appeals to be filed with local governments or firms by a group of citizen environmental volunteers that we recruited from one of China's local environmental protection NGOs. We use responses to the appeals and publicly available data on violations and emissions to measure the impacts of appeals.

The central government has explicitly encouraged the public to appeal violations and has mandated that local governments create specific channels for public participation, which we use to file appeals. Our field experiment is thus layered on top of existing firm-level disclosure mandates and utilizes existing channels sanctioned for public participation in the supervision of environmental regulations. Prior to launching the field experiment, we considered the impacts the treatments may have on several classes of humans and institutions.

Human Subjects

We did not collect data from or about any individual person as part of this study. All the appeals in the experiment were disseminated to institutional accounts of local governments and firms. All data used for analysis are publicly available (or a direct response to an appeal submitted as part of the experiment) and do not identify any individual government official or firm employee. Prior to launching the experiment, we sought clarification on the status of the research from the Institutional Review Boards at the University of Chicago and the University of California, Santa Barbara. Because we did not collect data about or from individual human beings, both boards determined that this project is not considered research with human subjects (UChicago protocols IRB19-1744, and letter of determination dated October 18, 2019 from UCSB FWA#00006361).

Citizen Volunteers

We partnered with several environmental protection NGOs in China to recruit a group of citizen environmental volunteers, who made public and private appeals when violations were identified using the Continuous Emissions Monitoring System (CEMS). We carefully considered the potential impacts of this research on the safety and employability of the citizen volunteers. We

reviewed policy documents relevant to public participation in environmental governance in China and determined that the kinds of activities that research staff undertook for the experiment are both permitted and encouraged under current legal standards (for details, please refer to China's new environmental law and the "Interim Measures for Public Participation in Environmental Impact Assessment" and the "Provisional Measures for Encouraging Environmental Violation Appeals"). We consulted with several non-government organization that had been making similar appeals for several years and did not learn of any negative repercussions for their organizations or individual staff. During the experiment and afterwards, we were in daily contact with the citizen volunteers who made appeals and actively monitored for adverse events. We received no indications that governments or firms attempted to sanction the citizen volunteers in any way for filing appeals, likely because all appeals in this experiment used channels explicitly permitted and encouraged under central policies.

Impacts on Local Governments

This field experiment increased the number of appeals about violations of pollution standards that were filed with local governments. It is likely that responding to these appeals involved time and effort. It is important to note that local governments are explicitly mandated to respond to appeals from the public and actively monitor reports of non-compliance through various channels for public participation ("Provisional Measures for Encouraging Environmental Violation Appeals"). Thus, while our experiment may have increased the effort required by local governments to regulate pollution, that effort is consistent with existing mandates and responsibilities under the law.

We considered the possibility that appeals from a research project could make local governments less responsive to public appeals in the future. We believe this is unlikely given the size of our experiment relative to existing public participation in environmental supervision. During the experiment, we identified a total of 5366 violations across all the experimental arms. Data from channels for public participation such as the 12369 hotline and website indicate that more than 600,000 appeals about pollution are filed by the public annually. Accordingly, we do not believe that the intensity of the treatments will influence government responsiveness to the public in the future. We also consulted with local organizations like the Institute of Public and Environmental Affairs (IPE) and the Public Environment Concerned Center (PECC) to ensure that the appeals filed during the experiment were consistent in channel and content with other public appeals.

Impacts on Firms

The firms that were subject to appeals in this field experiment may have had to increase their effort to comply with environmental standards, which likely imposed costs. We note that appeals were only triggered for firms that exceeded existing pollution standards set by Ministry of Ecology and Environment. Since the current environmental law has made it clear that these violations should be eliminated to promote environmental quality and public health, we considered it acceptable to impose costs of firms through the treatment, since policymakers have judged those costs to be acceptable considering the potential public benefits of reductions in pollution.

Appendix D. Treatment Effects of Appeals

Our baseline analysis focuses on the intention to treat (ITT) effects, which are smaller than the treatment effects of appeals for two reasons: (1) some firms assigned to treatment never violate and are thus not treated with an appeal; and (2) firms assigned to treatment that eventually violate do not receive an appeal until they commit their first violation. The intent to treat (ITT) effects averages the pre-violation and post-violation days of firms assigned to an appeals treatment.

To quantify treatment effects of appeals, we can thus adjust the baseline specification with an instrumental variable (IV) approach, where whether a firm has received an appeal is instrumented by its by "treatment assignment * whether experiment has started." Day fixed effects account for the growing propensity to receive an appeal as more time passes in the experiment. Specifically, we estimate the following 2SLS equations:

First stage:

$$\sum_j Appealed_{ijt} = \sum_j \alpha_j T_{ij} \cdot Post_t + \gamma_i + \eta_t + \epsilon_{ijt}$$

Second stage:

$$Y_{ijt} = \sum_j \widehat{Appealed}_{ijt} + \gamma_i + \eta_t + \epsilon_{ijt}$$

The 2nd stage IV results provide the treatment effects of different types of appeals. As shown in Appendix Table A14, receiving an appeal by citizens leads to large and significant reductions in violation rates, particularly if done publicly. The treatment effects of appeals are much larger than the ITT estimates, reflecting the fact that the baseline violation rate is very low and many of the firms assigned to the treatment arms never actually triggered the treatment or only triggered it after a substantial amount of the experimental period elapsed.