Addressing Environmental Justice through In-Kind Court Settlements

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Abstract

In US environmental court cases, a cash penalty can be mitigated if a defendant volunteers to undertake an in-kind project, for example, retrofitting school buses or building a public park. A goal of the policy is to address environmental justice concerns for low-income and minority populations, yet the historical record shows in-kind settlements most likely occur in the cases involving high-income, majority-white communities. A choice experiment reveals the public prefers in-kind settlements over cash, and a randomized survey reveals in-kind settlements improve the public's view of a violating firm, consistent with our finding of positive stock-market reactions to in-kind settlements.

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Introduction

Court cases for corporate wrongdoing often result in a defendant mitigating a cash penalty with an in-kind project, for example, by creating a training session or a public park. In the US, in-kind settlements have long been used in cases involving violations of environmental regulations, with one goal of addressing environmental justice (EJ) concerns in communities with low incomes and a high share of minorities. The implications of in-kind settlements are not straightforward yet policies on their use are being made in the absence of any quantitative analysis.

This paper provides insights into in-kind settlements, answering questions such as: What is the public's perception of in-kind versus cash settlements? In which communities are cases most likely to settle with in-kind projects? What are the implications for the defendants? What are the consequences for future environmental quality? We offer guidance to the now changing polices on in-kind settlements and contribute to the general discussion on targeting goods, environmental justice, corporate environmental stewardship, and the efficacy of environmental enforcement actions.

We estimate implications of in-kind settlements for firms and communities using the history of US federal environmental case settlements. Every year around 5,000 cases are brought against defendants for violating federal environmental statutes, such as the Clean Air Act and Clean Water Act. In the settlement of these cases, the Environmental Protection Agency (EPA) gives defendants the opportunity to reduce the assessed cash penalty by volunteering in-kind projects in the location of the violation. The projects have to go above and beyond what would be legally required of the defendant. They span a wide array of environmentally beneficial interventions including, for example, lead abatement, retrofitting school buses, emergency equipment for the local fire department, as well as upgrades at the violating facility. Typically every year around 56% of the cases result in cash settlements and around 4% include an in-kind project.

The EPA encourages the use of in-kind settlements in communities with environmental justice (EJ) concerns by naming EJ as a critical factor when evaluating a settlement. Whether the EPA's

efforts result in communities with EJ concerns being the site of more in-kind settlements is not obvious ex-ante. While EPA guidelines encourage in-kind settlements in communities with EJ concerns, the EPA does not have the statutory authority to require an in-kind settlement; in-kind projects must be volunteered by the firm and then approved by the EPA. The negotiations between firms and the regulator, with input from the community, give room for non-EJ communities to push for in-kind settlements. This paper provides the first description of which communities are more likely to benefit from in-kind settlements. More generally, this paper attempts to shed light on a policy that tries to combat environmental injustice. While the correlation between pollution and socioeconomics has been well documented (for reviews, see Mohai et al., 2009, Banzhaf et al., 2018 and Banzhaf et al., 2019), policies to combat environmental injustice directly have so far been little studied.[1] We find in-kind settlements occurring mostly in cases involving communities with the lowest incomes and largest share of minorities, but also in cases involving communities with the highest incomes and lowest share of minorities. Our findings suggest that the EPA's attempt to target EJ communities has less sway than the systemic factors that determine settlement decisions.

Next we investigate public preferences on in-kind settlements. We find that the policy to target communities vulnerable to EJ concerns is preferred by the general public. In a choice experiment with a representative sample of nearly 2,500 US residents, we allowed survey respondents to choose their preferred settlement: either a cash penalty to the US Treasury or an in-kind project targeted to the area of the violation. In the experiment we randomly varied the price tag associated with the in-kind settlement, as well as whether respondents were told that the violation occurred in an area vulnerable to EJ concerns. The extent to which respondents would forgo cash to the Treasury for a targeted in-kind project is striking: over 85% respondents were willing to forgo two thirds of the cash penalty (i.e., respondents preferred $100,000 in in-kind to the afflicted community rather than $300,000 cash to the Treasury). Moreover, the EJ treatment results in a statistically significant increase (6 p.p.) in preference for in-kind, which is in line with the previous finding

[1] Broadly speaking, policies can indirectly address environmental justice if, by uniformly lifting environmental quality, disadvantaged groups obtain larger marginal benefits (Hsiang et al., 2020), or can directly address environmental justice by delivering more environmental goods to disadvantaged groups. Less research exists on policies direcly tackling EJ, including the EPA's in-kind settlement policy.

of a public preference for redistribution to individuals living in distressed areas (Gaubert et al., 2020).

We then turn to the implications of in-kind settlements for firms and find that firms benefit in two different analyses. In a randomized survey of the same sample of US residents we find evidence that an in-kind settlement improves the public's perception of a violating firm. In our survey, we randomly assigned respondents to read a description of a hypothetical settlement, involving either a cash payment to the US Treasury or an in-kind project to the violated community, and then asked respondents to express their perception of the violating firm (e.g., how good of an investment the company would make or their overall feeling toward the company). Survey respondents that were given the in-kind treatment had a much more favorable view of the company, even though the company was guilty of the same violation. These findings support the emerging view that corporate social responsibility (CSR) might be an optimal strategy for firms, given the preferences of shareholders, consumers, employees, activists, and regulators (Kitzmueller and Shimshack, 2012).[2]

We then also examine whether investors react more positively to in-kind settlements than cash settlements. We use data on US environmental cases occurring between 1997 and 2017 and measure whether the announcement of a firm volunteering an in-kind settlement is associated with a different stock-market response than the announcement of a cash penalty.[3] Recent papers have examined the stock-market impact of environmental enforcement actions (Karpoff et al., 2005; Armour et al., 2019; Brady et al., 2019), but so far no attention has been paid to the difference between cash and in-kind settlements.[4] Our stock-market findings are in line with the survey findings. While there is no significant difference in abnormal stock-market returns by settlement

[2]While part of an enforcement action, in-kind projects resemble CSR in that they commit firms to provide environmental benefits above and beyond legal requirements, and might therefore be part of a firm strategy to respond to stakeholders pressures.

[3]Investors may view settlement types differently for various reasons: the ultimate cost associated with in-kind settlements is uncertain, implying potential savings on the project cost; the project might involve investments that are beneficial for the firm; and the in-kind settlement might improve the firm's reputation, as suggested by the survey.

[4]For example, Earnhart and Segerson (2012) and Brady et al. (2019) examine the implications of sanctions on firms for environmental violations, and in-kind projects are summed with other penalty amounts.

type before the settlement announcement, the stock-market response to the announcement is asymmetric: cash settlements are associated with a negative stock-market reaction, whereas the in-kind settlements are associated with a positive stock-market reaction. We consider several case- and defendant-level characteristics by settlement type and find no evidence of other significant differences. We also restrict the analysis to in-kind settlements only and study the response to in-kind amount: the larger the in-kind settlement, the more positive the stock-market reaction. All in all, the stock market analysis and survey experiments suggest that, even though in-kind settlements arise out of wrongdoing as much as cash settlements, they provide relatively more benefits to violating firms.

Long-run dynamics make the environmental implications of in-kind settlements ambiguous. The benefits accrued to violating firms could result in diminished deterrence, negatively impacting environmental quality. Alternatively, in-kind settlements themselves could improve environmental quality as well as increase deterrence. First, firm goodwill could incentivize firms to undertake more environmental stewardship. Second, local communities might become more likely to monitor and report violations.[5] And third, an additional benefit to the firm arising from the US in-kind settlements is that they allow for the purchase of equipment for environmental improvements. New equipment can help the firm remain in compliance or even go above and beyond regulatory compliance. Our investigation into the implications of settlement type on future environmental quality finds that cash and in-kind settlements might lead to lower local pollution to a similar extent, but the imprecision of the estimates ultimately prevents us from drawing definite conclusions.

The rest of the paper is structured as follows. Section 1 describes environmental enforcement actions and the resulting settlements. Section 2 provides an outline of tradeoffs to consider when weighing in-kind versus cash settlements. Section 4 presents the current allocation of in-kind settlements across communities. In Section 5 we present results from an online survey of the public's

[5]The public procurement literature suggests that a public administration is more likely to report a breach of contractual terms if part of the monetary fine goes to the administration (see Dimitri et al., 2006). A similar argument can be extended to communities that would benefit from in-kind settlements.

preferences. In Section 6 we estimate the stock-market response to settlement announcements. Section 7 presents results on environmental quality. Section 8 concludes.

1 Institutional background

When an individual, firm, or local government is found violating U.S. federal environmental laws, the EPA may initiate enforcement actions against the violator. Enforcement can start with a Notice of Violation, intended to encourage the violator to return to compliance as quickly as possible. The EPA may then start a civil administrative action or a civil judicial action. Civil administrative and civil judicial actions are similar, with the main difference being that judicial actions are brought on behalf of the EPA to courts by the Department of Justice (DOJ) or, in the case of the state-led cases, to state courts by State Attorneys General.[6] The EPA chooses between an administrative or judicial action depending on factors such as, for example, how long it might take to get into compliance or how much penalty will be sought. The penalty is determined according to various factors, such as the magnitude of environmental harm ("gravity"), the firm's economic gain from violating, the violation history, and the ability to pay. Apart from the penalty, settlements also often record the costs required to get back into compliance ("compliance action costs").

During the settlement negotiation, the EPA allows firms to propose in-kind Supplemental Environmental Projects (SEPs) which can be used to mitigate the assessed cash penalty. Supplemental Environmental Projects are voluntary and are negotiated solely between the EPA and the violator,

[6]Criminal cases, citizen suits, and private-party suits are three other categories of enforcement actions but are not included in our study because they are not included in our dataset and also do not allow the option of in-kind projects. Citizen suits are also rare for statutes other than the Clean Water Act (Langpap and Shimshack, 2010). Cases are deemed criminal when they result in significant environmental harm and when there is proof of deliberate misconduct. Private citizens can bring suits to enforce federal laws, which can result in settlements of civil penalties, attorney's fees, and costs to the plaintiffs. Private-party suits are designed to recover monetary compensation for harm to the plaintiff.

with encouragement by the EPA to the violator to reach out to the community affected for ideas, but no formal requirement for community engagement exists.[7]

The EPA has total discretion on whether to accept or reject a proposed project. In this respect, the guidelines on Supplemental Environmental Projects caution consideration when mitigating penalties: "Penalties help maintain a national level playing field by ensuring that violators do not obtain an unfair economic advantage over their competitors who made the necessary expenditures to comply on time. Thus, any mitigation of penalties must be carefully considered" (U.S. Environmental Protection Agency, 2015). The entire penalty cannot be mitigated, and one dollar spent in a Supplemental Environmental Project can offset at most 80 cents of the penalty.[8]

Guidelines also state that Supplemental Environmental Projects are only allowed if they have sufficient "nexus" with the violation. The nexus between the violation and the proposed project is defined by medium and geography. The project must relate to the violation by reducing future violations, adverse impacts, or risks to public health or the environment affected by the violation. The project should also "generally be in the area within a 50-mile radius of the site on which the violations occurred" (U.S. Environmental Protection Agency, 2015). Supplemental Environmental Projects should also not be an action that the violator is legally required to take, and they should reach environmental benefits "beyond compliance." The EPA then evaluates each proposed project based on six critical factors, namely the extent to which it: benefits public health and the environment, addresses EJ concerns, gets input from the affected community, furthers innovation

[7]The EPA notes that missing community involvement in the development of Supplemental Environmental Projects could arise from a number of reasons, including disagreement within the community as well as the unwillingness of defendants (U.S. Environmental Protection Agency, 2003a). Another explanation for missing involvement could be that communities might not be well-positioned to participate in the legal and technical discussions that typically precede the establishment of in-kind projects (we thank an anonymous reviewer for raising this point).

[8]In the legal interpretation of the policy, Supplemental Environmental Projects are not penalties; the EPA clearly states that "SEPs are not penalties, nor are they accepted in lieu of a penalty" (U.S. Environmental Protection Agency, 2015). This is necessary to ensure the policy does not violate federal law. The US Miscellaneous Receipts Act (33 U.S.C. §3302(b)) requires cash penalties to be paid to the US Treasury. It is the EPA's view that Supplemental Environmental Projects are not a diversion of penalty funds (https://www.epa.gov/enforcement/supplemental-environmental-projects-seps). Nevertheless, Supplemental Environmental Projects are directly intertwined with penalties: the EPA acknowledges that "a primary incentive for a defendant to propose a SEP is the potential mitigation of its civil penalty" (U.S. Environmental Protection Agency, 2015). Thus we proceed with asking about the tradeoffs between a cash-only settlement and a settlement that includes a Supplemental Environmental Project but recognize that Supplemental Environmental Projects are not penalties but mitigating factors in penalty assessment.

that is environmentally beneficial, reduces pollution across more than one medium, and prevents pollution. Examples of Supplemental Environmental Projects can be found in Appendix Section A1, Tables A1 and A2.

Supplemental Environmental Projects are rare, occurring in 4.1% of the cases. We don't have a record of whether a Supplemental Environmental Project was proposed and turned down. Many of the cases settle without any penalty, and many with only small cash penalties, so in-kind projects of a comparable amount are unlikely to interest all the parties involved. Additional impediments of Supplemental Environmental Projects could arise from ensuring all legal guidelines are followed. Requirements include, for example, that the project is not otherwise legally required, the project has sufficient nexus with the violation, that it does not involve companies that are receiving federal loans, contracts, and grants, and firms cannot just simply write a donation cheque (U.S. Environmental Protection Agency, 1998). In general, the infrequency of Supplemental Environmental Projects suggests additional costs associated with including Supplemental Environmental Projects (see Section 2). Per guidelines, the EPA cannot demand, control, or manage Supplemental Environmental Projects, but the EPA has made official attempts to increase the use of Supplemental Environmental Projects, by shortening and simplifying the policy and providing information on completed and new projects (U.S. Environmental Protection Agency, 2003b). We interpret the EPA documents that point to the EPA actively seeking and encouraging Supplemental Environmental Projects to imply the infrequency of Supplemental Environmental Projects is likely driven by disinterest from firms and persistent administrative and legal impediments.

2 Conceptual framework weighing in-kind versus cash settlements

A settlement in-kind comes with both costs and benefits. Here we group these costs and benefits into four different categories:

Community and redistributive benefits. A central question in welfare economics is how to allocate goods to the most deserving party. Embedded in this question are choices on redistribution, ethics, and paternalism.

A social planner might prefer targeting of environmental projects on redistributive grounds for two reasons. First, as for many other goods, the value of an environmental project depends on the marginal utility of the environmental improvements, which vary by community depending on the existing levels of environmental quality, health conditions, or willingness to pay for defensive expenditures. Diminishing utility from improvements in environmental quality provides the first reason to target environmental projects in communities with disproportionate environmental burdens. Second, simple social welfare weights in a social welfare function that puts more weight on disadvantaged communities would provide additional impetus to target environmental projects. For example, a Rawlsian social welfare function, aiming for equality of opportunity, would put all weight on the most disadvantaged. Social welfare weights could also favor harmed communities based on the ethical justification of compensating those that were wronged.

Once a redistributive choice is made, an in-kind settlement might be preferred simply by being better able to deliver benefits to the targeted community.[9] This is particularly salient in the context of US federal law in which a cash penalty must go to the US Treasury while an in-kind project remains in the harmed community. Therefore, in the context of US EPA case settlements, weighing in-kind versus cash involves weighing the value of an environmental project in a local community compared to the value of cash in the Treasury.

Absent preferences for redistribution, an in-kind settlement can also be preferred by function of the specific type of good being delivered.[10] Environmental projects might be preferred for paternalistic reasons, in which improving environmental quality is preferred over improving overall welfare. In the presence of environmental violations, paternalistic preferences for environmental

[9] In the benefits transfer literature, e.g., food stamps or housing assistance, targeting the deserving party is easier with in-kind transfers than cash (Nichols and Zeckhauser, 1982; Blackorby and Donaldson, 1988; Currie and Gahvari, 2008; Lieber and Lockwood, 2019).

[10] We thank an anonymous reviewer for this point.

improvements might be even stronger. In-kind settlements would better satisfy paternalistic preferences for environmental quality, by allowing compensation to be of the same nature as the harm, or a "linked compensation" (Burtraw, 1991).

Administrative burden and political economy considerations. An in-kind settlement is administratively more burdensome than a cash-only settlement. The proposed project has to meet regulatory guidelines (e.g., sufficient nexus with the violation) and be contained within the limits imposed by federal law.[11] In an in-kind settlement, an accurate estimate of the project costs is needed and the amount of mitigation of the counterfactual cash penalty needs to be determined. Also needed is a definition of what will entail satisfactory completion, including a definition of the final product and timeline. Absent a stringent definition, the risk is that communities are satisfied with the project ex-ante but not ex-post.[12] Enforcement costs accrue when firms fail to complete a project satisfactorily. Overall the administrative and enforcement burdens are higher before and after an in-kind settlement.

On the other hand, in-kind settlements could have positive political economy implications. Cash-only settlements might elicit political concerns arising from how to distribute money in the public fund.[13] An in-kind project could prevent politicians from discretionary spending or time-inconsistent policymaking, similar to the advantages outlined in the earmarking literature (Brett and Keen, 2000 and Marsiliani and Renstrom, 2000).

Firm benefits. Given the administrative burden of assessing the cost of an in-kind project, firms could come out ahead on gross compliance grounds. After settlement approval, firms are the recipients of any efforts to minimize costs below what was listed in the settlement. The EPA

[11] As explained above, the US Miscellaneous Receipts Act gives the Congress the exclusive power over federal government spending, thus constraining what type of projects can be accepted. For instance, simply writing a check is not accepted.

[12] The EPA guidelines push for specifying the final product, not a minimum spending level. For example, a conservation project should specify the minimum number of acres of land to be purchased, even if market fluctuations make the cost uncertain (U.S. Environmental Protection Agency, 2015).

[13] Choices on re-distribution are ultimately political ones, and as such are influenced by, e.g., lobbying and electoral incentives (Pacca et al., 2021). One could argue that in-kind settlements help insulating the delivery of environmental projects from these influences, as compared to an approach where externalities are taxed and then money is distributed to the deserving party through the tax system.

discounts a dollar spent on in-kind relative to cash, which would dampen the potential cost savings of an in-kind settlement to the firm, but nonetheless, the amount listed in the settlement could be higher than the final amount spent.

Firms may also benefit from improved community and investor goodwill. The OECD observes that "in several OECD countries such as the US, the regulated community has been very receptive to this practice [in-kind settlements], as it helps an offender repair its public image tarnished by the violation" (OECD, 2009). Moreover, some projects could be profitable for the firm, for example those involving the installation of own pollution prevention technologies. The EPA flags the concern that in-kind projects "contribute to 'un-leveling the playing field' between violators and their competitors who stayed in compliance with the law" (U.S. Environmental Protection Agency, 2015) and has put in some rules on the length of time required before a project can be profitable. And most broadly, the EPA states that "while in some cases a SEP may provide the alleged violator with certain benefits, there must be no doubt that the project primarily benefits public health and/or the environment" (U.S. Environmental Protection Agency, 2015).

Dynamic implications. An efficient pollution policy entails a polluter facing a marginal cost of pollution that is equal to the marginal damage to the victims, such that the polluter undertakes their least-cost abatement strategies and the victims undertake their own least-cost averting expenditures. The choice of cash versus in-kind can move a settlement away from the theoretical optimum if the choice influences the behavior of communities and firms.

First, let's discuss the efficiency implications for communities. The theoretically optimal policy precludes victim compensation (Baumol and Oates, 1988; Cropper and Oates, 1992), because if a victim expects that they will be compensated, they are disincentivized from undertaking the efficient level of pollution avoidance. Moreover, knowledge of compensation could incentivize even more risk-taking. Burtraw (1991) argues moral hazard is more likely with cash compensation than in-kind compensation. However, in the US institutional context, federal cash penalties by law go to the US Treasury, so only in-kind settlements have the disadvantage of inciting inefficient pollution avoidance. An in-kind settlement might also lead to an inaccurate view of environmental safety.

For example, the construction of a vegetable garden in response to an air pollution violation might increase pollution exposure.[14] This concern stresses the importance of in-kind settlements to be of the same medium as the harm, which the EPA strives to do. Nonetheless, inefficiencies will arise if the amenities provided by in-kind settlements result in inefficient sorting into polluted areas.

Second, efficiency implications also arise on the side of the firm. One goal of penalties is to deter violations in the future.[15] As Aguzzoni et al. (2013) put it in their analysis of antitrust enforcement actions, "only if the penalties that firms incur when found guilty of antitrust infringement are large enough, will the firms be deterred from engaging in anti-competitive behavior." Their argument can naturally be extended to penalties associated with enforcement actions in other areas, including environmental enforcement. An in-kind settlement can also benefit the firm and, therefore can "undermine the deterrent value of penalties" (U.S. Environmental Protection Agency, 2015). In-kind settlements, with the firm benefits described above, could be a less lenient form of penalty, reducing deterrence of future violations.

The dynamic behavior of communities and firms together make the environmental implications of an environmental project less clear. If communities are more likely to monitor and report violations upon receiving an in-kind settlement, environmental quality could be improved further.[16] However, diminished deterrence from the less stringent sanction could negate the environmental improvements.

3 Data on settlements

The EPA keeps a record of all the enforcement cases for violations of federal environmental statutes and makes the information available in the Federal Enforcement and Compliance (FE&C) database

[14] "Port Arthur residents balking at Valero's proposed parkland near refinery," *San Antonio Business Journal*, Apr 6, 2015.

[15] "Penalties promote environmental compliance and help protect public health by deterring future violations by the same violator and other members of the regulated community" (U.S. Environmental Protection Agency, 2015).

[16] The public procurement literature suggests that a public administration is more likely to report a breach of contractual terms if part of the monetary fine goes to the administration (see Dimitri et al., 2006). A similar argument can be extended to communities that would benefit from in-kind settlements.

(U.S. Environmental Protection Agency, 2017).[17,18] These data track all formal administrative and judicial enforcement actions taken by the EPA and by some states.[19,20] We start the sample in 1997 because the EPA took an effort to improve reporting and tracking in 1996 and the data dictionary warns that cases entered prior to 1996 may not provide much settlement detail.[21] For each enforcement case, we use data describing the enforcement action from initiation to its conclusion. A single case may result in: no case conclusion (e.g., where a case is withdrawn and as such does not appear in our dataset), a single case conclusion, or multiple case conclusions. The most common occurrence is a single conclusion (nearly 92% of the cases); when there are multiple conclusions, the sum of their dollar values is assigned to the respective case. We convert all dollar amounts to their 2019 equivalent, using the Consumer Price Index from the Bureau of Labor Statistics (2019).

In more than half of the cases (57%), the defendant pays some form of penalty (cash or a combination of in-kind and cash). Summary statistics for cases that have some form of penalty are reported in the left panel of Table 1 below.[22,23] While Supplemental Environmental Projects are rare, occurring in 4.1% of cases, when they are present, their value is larger than cash penalties: the average in-kind settlement amount is around $300,000, whereas the average cash settlement is roughly $44,000. In general, the large standard deviation for the dollar amounts documents that the size of the settlements is highly variable. In nearly one third of the cases (32%), *Other*

[17]Federal environmental statutes include the Clean Air Act (CAA), the Clean Water Act (CWA), the Resource Conservation and Recovery Act (RCRA), the Emergency Planning and Community Right-to-Know Act (EPCRA) Section 313, the Toxic Substances Control Act (TSCA), the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund), the Safe Drinking Water Act (SDWA), and the Marine Protection, Research, and Sanctuaries Act (MPRSA).

[18]The FE&C data are available from the Enforcement and Compliance History Online (ECHO) system (https://echo.epa.gov/). ECHO incorporates data from the Integrated Compliance Information System (ICIS), used to track federal enforcement cases. For a detailed description of ICIS see https://echo.epa.gov/tools/data-downloads/icis-fec-download-summary

[19]These are the states that use the ICIS-National Pollutant Discharge Elimination System.

[20]Informal enforcement actions or notices of violations often precede a formal administrative or judicial enforcement action and are also tracked in ICIS, but they are not included in our dataset.

[21]See https://echo.epa.gov/tools/data-downloads/icis-fec-download-summary.

[22]The condition that the case has some form of penalty implies that it certainly includes a cash penalty, because the occurrence of a Supplemental Environmental Project is conditioned to the assessment of a cash penalty; the project can mitigate the penalty but never completely cancel it.

[23]In Table A3 in the Appendix, left panel, we also show summary statistics for the universe of cases from the FE&C dataset for years 1997 to 2017.

expenditures are included, namely compliance action cost[24] and recovery costs.[25] The bulk of the dollars paid by violating entities (around $4.5 million on average) goes into compliance action and recovery costs.

Table 1: Summary statistics of environmental enforcement actions

	Full sample		**Cases in stock-market analysis**	
	Mean	(Std. Dev.)	Mean	(Std. Dev.)
I(In-kind settlement)	.041	(.199)	.093	(.291)
I(Other $ amount)	.323	(.468)	.509	(.500)
Cash $ amount	44,588	(721,176)	251,673	(1,168,026)
In-kind $ amount, when present	304,794	(1,357,949)	352,717	(1,179,404)
Other $ amount, when present	4,467,918	(89,674,744)	12,556,564	(153,547,757)
Observations	56,631		678	

Notes: Summary statistics of single-defendant enforcement cases with some form of penalty, 1997-2017. The left panel includes any case with only one defendant and some penalty in the FE&C dataset. The right panel includes information for cases that we use in the stock-market analysis; see Section 6 for a description of how we selected these cases.

4 Which communities are getting in-kind settlements?

EPA guidelines demonstrate a preference for targeting in-kind settlements to communities with EJ concerns, in line with preferences among the public measured through our survey. Yet, due to several factors, it is not clear whether we would see more in-kind settlements ending up in these communities. First, there may be differences in exposure to violations. The environmental justice literature points to a number of reasons why pollution might be positively correlated with demographics indicating vulnerability, namely firms siting decisions based on economic factors such as taxes (Jenkins and Maguire, 2012), land, labor, or proximity to transportation networks (Wolverton, 2009), households sorting based on tradeoffs between housing prices and environmental quality (Banzhaf and Walsh, 2008; Kuminoff et al., 2013), differences in access to information (Hausman and Stolper, 2021), or racial steering by real estate agents (Christensen and Timmins, 2022). Indeed the high incidence of pollution in communities with EJ concerns is the main reason

[24]Compliance action cost includes the cost of the physical and nonphysical actions an entity must undertake to achieve and maintain compliance, including installing new pollution control devices to reduce emissions, preventing emissions of a pollutant etc.

[25]Recovery costs are costs to reimburse expenditures made by the EPA, usually to stabilize or clean up Superfund sites.

the EPA guidelines state that in-kind settlements "that benefit communities with EJ concerns are actively sought and encouraged." (U.S. Environmental Protection Agency, 2015).Second, the probability of detecting and enforcing a violation might be different for EJ communities; less political influence (Gray and Shadbegian, 2004) or structural racism (Bailey et al., 2017) could result in fewer inspections and less detection of environmental violations. The evidence on differences in enforcement suggests poor neighborhoods get fewer enforcement actions (Gray and Shadbegian, 2004; Konisky, 2009), with evidence on inspection counts mixed. Non-white neighborhoods have been found to have small or statistically insignificant differences in enforcement actions and inspection counts (Gray and Shadbegian, 2004; Konisky, 2009), but longer response times to non-compliant facilities (Konisky et al., 2021). Third, upon detection and prosecution, limited access to power, formal education, or language barriers could result in less ability to organize and be heard (Hamilton, 1995). EPA guidelines encourage communities to develop Supplemental Environmental Project-idea libraries that a defendant can turn to in case of a violation, suggesting ideas come "through town meetings, publications, the internet, or public hearings," (U.S. Environmental Protection Agency, 2003a). While community involvement is not a requirement in the approval of Supplemental Environmental Projects, a vocal community could either encourage or dissuade firms from undertaking a Supplemental Environmental Project. Fourth, the firm itself might be more or less willing to perform a Supplemental Environmental Project in a community with EJ concerns.

We study whether the EPA effort to promote in-kind settlements in EJ communities effectively results in more in-kind projects following those enforcement cases that involve such communities. To classify communities as susceptible to environmental justice concerns, we use a census-block-group demographic index that the EPA uses for the same purpose, namely to screen for areas that may be candidates for outreach, analysis, or activities, as part of a program called EJSCREEN. The EPA constructs EJ indices interacting the demographic index with population and 11 environmental indicators. The environmental indicators however do not cover all areas or time periods of our sample. In this paper, we use only the demographic index, not EJ indices, so that we have

more years of data.[26] We use data from the census' Integrated Public Use Microdata Series (2017) and re-construct the EPA's demographic index. The demographic index is the block-group average of the percent minority and percent low income.[27] We use the zip-code of the facility where the case occurred as the location of the in-kind project, given the rule that the project be within 50-miles of the violation, and assign the block-group demographics falling in the respective zip-code following boundaries from the United States Census Bureau (2017). We note that a 50-mile radius might encompass more than one zip code and we are therefore missing valuable information on where the in-kind project is targeted as compared to where the violation occurred. With this assumption, our findings only speak to the likelihood of cases in EJ areas to settle with in-kind projects, and we might miss some nuances as to the likelihood of in-kind projects being targeted to EJ areas.[28] Using the demographic index of the facility of the case, we categorize case locations into deciles, determined from the nationwide distribution of the demographic index across all US zip codes. Our results present information of the likelihood of settlement type using variation from areas of 50-mile radii across the US.

For each decile of the demographic index, we calculate the percent of cases that settle in-kind and find a U-shaped relationship (Figure 1). While there are fewer total cases in the first and tenth decile (as represented by the size of the circles), these are also the two deciles most likely to have an in-kind settlement when there is a case.[29] More specifically, the first decile, indicating

[26] One concern of using the demographic index and not the EJ indices, is that we are missing important information on which communities are overburdened by pollution. We show that the demographic index is correlated with environmental indicators, suggesting it might be a good proxy to capture overburden (Figure).

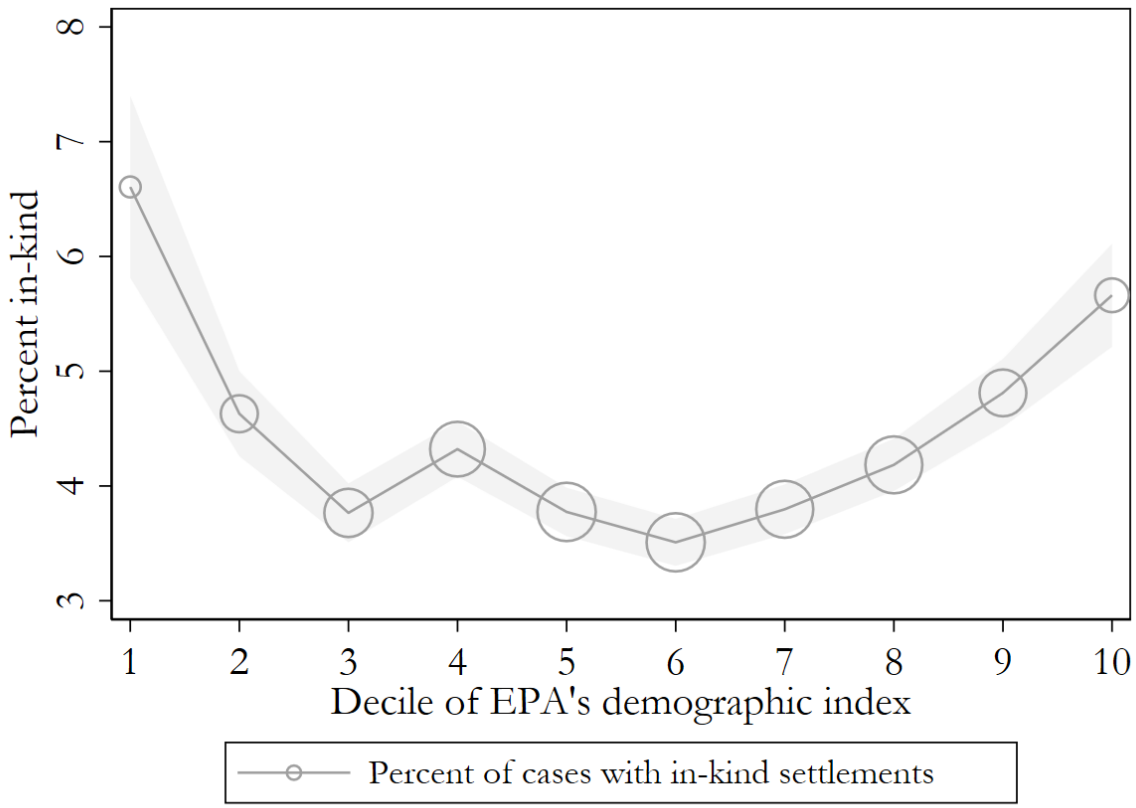
[27] Following the EPA's EJSCREEN methodology, percent minority is the percent of individuals in a block group who list their racial status as other than "non-Hispanic white-alone." Percent low income is calculated as the percent of the population for whom poverty status is determined, that have income below two times the federal poverty threshold. The EPA then takes the average: Demographic Index = (% minority + % low-income)/2).

[28] Using the facility's zip code as the location of violation also requires some caveats. Error would arise in a handful of cases when the violation occurs outside of the facility. The two largest settlements in the dataset, the BP oil spill and the Volkswagen Clean Air Act violation, would fall into this category and are dropped from our data. Similar smaller cases, however, are still included in the dataset. Additional error could stem from assuming that the violation affects everyone in the zip code equally, even though these zip codes vary in size. Further, the match with the affected area is imprecise when the nuisance is located near the zip code's boundary. Nevertheless, our reading of the cases leads us to conclude that the facility's zip code is the best indicator of where the violation occurred.

[29] We only include cases that have some form of monetary penalty, but the first and tenth decile also are the most likely to have in-kind settlements if we include all cases, even those that don't result in a punishment of any kind.

the whitest and richest communities, is the most likely to receive an in-kind settlement, and the 10th decile, indicating communities with the highest share of minority and poor individuals, is the second most likely. Summing up, the EPA's effort to prioritize communities with environmental justice concerns is partly overshadowed by systemic factors that determine settlement decisions.

Figure 1: In-kind settlements by decile of the EPA's demographic index



Note: Data include all cases from 1997-2017. Markers designate the percent of cases which resulted in one or more in-kind settlements, for each decile of the demographic index. Following the EPA, a zip code's susceptibility is calculated as the average between % low income and % minority and the decile is determined from the nation-wide distribution of zip codes. The size of each marker indicates the number of cases in each decile bin and the grey area designates one standard error above and below the mean.

5 What is the public's perception?

Using a choice experiment and a randomized survey we answer two intertwined questions: (1) does the public prefer in-kind local projects or cash paid to the Treasury in the settlement of environmental violations, and (2) does the type of settlement change the public's views about a company? The answers to these questions provide the first ever insights into public views around

an instrument that has been so far used, recommended, and modified in the absence of discussion in the economics literature.[30]

In what follows we first describe the study design and then present the results, and refer to the Online Appendix for more details (Section A3).

5.1 Survey design

Both our choice experiment and randomized survey were administered online through a survey firm (Prolific), and returned a sample of 2,361 respondents.[31] Respondents had two sections of a survey to answer, presented to them in random order.[32]

Part A: Choice experiment for public preferences and an attention question. The goal of the choice experiment was to assess whether and under what conditions the public prefers penalties as cash to the US Treasury versus in-kind projects targeted to the violated community. To this end, we described a fictitious situation, phrased to resemble as much as possible a typical environmental enforcement case in the US, where the EPA was negotiating a settlement with a company for an environmental violation, namely exceeding regulatory limits on air emissions. We also informed roughly half of the respondents, selected randomly, that the company's facility is located in a community vulnerable to environmental justice concerns.[33] Next we asked the respondents to choose their preferred settlement between a cash penalty of $300,000 to the US Treasury and an environmental project in the community.[34] Across roughly equally sized groups

[30] In similar spirit, Liscow and Pershing (2022) survey a sample of US residents about their preferences on in-kind versus cash transfers; they notice that while a large portion of US income redistribution happens through in-kind transfers, we know little about whether the US public prefers in-kind redistribution, how strong this preference may be, and why preference for in-kind redistribution might be prevalent.

[31] We record a 2.5% attrition rate of respondents not completing the survey. See Appendix Section A3 for causes of attrition.

[32] The flow of the survey is outlined in Appendix Figure A1.

[33] We explained what is a typical definition of environmental justice. See Figure A3 for the exact text that we used.

[34] We provided examples of in-kind projects, see Figure A3.

of respondents, we varied randomly the size of the cost of the in-kind project, presenting them with costs both larger and smaller than the cash option (see Figure A1).

The attention question at the end of Part A checked that the respondent could recollect the violation described in the previous question.[35]

Part B: Randomized survey of perception of firms. The goal of the randomized survey was to learn whether the public's perception of a firm that violates an environmental regulation is influenced by the type of settlement. First we informed the respondents that the EPA had concluded a settlement for environmental violations. Then we randomly allocated roughly half of them to read that the settlement consists of a cash penalty of $300,000, and the other half to read that the settlement consists of both a cash penalty of $150,000 and a $225,000 in-kind project (retrofitting local school buses).[36] Once given the information treatment, we asked respondents to indicate where their opinion about the company fell within five pairs of opposing statements describing overall perception of the company, as well as one's beliefs about the future company's relationship with some of its relevant stakeholders (investors, community, regulators).[37]

5.2 Survey Results

The sample is broadly representative of the US population on gender, employment status and ethnicity, based on a comparison with estimates from the US Census Bureau.[38]

[35] For text used, see Appendix Figure A4.

[36] This choice of dollar amounts was to keep the amounts as similar as possible to what one might see in EPA Supplemental Environmental Projects; the settlement cannot be completely mitigated by in-kind, and a dollar in-kind can only mitigate at most 80 cents.

[37] We randomized the order in which the respondent reads the statements. The five opposing statements read as follows: I feel negatively toward the company/I feel positively toward the company; The company will have a hard time hiring workers/The company will have an easy time hiring workers; An investment in the company would be a bad investment/An investment in the company would be a good investment; The company will have hard time getting community approval to expand operations in the area/The company will have an easy time getting community approval to expand operations in the area; The company is unlikely to comply with environmental regulation in the future/The company is likely to comply with environmental regulations in the future. Figure A3 depicts how the respondents saw the question and how they could express their position with respect to each of these pairs of statements.

[38] See https://www.census.gov/quickfacts/fact/table/US/PST045219. In the Appendix Section A3 we provide more details on sample representativeness.

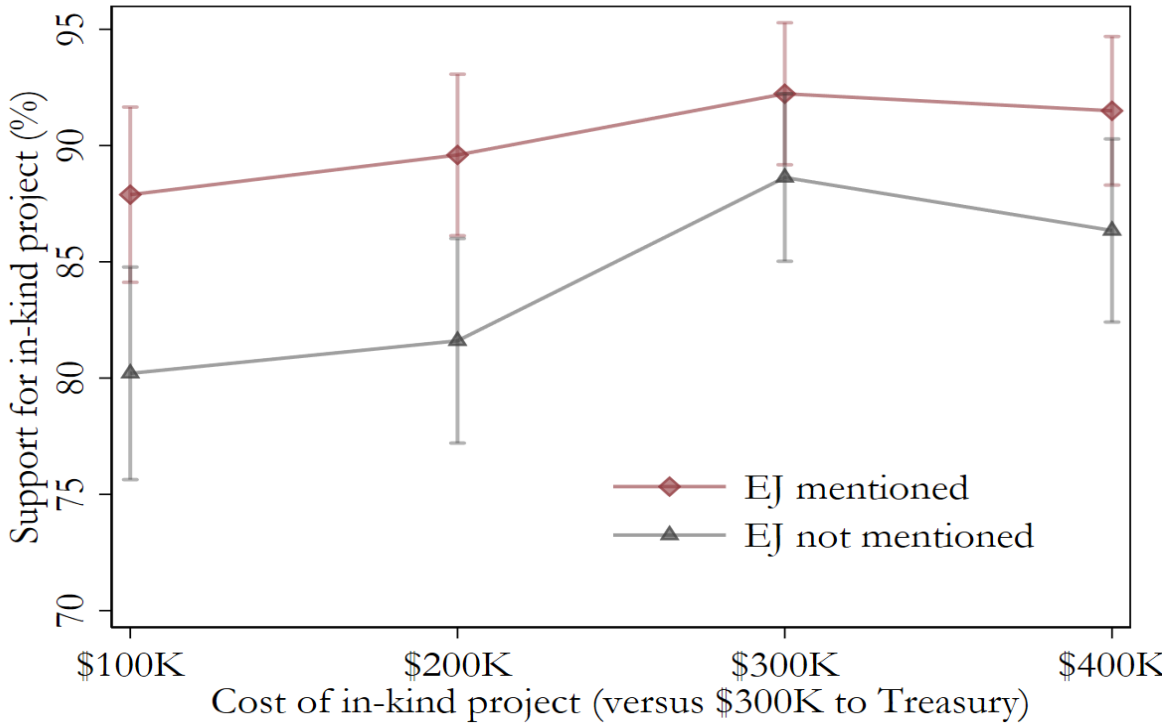
Part A: Choice-experiment of preference for settlement type. We summarize the results of the choice experiment in Figure 2 and Table 2. An overwhelming majority of respondents (87%) prefer in-kind settlements over cash penalties, even when the size (in dollar amount) is smaller; in other words, most respondents are willing to forgo cash in order to choose an in-kind settlement. The preference for in-kind settlements are also 6 p.p. larger when the settlement description mentions environmental justice concerns (see Table 2 column 1). Importantly, under the EJ treatment the size of the proposed in-kind project does not significantly impact the choice (see Table 2 column 3); instead, absent the EJ treatment the propensity to choose the in-kind project is significantly larger if the project size is equal to or larger than the cash punishment (see Table 2 column 2). Put differently, respondents are more willing to forgo money to choose an in-kind project when the violation occurred in a community subject to EJ concerns. Overall, the choice experiment suggests that (a) the public has a strong preference for in-kind settlements following an environmental violation and (b) the public sees in-kind settlmeents even more favourably when the violation and the project takes place in a community subject to EJ concerns.[39] We are further assured of the strong preference for in-kind settlements by the high rate of attention, since only 2.5% provided the wrong answer to our attention question.

Potential biases. Stated preference surveys have a wide range of potential biases (Arrow et al., 1993; Diamond and Hausman, 1994; Johnston et al., 2017). Three biases are most relevant for our choice experiment:

First, in experimenter-demand bias, respondents might change their responses in a conscious or subconscious attempt to please the experimenter (Bertrand and Mullainathan, 2001; Zizzo, 2010; De Quidt et al., 2018). Sending benefits to localities affected by pollution could be seen as the moral thing to do, making respondents embarrassed to choose otherwise. A preference for in-kind settlements could therefore be partly driven by experimenter demand. While we can't rule

[39]Notice that, given the options proposed to the respondents, we can only conclude that they prefer in-kind settlements targeted to affected communities to funding for the US Treasury, and the preference for targeting is larger when EJ concerns are involved. While this limits our ability to answer another interesting question, namely whether the public prefers in-kind to cash punishment targeted to the same community, arguably in the context of the US the question that we pose is the most relevant one, since the transfer of cash to the Treasury is the only available alternative to in-kind local projects.

Figure 2: Choice experiment: Support for in-kind over cash to Treasury



Note: Each marker indicates a group of participants randomized into eight different treatments (an information treatment indicating the in-kind project would occur in an environmental justice area and a treatment that varies by cost of the in-kind option). We depict 95% CIs around each treatment; while most confidence intervals overlap, after pooling the data, the EJ treatment is statistically significantly different from the non-EJ treatment (see Table 2).

this bias out, aspects of our survey alleviate some concern. Respondents are contacted through a third-party firm, Prolific, which adds an extra layer of anonymity. To welcome all viewpoints, we started the survey with the statement "No matter what your views are, by completing this survey you are contributing to our knowledge as a society."

Second, in strategic bias, respondents with particularly strong preferences, wanting to influence future policy, could inflate the magnitude of their responses. However, in our choice experiment we provide each survey respondent with one binary, discrete choice, an experimental setup that is incentive compatible for responding truthfully (Carson et al., 2001; Carson and Groves, 2007).

Third, in embedding bias, changes in scope of the question result in irrational changes in responses (Kahneman and Knetsch, 1992). We find changes in the cash alternative result in little change to a respondent's preference for in-kind, a finding that could be due to embedding bias. We note however, the bias only has implications on our estimates of the magnitude of the willing-

Table 2: Choice experiment: Support for in-kind punishment

	(1) Full sample	(2) Non-EJ-info sample	(3) EJ-info sample
	I(Chooses in-kind)	I(Chooses in-kind)	I(Chooses in-kind)
I($200K in-kind)	0.02	0.01	0.02
	(0.02)	(0.03)	(0.03)
I($300K in-kind)	0.06***	0.08**	0.04
	(0.02)	(0.03)	(0.02)
I($400K in-kind)	0.05*	0.06*	0.04
	(0.02)	(0.03)	(0.03)
I(EJ mentioned)	0.06***		
	(0.01)		
Constant	0.81***	0.80***	0.88***
	(0.02)	(0.02)	(0.02)
Observations	2,361	1,184	1,177

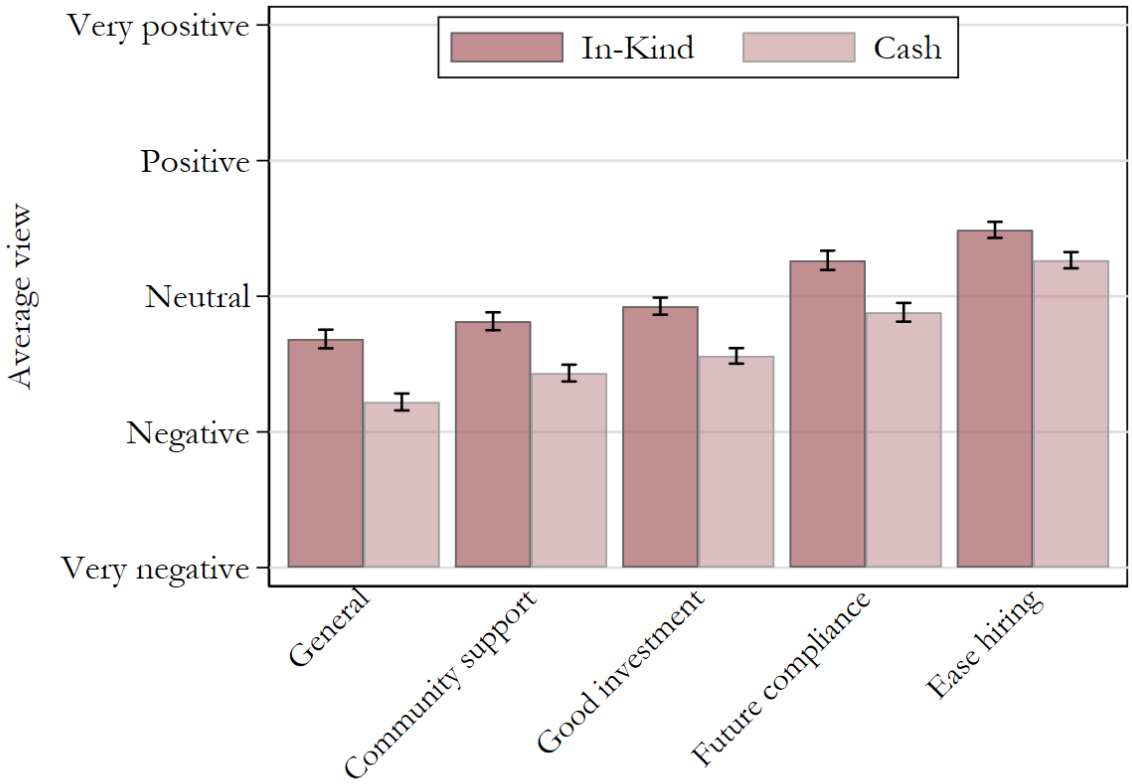
Note: This Table presents regression results from the choice experiment. The dependent variable in each column is an indicator for whether the respondent chooses the in-kind option. Independent variables are indicators for the treatment the respondent received. Specifically, I ($200K in-kind) indicates that the respondent choice was between $300,000 in cash or $200,000 on an environmental project, I ($300K in-kind) indicates that the respondent choice was between $300,000 in cash or $300,000 on an environmental project, and so on. The omitted category is I ($100K in-kind); therefore, the coefficients measure the difference in the share who prefers in-kind, with respect to the group whose choice was between $300,000 in cash or $100,000 on an environmental project. I(EJ mentioned) indicates EJ treatment, namely that the respondent was informed that the company's facility is located in a community vulnerable to environmental justice concerns. Column (1) pools all observations, column (2) includes only respondents who were not exposed to the EJ treatment, and column (3) includes only respondents who were exposed to the EJ treatment. Hetorskedasticity-robust standard errors in parenthesis, ***1%, **5%.

ness to forgo cash to the Treasury, but the qualitative finding would still hold, that respondents overwhelmingly prefer local in-kind settlements to cash to the Federal Treasury. Furthermore, we note that the strong preference for in-kind could be due to the payment vehicle, that respondents could have an aversion to cash going to the Federal Treasury. Cash going to the state or municipality might have led to a less strong preference for local in-kind settlements. We chose the Federal Treasury as the payment vehicle to mirror the choice set found in the current institutional framework around the EPA's in-kind settlements. The payment vehicle is intentionally stated in the choice experiment as it is intrinsic to the EPA's policy and as such is not interpreted as a bias (Mitchell and Carson, 2013).

We are less concerned with other biases, specifically, that of interview fatigue, because our survey only consisted of three questions, unconsidered responses, because almost all respondents answered our attention question correctly, and hypothetical bias or budget constraints, because we are not asking how much people themselves would be willing to pay.

Part B: Randomized survey findings on perception of firms by settlement type. The responses to the survey experiment reveal that the public holds a more positive view of firms that are subject to in-kind rather than cash punishment. To get an average of how respondents viewed companies, we created a scale representing where respondents views fell between the opposing statements, with evenly spaced increments. We depict the averages of the responses in Figure 3, and find that across all questions, respondents have a statistically significant more negative view of the company when the punishment was in cash.

Figure 3: Randomized survey: perception of firm by settlement type



Note: Participants were given information about a company violating the Clean Air Act and randomized into two groups, based on whether the violation resulted in an in-kind or a cash settlement. After reading the violation and settlement type, participants were asked to indicate where their opinion about the company fell between two opposing statements. To depict their responses on the same figure, we categorized their responses to fall on a scale between very negative and very positive. The error bars indicate 95% confidence intervals.

6 How do firms' share prices respond?

Survey evidence suggests that in-kind settlements shed firms in more favorable light than cash settlements, and in the case of respondent's expectations for future compliance, mark the difference between overall positive and overall negative expectations. Here we examine whether in-kind settlements are also associated to different responses from investors. Recent literature has studied the effects of financial payments ordered to firms within settlements of environmental litigations, by considering the stock-market response to news of these settlements (Karpoff et al., 2005; Brady et al., 2019; Armour et al., 2017).

Share prices might decrease after a settlement because the market prices-in the financial penalty ordered. Additionally, as observed in Brady et al. (2019), investors may revise their expectations of long-term profitability if they foresee changes to future interactions of the firm with some of its stakeholders, such as customers, suppliers, regulators, or neighbouring communities. The most recent literature tends to agree that financial penalties for environmental violations cause a drop in defendants' market valuation, largely reflecting the size of the financial penalty (Karpoff et al., 2005; Brady et al., 2019). However, so far no attention has been paid to the use of in-kind penalties, which might vary how investors react. For example, the cost of an in-kind settlement is only estimated, and so if investors are risk averse, the impact of the settlement on the company's valuation might be larger than the in-kind settlement's dollar amount; or the impact might be lower if the investors anticipate the firm to be able to save on the cost of delivering the in-kind project. Some in-kind settlements also involve a capital upgrade for the defendant, which may be perceived as an improvement in the company's bottom line. Another important aspect is the difference between settlements in terms of reputational effects. Investors might have a more positive view of companies that undertake in-kind projects, either because some investors are environmentally minded and see the projects as commitment to environmental stewardship, or because they anticipate better economic performance due to improved relations between the company and the community targeted by the project, the regulator, and other relevant stakehold-

ers, such as consumers (Konar and Cohen, 2001).[40, 41] In the face of an environmental violation a company's dedication to environmental stewardship (real or disguised) may mitigate the negative reputational effect associated with the violation. Barrage et al. (2020), for instance, find that the negative impact on sales and prices of the BP 2010 Deepwater Horizon Oil Spill was attenuated in areas where BP had previously spent more in its "Beyond Petroleum" advertising campaign.

Stock market data. The EPA enforcement data provide the names of the defendants in each case. To identify the defendants that are publicly traded companies, we used a commercial web interface for searching company names, called Orbis from Bureau van Dijk Electronic Publishing (Bureau van Dijk Electronic Publishing, 2017).[42] Using a company identifier from Orbis we matched defendants' daily stock market prices from the CRSP U.S. Stock database provided by Wharton Research Data Services (Wharton Research Data Services, 2019).[43] We match stock-market information for nearly 2,700 cases ($\approx 2.5\%$ of the total), involving 781 firms.[44] From this sample, we keep the settlements that involve a financial penalty (cash or in-kind), and perform some additional selection based on standard criteria for stock-market analysis, which we describe in detail in Appendix Section A4.1. Then we focus on the date when information about the case settlement is announced. The date an in-kind or cash settlement is announced is the day when the final order is lodged if the case is judicial (which is the date when the settlement document is given to the Clerk of the Court for lodging in the District Court), and the date when the final

[40] Local communities' goodwill is potentially material to the firm because citizens can start enforcement actions by initiating lawsuits or by triggering inspections; public agencies may also intervene to preempt citizens' actions (see Shimshack, 2014). Consumers' goodwill in general is likely important for firms that produce consumer goods; Campa (2018), for instance, finds that these firms reduce toxic emissions after news-media print stories featuring them as major polluters, and they are especially likely to respond to the media coverage if they produce local goods.

[41] The media coverage of the settlement may also influence its impact on reputation, if any, because discussion of the in-kind project itself might crowd out discussion of the violation; for example, the following headlines highlight the in-kind project, not the violation leading to the project: Natsu, Jennifer, "Seafood giant agrees to $23M in upgrades to reduce coolant leaks, EPA says," *Environment+Energy Leader*, February 20, 2019; or Heath, Michelle, "Valero proposes vegetable garden near Port Arthur refinery," *Beaumont Enterprise*, April 6, 2015. This aspect makes our analysis also relevant to studies of the phenomenon of "green washing" (Wu et al., 2020).

[42] Orbis uses an approximate string matching algorithm, which in a test sample of 1,000 cases resulted in a better match of defendant names than Stata's fuzzy match algorithm.

[43] The company identifier from Orbis is the ISIN number, which we converted to the identifier in the CRSP dataset—the CUSIP number—by removing the first two characters and the last digit.

[44] The low rate of matching is predominantly due to most companies involved in the settlements not being publicly listed.

order is issued if the case is administrative.[45] We manually checked the cases to see if information about the settlement was released before the lodge/issue date, for a period of up to two months. As is standard in studies of the stock-market response to events of interest (e.g. Armour et al., 2017), we also searched the web for news of significant events involving the same firm occurring at around the same time as the settlement, as these events could also be reflected in stock-market fluctuations. Based on these criteria we dropped 206 cases. In the right panel of Table 1 we show summary statistics for the selected cases used in our stock market analysis. All the monetary values are expressed in 2019 dollars.[46]

The mean cash and in-kind settlements are comparable, at around $300,000; they both have a large dispersion, with maximum values equal to roughly $16 and $8 million respectively (not shown in table), and they are relatively minor as a share of the average market capitalization of the defendants ($\approx$ $20 billion, not shown in table). The compliance action cost and recovery amount, summed in the category *Other*, are substantially larger than the penalties (mean = $12 million) and they have an even greater dispersion. The settlements stretch over a mean period of 72 days (measured as the time between the compliance action being filed and the final order being issued; not shown in table).

6.1 Stock-market event study methodology

We examine abnormal stock-market returns upon announcement of a final settlement. An enforcement action involves a sequence of visible steps that possibly stretch over years (Armour et al.,

[45]The FE&C data record a number of milestone activities dates for each case. For judicial cases, the most important milestone dates are: the day when the complaint is filed, the day when the final order is lodged, the day when the final order is entered, and the day when the action is closed. For administrative cases, the most important milestone dates are: the day when the complaint is filed, the day when the final order is issued, and the day when the action is closed. See `https://echo.epa.gov/help/enforcement-case-search-help#admin`. We focus on the date when the decision to include a cash or in-kind settlement, and the respective dollar amounts, are announced; this should allow us to best capture the different stock-market response by settlement type.

[46]The cases that we study in the stock-market analysis tend to be larger than the other cases, based on monetary payments and likelihood that there are other costs. Interestingly, in-kind settlements are also more frequent, probably reflecting the fact that public listed companies are in general different from other companies, in terms of, e.g., attention to reputation. In Appendix Table A3, we also compare the universe of cases in the FE&C dataset since 1997 and the cases for which we recover stock-market information.

2017), however, we only focus on the stock-market response to the settlement announcement, since this is when investors learn about the settlement type (cash or in-kind), and the respective dollar amounts. The time of the lodging (for judicial cases) or the issuing (for administrative cases) of the decisions corresponds to the announcement of the settlement type and amount.

We use a panel regression approach in the spirit of Dube et al. (2011) and Luechinger and Moser (2014). Our main specification regresses the raw returns of individual stocks on (a) an indicator for the time-window when we estimate the stock-market response, and (b) an interaction term that allows the stock-market response to differ between cash and in-kind settlements. We consider different estimation windows for the stock-market response, varying the treatment and the sample, from the day before to up to 30 days after the settlement, and use data on stock market returns for 364 trading days before the settlement to account for market-induced variations in stock-prices. We augment the regression with firm-settlement fixed-effects and the three Fama-French factors, interacted with firm-settlement dummies, to capture market-wide conditions that vary across firms-by-settlement.[47,48]

Our regression specification is:

$$R_{fjt} = \phi_{fj} + \phi_{fj} \cdot R_{mt} + \gamma_1 \mathbf{1}[t \in \mathbf{W}] + \gamma_2 \mathbf{1}[t \in \mathbf{W}] \cdot \mathbf{1}[\textit{In-kind}] + \varepsilon_{fjt} \tag{1}$$

R_{fjt} is the one-day raw stock return, calculated based on the change between the closing price at date $t-1$ and the closing price at day t, $\mathbf{1}[t \in \mathbf{W}]$ is an indicator for the trading day t falling in a window $\mathbf{W}$, and $\mathbf{1}[\textit{In-kind}]$ is an indicator for in-kind settlements. We use data for trading days $t = \{\tau - 365, \tau + 30\}$, where τ is the settlement date, which we refer to as day 0. We estimate equation (1) 60 times, varying the window of treatment $\mathbf{W}$, and consequently the number of

[47]The Fama-French factors are: (1) the average return on the three small portfolios minus the average return on the three big portfolios (2) the average return on the two value portfolios minus the average return on the two growth portfolios, and (3) the excess return on the market. Within our empirical framework, these interaction terms are virtually equivalent to the time fixed-effects in an event study where the various firms would be observed over the same time span.

[48]We use firm-by-settlement rather than firm fixed-effects because the same firm can appear as defendant in different settlements over time. This is not a rare occurrence: 69% of the settlements in the stock-market sample involve defendants with at least another settlement, and 39% of the firms appear in more than one settlement; practically speaking, we treat these as different firms.

observations. Following other stock-market event studies, we start measuring the stock-market response to the settlement from day -1, because the settlement may be concluded the day before the order is lodged and information might diffuse immediately (see Armour et al. (2017)). Specifically, we start with **W** being an indicator for only one day before the settlement announcement (day -1), and include observations from 365 to 1 day before the settlement announcement (days -365 to -1). We then increase the window **W** such that it indicates both days -1 and 0 as treated, and also increasing the number of observations in the estimation by one. We proceed until the treatment window includes all dates from one day before to 30 days after the settlement date. Next, we run placebo regressions to test for anticipation, by constructing treatment windows that aggregate backward from days -2 to -30 before the settlement, and using information from days -365 to -2 from the settlement. R_{mt} includes the three Fama-French factors and ϕ_{fj} are firm-by-settlement fixed effects. Based on this specification, γ_1 is the average abnormal stock-market return in a time window **W** after a cash settlement, and γ_2 estimates the difference in average abnormal stock-market return between cash and in-kind settlements.[49] Standard errors are two-way clustered at the date and firm-settlement-level. We estimate equation (1) on the sample of selected settlements described in Section 6 (see *Stock market data*, summary statistics in Table 1).

6.2 Results from the stock-market analysis

We show results from equation (1) in Figure 4. The graphs display coefficients (γ_1 and γ_2) and confidence intervals for regressions with different time-windows **W**. For instance, the coefficient and confidence interval for day -1 refer to the stock market abnormal return one day before the final order is lodged or issued as compared to the previous 364 days. The coefficient and confidence interval for day 0 represent the average abnormal return on the day the order is lodged or issued and one day before, as compared to the previous 364 days.

[49]For companies that are cited in more than one settlement on the same date, we sum the monetary payments across all the settlements (the same company appears in multiple settlements mostly when it is involved in a national case). Moreover, for the windows before the event, we follow Dube et al. (2011) and augment equation (1) with a dummy that takes value 1 if a date coincides with the "after" of another settlement at the same firm.

Based on Figure 4a, a number of conclusions emerge: first, there is no evidence of significant abnormal stock-market returns post-cash settlements but there is increased noise around the settlement day; second, in-kind settlements appear to be associated with more positive abnormal returns within 5 days from the settlement, but the respective point estimates are not statistically significant.

These conclusions apparently collide with the results in Karpoff et al. (2005), who find a significant negative stock-market impact of press announcements disclosing environmental violations in the US between 1980 and 2000, nearly half of which are settlement announcements. The discrepancy between our results and Karpoff et al. (2005)'s may be due to their focus on news in the press, which likely cover only the largest settlements. Thus, in a similar spirit, we re-estimate equation 1 on samples of progressively larger settlements, while allowing for different responses to cash and in-kind settlements.

When we study settlements with a total punishment (cash + in-kind) larger than the median (Figure 4b) or the 75^{th} percentile (Figure 4c) the conclusions of the analysis are largely unchanged, with no significant abnormal returns associated with cash settlements and a possibly significant positive response to in-kind settlements.[50] Instead, once our sample is further restricted to 68 very large cases (punishment larger than the 90^{th} percentile), we document a significant decline in shares prices following a cash settlement, and an opposite response following in-kind settlements (Figure 4d).[51] The difference in response is statistically significant at conventional level, whereas there are no statistically significant differences in abnormal stock-market returns by settlement type in the 30 days leading up to the settlement announcement.

Importantly, we do not find statistically significant differences by settlement type across a num-

[50] We use percentiles of the sum of cash and in-kind to select samples of progressively larger cases; the median punishment is nearly \$79,000 for settlements larger than the median, nearly \$234,000 for settlements larger than the 75^{th} percentile, and around \$1,140,000 for settlements larger than the 90^{th} percentile.

[51] Of the largest settlements, 55 are cash settlements and 13 are in-kind. The former have a median cash punishment equal to approximately \$890,790; for the latter, the median cash punishment is nearly \$780,000 and the median in-kind is approximately \$341,000, for a total median punishment of roughly \$1,400,000. All in all, the size of the punishment is largely comparable between cash and in-kind settlements. Notice also that among large cases the share of in-kind settlements is larger than in the overall sample.

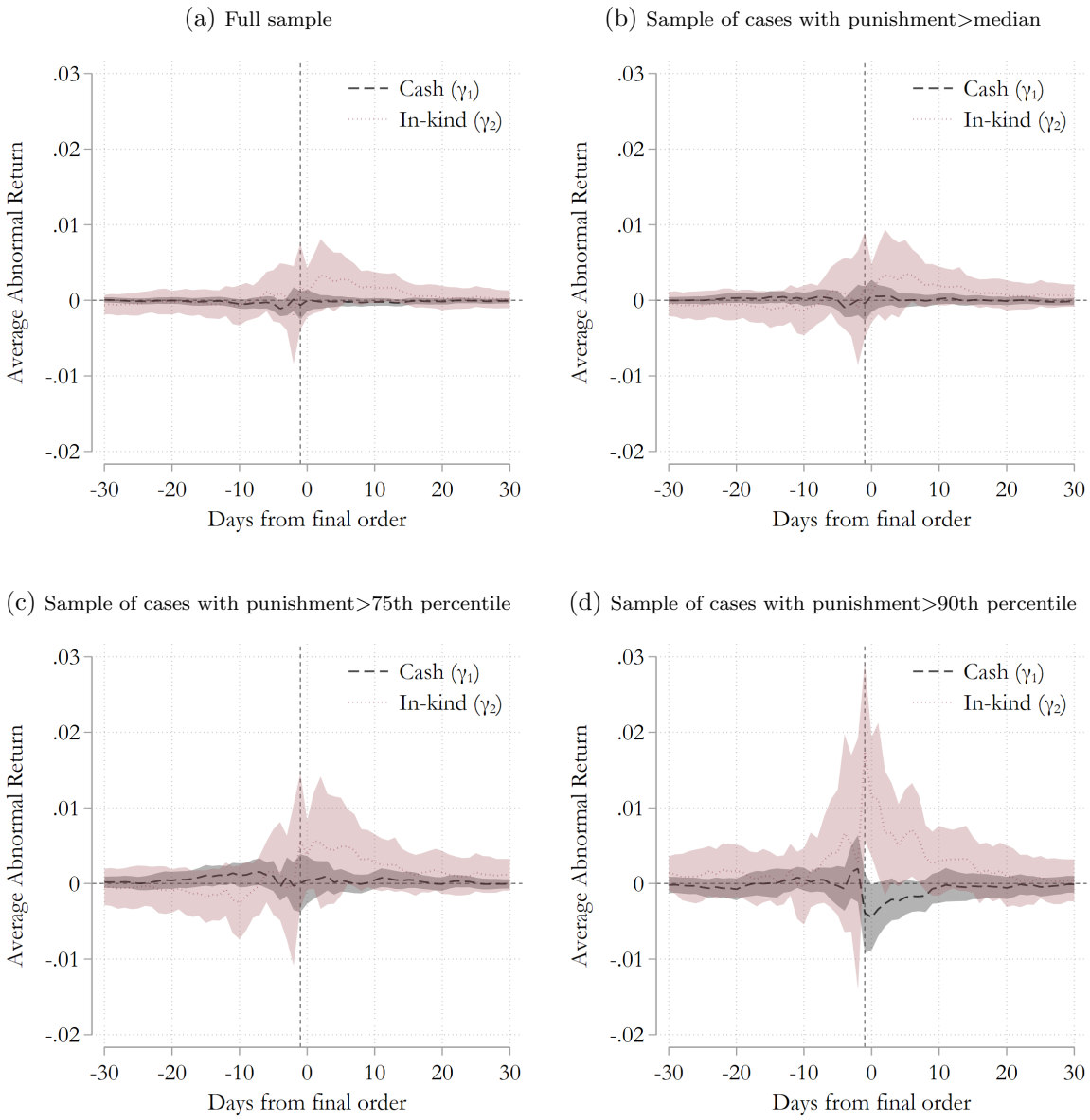


Figure 4: Average abnormal returns

Notes: The figures depict the average abnormal returns for different windows around the settlement date from four different samples. Darker line depicts the average abnormal return from a cash settlement and the lighter line the difference in average abnormal returns between cash and in-kind settlements, obtained from coefficients γ_1 and γ_2 in equation (1). The x-axis labels represent the window over which we estimate the average abnormal return. Following the literature, each window starts at one day before the final order is issued or lodged. For example, the label 5 refers to the average abnormal return between one day prior and six days after the order is issued, and -5 refers to the average return between the one day prior and four days prior. The shaded areas depict 95% confidence intervals.

ber of settlement- or firm-level characteristics either. This finding lends support to the identifying assumption that in-kind and cash settlements are similar in characteristics that influences share prices upon the settlement announcement. Specifically, we exploit information on the size of the

case, as measured by the fine and other expenditures included in the settlement, its duration, the specific civil procedure followed (i.e. whether the case was led by the State or the EPA, whether it resulted from self-disclosure, and whether it was administrative or judicial), measures of the size of the defendant (market capitalization, number of employees, operating revenues, assets, and number of companies in corporate group), and whether the defendant is a consumer-goods producer, which would likely make it more exposed to consumers' pressure (the consumer-good indicator is based on the 4-digit NAICS sector where the company operates). As we show in Table 3, for all of these variables except one we fail to reject the null that there are no statistically significant differences between in-kind and cash settlements.[52] The only exception is that in-kind settlements are always initiated by the EPA, whereas cash settlements in rare cases arise from a State-led initiative. In Figure A5 we show that limiting the analysis to EPA-led cases leaves the conclusions virtually unchanged.

Table 3: Comparison of case and firm characteristics across settlement types

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Cash-only settlements			In-kind settlements			Equality of means
	Obs	Mean	(Std. Err.)	Obs	Mean	(Std. Err.)	p-value
Case-level variables							
Cash ($ 000)	615	228	(431)	63	488	(236)	.28
Other ($ millions)	615	7	(5)	63	.7	(.5)	.18
Settlement duration (days)	559	68	(12)	62	107	(41)	.36
I(Self disclosure)	603	.05	(.01)	61	.03	(.02)	.45
I(Judicial case)	615	.09	(.01)	63	.11	(.04)	.55
I(Led by EPA)	615	.98	(.01)	63	1	(0)	.00
I(Notification and settlement same day)	615	.71	(.02)	63	.71	(.06)	.96
Defendant-level variables							
Market cap ($ millions)	615	20,543	(2,120)	63	16,689	(4,385)	.43
Number of employees (000)	504	62.6	(11.6)	49	73.5	(44.8)	.81
Operating revenue ($ millions)	517	26.3	(3.1)	50	25.7	(10.7)	.95
Assets ($ millions)	515	36	(7)	50	25.4	(5)	.23
Number of companies in corporate group	518	408	(30)	50	316	(39)	.06
I(Consumer goods producer)	478	.38	(.02)	58	.40	(.06)	.81

Note: Sample of cases in the stock market analysis. Column (7) compares the cash-only cases to the in-kind cases, reporting the p-value from a test of equality of means with unequal variances. When we impose equal variances p-values are always > 0.05.

In Appendix Section A4.2 we discuss remaining concerns about identification and interpretation of the results and show that the conclusions of our analysis are confirmed when we add controls, study the intensive margin of the treatment focusing on the sample of settlements in-kind, and

[52] We compare means by estimating t-tests that allow for unequal variance between cash and in-kind settlements; when we impose equal variance, all the p-values are strictly larger than 0.05.

produce "leave-one-out" estimates where we exclude one in-kind settlement at time from the estimation sample.[53]

In quantitative terms, large cash settlements are associated to an average drop in defendant's share price equal to 0.45% on the day the order is lodged or issued and the day before. For comparison, Karpoff et al. (2005) also consider the two-day window consisting of the day before and the day of the press report and estimate an average negative abnormal return for settlement announcements equal to 0.35%. For those settlements that include an in-kind project, however, our estimates imply an average positive abnormal return during the same time window of around 0.70%. The stock-market response is concentrated around the first few days from the settlement, consistent with information diffusing and being incorporated in stock-market prices immediately, as found in related studies (e.g. Karpoff et al., 2005 and Luechinger and Moser, Luechinger and Moser).[54,55]

This analysis suggests that environmental enforcement actions generate a discernible stock-market response as long as the penalty amounts are large enough and, together with the survey evidence, supports the presumption that in-kind settlements be advantageous for companies that settle for environmental violations. Given that penalties usefully deter future violations (Shimshack, 2014), our findings imply potential differences in deterrence as well, motivating the analysis in Section 7.

[53]To corroborate our conjecture that settlements that receive media coverage tend to involve larger penalties, we conducted a manual search of the media coverage of the 68 largest settlements. The search results, which we describe more in detail in Appendix Section A4.3, confirm the conjecture.

[54]Since the coefficients measure the *average* abnormal return over the time-window W, the stock-market response being concentrated in the first days after the settlement implies that the farther away we move from the settlement date, i.e. the larger is the post-settlement window, the lower the average abnormal return. Notice that this does not imply that share prices return to pre-settlement levels in the medium run, however, because the return captures the *growth* in prices.

[55]Notice that these estimates do not necessarily capture the stock-market response to the entire enforcement action, whose quantification is beyond the scope of this paper. The enforcement action can stretch over a variable number of days: while in most of the cases in our sample (72%, 68% among the largest cases) the settlement is announced on the same day when the complaint is filed, sometimes the lag between these actions can be quite large.

7 What are the implications for environmental quality?

We investigate whether settlement type has implications for environmental quality. In a number of ways settlements can affect environmental quality. If stringent, a settlement could deter future violations or alternatively, if too lenient, a settlement could encourage future violations.[56] Second, they can foster voluntary pollution reductions at the regulated facility, if the parent firm aims at improving its reputation and relationship with the regulator after the fallout from the settlement. Third, a large monetary sanction might drain resources that could have otherwise been invested in pollution reduction efforts or pollution causing activities. Fourth, in-kind settlements might deliver environmental improvements in the neighbourhood of the facility. Therefore, many pathways exist through which the environmental impacts might differ depending on settlement type.

We use an event-study framework and study how environmental quality evolves in the neighbourhood of a facility after the facility was implicated in a cash or in-kind settlement. We measure environmental quality with a proxy based on concentration of toxic substances in the zip-code where the facility is located. In what follows we provide more details on the data used, we present the empirical strategy, and discuss results.[57]

7.1 Data on zip-code environmental quality

First we describe how we construct the dataset for the analysis of environmental quality. As in the stock-market analysis, we start by attributing a settlement to facility if the facility is cited as the location of a violation that instigated the enforcement action leading up to the settlement.[58] We use the year the final order is issued for administrative (and lodged for judicial) cases as the settlement

[56] In particular, if the sanction is perceived as lenient, and the violation delivered some competitive advantage to the regulated facility, managers might perceive the benefits of violating environmental regulations as exceeding the expected cost.

[57] From a statutory perspective, the outcome of interest would be the occurrence of future violations, which enforcement actions aim to deter. However, we are not aware of a good measure of occurrence of violations; the data on settlements that we draw information from report only detected violations and are thus not suitable to study how settlement type affects deterrence, unless the probability of detection of violations is close to one or is not affected by settlement type.

[58] As in the other sections of the paper, we consider only single-defendant settlements.

year. Then, we aggregate separately cash and in-kind settlements at the zip code-by-year level, based on the zip code where the facility is located.[59] The result is a panel of 23,617 zip codes where a settlement ever occurred, which we follow from 1998 to 2017. We merge this panel with information on a zip code-level measure of total toxic concentration of chemical substances from the EPA's Risk-Screening Environmental Indicators (RSEI) Geographic Microdata[60], resulting in a smaller sample of around 19,000 zip codes, most of which (95%) we follow through the entire sample period.[61] RSEI calculates air concentrations resulting from facility-level chemical releases as reported in the Toxic Release Inventory (TRI), using an EPA dispersion model to consider fate and transport, and weighting chemicals by toxicity based on known human health effects from long-term exposure.[62] We describe the toxicity-weighted concentration in more detail in Appendix Section A5.1.

The choice of our measure of environmental quality admittedly presents a number of disadvantages. First, while the Toxic Release Inventory captures the largest point-source air pollution emissions in the United States, it does not include emissions of significant pollutants such as sulfur dioxide, nitrogen oxides, ozone, carbon monoxide, particulate matter, carbon dioxide and not-listed toxic chemicals.[63] However, a large literature has established the existence of complementarities in the production of different pollutants. For instance, recent evidence in Persico and Johnson (2021) shows that the rollback of EPA's enforcement of environmental regulation during the COVID-19 pandemic caused a sizeable increase in particulate matter (PM2.5) and ozone pollution in counties with more Toxic Release Inventory sites, suggesting that these plants are major PM2.5 and ozone polluters. Pham and Roach (2021) find that a regional cap-and-trade

[59] In few instances (about 10% of the cases that we consider), one case involves multiple facilities, owned by the same parent company; in these cases, we split the penalty across the listed facilities (and thus their respective zip codes).

[60] See https://www.epa.gov/rsei/rsei-geographic-microdata-rsei-gm.

[61] For a small number of zip codes we cannot match RSEI data in the earliest part of the sample. We also drop those zip codes where toxic concentration was zero at some point during the sample period (30 zip codes-by-year); this is to be able to take the logarithm of the dependent variable in the estimated model that we will introduce below.)

[62] The toxic concentration being based on a dispersion model is particularly important given that Toxic Release Inventory emissions tend to be detected only within a short distance from the reporting facility (Currie et al., 2015).

[63] See https://peri.umass.edu/how-accurate-are-the-rsei-data-on-toxic-air-pollution)

program designed to regulate carbon dioxide emissions has also affected the release of regulated chemicals reported to the Toxic Release Inventory by electric utilities, suggesting the existence of complementarities between carbon dioxide and chemical emissions. Second, measurement error might stem from the fact that we consider pollution in the zip code where the facility is located, however depending on the precise location of the facility its operation might impact environmental quality in other zip codes. As a result, an important caveat of our analysis is that noise in the data could prevent us from capturing relatively small settlement impacts.

On the other hand, advantages of the toxicity measure include that the measure does not depend on detection of violations and that it puts more weight on substances that are known to be more harmful, whose release is therefore more likely to be regulated and as such directly affected by enforcement actions.[64,65]

7.2 Empirical strategy to measure environmental quality

We estimate treatment effects of cash and in-kind settlements on environmental quality at the zip-code level, allowing for instantaneous and dynamic effects. The dependent variable of our analysis is the logarithm of toxic concentration described in 7.1.[66]

Across the panel of zip codes, treatment occurs at different time periods.[67] In this setting,

[64]Measurement error might also result from the TRI data being self-reported. Several papers in the economics literature use data from the TRI and the general consensus is that, while there is a certain degree of error in the self-reported emissions, there is no systematic evidence of strategic over- or under-reporting from firms, leading us to assume that mis-reporting should not change following settlement type. For more discussion on reporting error see Campa (2018). An important concern, however, is that some enforcement actions (nearly 3% of the total) are initiated because of failure to report to the TRI; in these cases, the settlement would induce an increase in emissions if the facility has not corrected the mis-reporting before the settlement. In robustness checks we exclude settlements resulting from TRI enforcement actions, and the conclusions of the analyis are virtually unchanged (result not shown and available upon request).

[65]Another shortcoming of the TRI data is that the set of industries and chemicals covered in the program changes over time. However, these changes should not undermine the consistency of our estimates under the plausible assumption that they are not more or less likely to affect treated versus untreated zip codes.

[66]We consider the log transformation because the distribution of the toxicity measure is highly skewed to the right (see Figure A7 in the Appendix).

[67]We study the extensive margin of the treatment under the assumption that having a cash or in-kind settlement is more consequential than their exact number in a given year. However, the conclusions of the analysis are largely unchanged if we redefine the treatment as the number of cash or in-kind settlements in a given year (result not shown and available upon request).

recent literature has shown that if treatment effects are heterogeneous across units or time, then standard two-way fixed effects and event-study estimates might be biased (see De Chaisemartin and D'Haultfoeuille, 2022b, for a review). Settlements might have different effects on different facilities, for example, based on their marginal abatement costs curves, age, etc. Further, in our panel, the same zip code might be treated multiple times. We follow De Chaisemartin and D'Haultfoeuille (2022a), who propose a difference-in-difference estimator that is unbiased for treatment effects in a panel where treatment might occur multiple times at the same unit and effects might be heterogeneous across units or time periods. This approach is a generalization of the standard event study by redefining the event as the first time a unit changes its treatment status and when estimating the l^{th} dynamic treatment effect of a "switcher" (i.e. a unit that switched into treatment l periods ago) the estimation uses as a control those units whose treatment status has not yet changed ("non-switchers"). In Appendix A5.2 we provide more details on the DID_l estimator proposed by De Chaisemartin and D'Haultfoeuille (2022a). We focus only on zip codes that are treated at some point during the period of analysis. Implicit in this setup there is a parallel trend assumption, based on the comparability of zip-codes that at some point are involved in respectively a cash or in-kind settlement. To test this assumption, we also estimate "long-term placebo" estimators, DID_l^{pl} (De Chaisemartin and D'Haultfoeuille, 2022b), that compare the outcome trends of switchers and non-switchers before the switchers switch (see Appendix Section A5.2 for more details on the construction of the placebo estimators).[68] We separately estimate the model for cash and in-kind settlements.[69]

We show results in event-study graphs with the distance (l) in years to the first time a zip code is treated on the x-axis, the DID_l estimates on the y-axis to the right of zero, and the DID_l^{pl} placebo estimates to the left of zero. We show dynamic coefficients since we hypothesize that there might be a lag for the impact of settlements on environmental quality.

[68] We estimate the dynamic model using the Stata command *did_multiplegt*. Standard errors are estimated using 100 bootstrap replications clustered at the zip-code level.

[69] As observed in De Chaisemartin and D'Haultfoeuille (2022a), some zip codes may have already been treated prior to the first year of our panel, and those treatments may still affect some of the outcomes in the period that we study, the so-called initial conditions problem.

7.3 Results on environmental quality

In Figure 5 we report results from the DID_l estimation. Panel (a) shows estimates when we define treatment as punishment of any size. The figure suggests that cash settlements are associated with an improvement in environmental quality: in the five years following a cash settlement, toxic concentration declines more in treated versus not-yet treated zip codes as compared to the year before the settlement. However, the graph also reveals that the parallel trend assumption required for the validity of the design does not hold, as confirmed by a test of joint statistical significance of all the placebo coefficients (p-value=0.02). The improvement in environmental quality appears to start before the settlement, and the data do not allow us to distinguish whether the decline is the result of the onset of the enforcement action or other confounders. The analysis of in-kind settlements also suggests a declining trend in toxic emissions that seems to predate the settlements, although none of the coefficient estimates is statically significant at conventional levels.

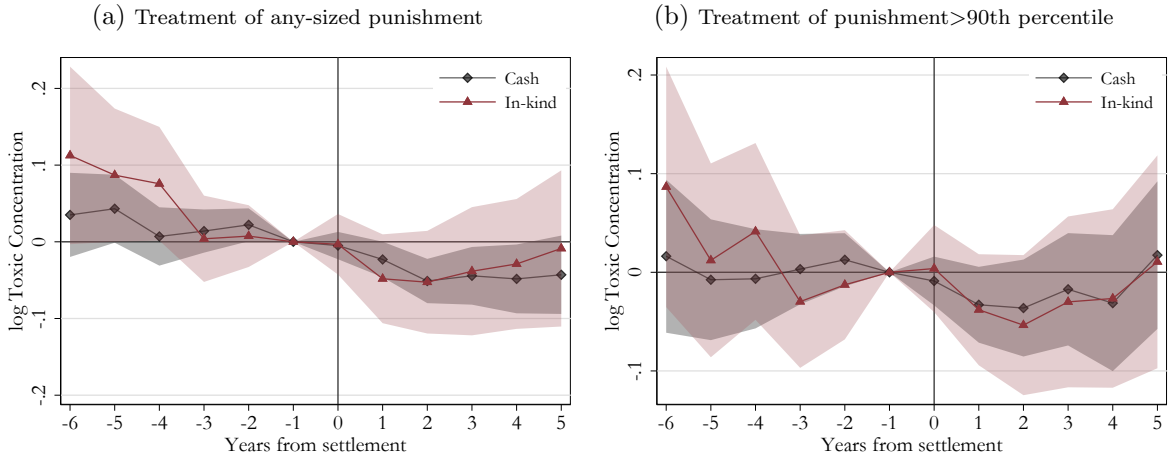


Figure 5: Toxic concentration

Notes: To the right of zero, the figure shows the DID_l estimates (De Chaisemartin and D'Haultfoeuille, 2022b) of the effect of lags of the first settlement with penalty on the logarithm of toxic concentration (cash and in-kind are analyzed separately but plotted on the same figure). To the left of zero, the figure shows the DID^{pl} placebo estimates (De Chaisemartin and D'Haultfoeuille, 2022b). At x = -1, the placebo is normalized to 0. DID^{pl}_0, i.e. the placebo coefficient for the instantaneous effect, is shown at x = -2 and tests the parallel trend assumption for the interval of one year, etc. The shaded areas depict 95% confidence intervals relying on a normal approximation. We use the 1997-2017 panel dataset of zip codes that were ever treated with respectively a cash or in-kind settlement (sample of large cases in panel b). Standard errors are estimated using 100 bootstrap replications clustered at the zip-code level.

In Panel (b) we restrict the analysis to "large" cases as defined in Section 6 (sum of cash and in-kind dollar amounts is larger than the 90^{th} percentile) thus studying an arguably more homogeneous set of locations, namely those that at some point are the site of some major detected violation. This restriction has the additional benefit of allowing us to focus on units where treatment intensity is highest. Nevertheless, we fail to reject the null hypothesis that settlements have no effect on environmental quality, regardless of settlement type. Based on the joint test of statistical significance of the placebo coefficients, the parallel trends assumption holds for both cash (p-value=0.83) and in-kind (p-value=0.12) settlements.[70] The estimated dynamic effects suggest that environmental quality improves following a settlement, but none of the estimates is statistically significant at conventional levels. Considering the first and second dynamic coefficients, which are estimated out of a larger number of switchers, the point estimates imply that one year after a large cash settlement, toxic concentration could decline by up to 7% or increase by up to 0.5%. Two years later the decrease could amount to up to 9% and the increase could amount to up to 1.3%. Large in-kind settlements are associated with similar changes in environmental quality: one year after the settlement, toxic concentration could decrease by up to 9% or increase by up to 1.8%; the respective magnitudes two years after the settlement are -12% and +1.7%.

Overall the analysis suggests that both cash and in-kind settlements might lead to an improvement in environmental quality, in spite of the concerns about in-kind settlements being more lenient, but the imprecision of the estimates ultimately prevents us from drawing definite conclusions. The challenge of measuring environmental quality in a comprehensive manner, paired with the lack of geo-localized data on the site of violations (the FE&C database reports only the zip-code of the violating facility), likely contribute to the imprecision of the estimates (see Section

[70] The 5^{th} placebo coefficient in the in-kind regression is large (0.07) and its standard error is wide; as suggested in De Chaisemartin and D'Haultfoeuille (2022a), not much weight should be put, however, on this coefficient, as it is estimated out of a number of switchers that is less than 50% of the 940 zip-codes out of which the instantaneous treatment effect is estimated. Repeating the test of joint statistical significance for four placebo coefficients yields a p-value of 0.38.

A5.1 for a discussion of data limitations). Replicating this analysis with richer datasets that might become available in the future is a promising avenue of future research.[71]

8 Conclusion

In civil court cases, the EPA encourages environmentally beneficial in-kind projects destined to communities exposed to environmental violations, particularly those with environmental justice concerns. We use data from approximately 56,000 environmental enforcement cases in the US between 1997 and 2017 as well as online survey responses, stock-market responses, and toxic emissions to study the implications of in-kind settlements for firms and communities.

The EPA does not have the authority to mandate in-kind projects in settlements, but rather can only accept or reject them when proposed by defendants. Thus, even though the EPA encourages the use of in-kind projects in areas with environmental justice concerns, the ultimate allocation is not necessarily confined to these areas. We document that the share of cases resulting in in-kind settlements is largest in communities that are least vulnerable to environmental justice concerns, and the second largest beneficiary are communities that are most vulnerable to such concerns.

We find a strong preference for targeting in-kind projects to afflicted communities in an online choice experiment: the overwhelming majority of online respondents would be willing to forgo large amounts of cash to the public fund in exchange for local in-kind projects, particularly in the case of areas with environmental justice concerns. These results provide the first-ever insights into the public preference for the use of in-kind settlements, at least within the US institutional context.[72]

[71] In Section A5.3 we also report estimates from a standard event-study design, where we consider the first in-kind or cash settlement in a zip-code. While some of these estimates are broadly similar to those delivered by the DID_l estimator, there are also some striking differences, mainly cash appears to be associated with an increase in toxicity after the settlement. However, while we choose to report the standard design estimates for completeness, major limitations associated with such an approach (see De Chaisemartin and D'Haultfoeuille (2022b)) suggest focusing instead on the DID_l estimator, which we have presented in this Section.

[72] The preferences for in-kind might be different if the choice was between cash to the community or in-kind project; however, in this paper we have focused on the cash to the Treasury versus in-kind to the community because in the US context, where the Congress has the exclusive power over federal government spending, alternative arrangements can not be considered.

With an online randomized survey we also show that the public perceives a firm more favorably after the firm settles with an in-kind project instead of a cash penalty. Stock-market reactions to settlements involving publicly listed firms are also consistent with a positive view among investors of in-kind settlements: cash settlements are associated with negative reactions, whereas in-kind projects are associated with positive reactions. Importantly for the ultimate merits of in-kind settlements, we do not find evidence of a difference in changes to future environmental quality following in-kind versus cash punishment, although a number of caveats apply to this analysis, and future research should extend its scope to alternative measures of environmental quality as well as more spatially disaggregated data.

Against the background of changing policy on the use of in-kind settlements, our paper highlights that several trade-offs should be considered, taking into account the incentives of regulated firms, the views of the public on redistribution and on the merits of targeting environmental goods, and the administrative and political economy aspects that affect the viability of in-kind settlements.[73] The US experience suggests that environmental agencies worldwide that consider using in-kind settlements, as recommended by the OECD (OECD, 2009), would likely encounter support from the public and the regulated community. However, crucially the level of support could vary under alternative institutional arrangements. Moreover, the question of what are the implications for environmental quality, an important one to ultimately assess costs and benefits of in-kind settlements, needs additional investigation, which we suggest as a promising avenue of future research.

[73]Policy changes include a temporary restriction on the use of in-kind settlements (US Department of Justice, 2020), which was later withdrawn (US Department of Justice, 2021).

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Appendix for Online Publication: Addressing Environmental Justice through In-Kind Court Settlements

Pamela Campa and Lucija Muehlenbachs

A1 Examples of In-Kind Settlements

Table A1: Examples of in-kind settlements by category

Category	Frequency	Average Cost	Example
Emergency Planning and Preparedness	527 (20.80%)	$43,854	Purchase and donate equipment to the local fire department/emergency management agency/local emergency planning committee.
Pollution Prevention	527 (20.80%)	$246,151	Retrofit of 4 heaters on-site with next generation-ultra low NOx burners.
Pollution Reduction	400 (15.79%)	$316,845	Conceptual design and installation of an exhaust fan and carbon filter for the outer extruder area.
Environmental Restoration and Protection	301 (11.88%)	$402,750	Purchase and protection of 36 acres of Wetlands, in perpetuity.
Multiple Categories	235 (9.27%)	$730,680	[1] Install Novo Bioreef system [2] Install onsite wastewater treatment system.
Other Program Specific SEP	226 (8.92%)	$229,105	Develop a green chemistry curriculum for implementation throughout local public schools.
Public Health	216 (8.52%)	$171,453	Form a Health Care Project to establish a program to pay for medical care for asbestos-related illnesses.
Environmental Compliance Promotion	57 (2.25%)	$93,224	Develop and deliver training for the roofing industry on proper handling of hazardous wastes.
Assessments and Audits	45 (1.78%)	$120,977	Perform certified lead-based paint inspection.
Total	2534 (100%)	$265,224	

Notes: Categories are defined by the EPA; we aggregated Pollution Prevention which is broken into 7 subcategories (Energy Efficiency-Conservation / Equipment-Technology Modification / Improved Housekeeping, O&M, Training, Inventory Control / In-Process Recycling / Process-Procedure Modification / Product Reformulation, Redesign / Raw Materials Substitution).

Table A2: Examples of in-kind settlements by law violated

Statute	Example in-kind project
Clean Water Act	Preservation of an 11.54 acre Wetland parcel and construction of nature trails.
Clean Air Act	Installation of a new roof ventilation hood to collect fumes.
Safe Drinking Water Act	Properly plug and abandon orphan wells.
Resource Conservation and Recovery Act	Replacement of 6 refrigeration units for units that will use non-ozone depleting substances.
Federal Insecticide, Fungicide and Rodenticide Act	Perform a pesticide safety and compliance training program.
Comprehensive Environmental Response, Compensation and Liability Act	Provide equipment for local emergency planning committee & funding for local emergency planning committee conference.
Toxic Substances Control Act	Replacement of 40 windows to reduce lead-based paint and lead-based paint dust hazards.
Emergency Planning and Community Right-to-Know Act	Purchase and donate equipment to the local fire department/emergency management agency/local emergency planning committee.
Marine Protection, Research and Sanctuaries Act	Placement of artificial reef materials within a authorized artificial reef site.

Notes: Examples of Supplemental Environmental Projects assigned by the federal statute that was violated.

A2 Additional summary statistics

Table A3: Summary statistics of environmental enforcement actions, No selection

	Full sample		**Cases with stock-market information**	
	Mean	(Std. Dev.)	Mean	(Std. Dev.)
I(Cash settlement)	.565	(.496)	.468	(.499)
I(In-kind settlement)	.024	(.154)	.047	(.211)
I(Other $ amount)	.353	(.478)	.516	(.500)
Cash $ amount, when present	57,401	(1,053,996)	408,951	(2,018,492)
In-kind $ amount, when present	339,389	(1,392,728)	593,514	(1,429,135)
Other $ amount, when present	4,228,128	(83,424,179)	16,175,759	(116,868,171)
Observations	104,742		2,684	

Notes: Summary statistics of enforcement cases, 1997-2017. The left panel includes any case in the FE&C dataset. The right panel includes information for cases where we find stock-market information for at least one of the respective defendants.

A3 Additional information about survey design and results

We posted a Qualtrics survey on Prolific on October 14th, 2020. The description stated that we would pay £0.60 for an estimated time of 3 minutes, i.e., a £12.00/h wage. We also informed participants that they were contributing to a research project. Respondents could take up to 23 minutes to answer the survey.

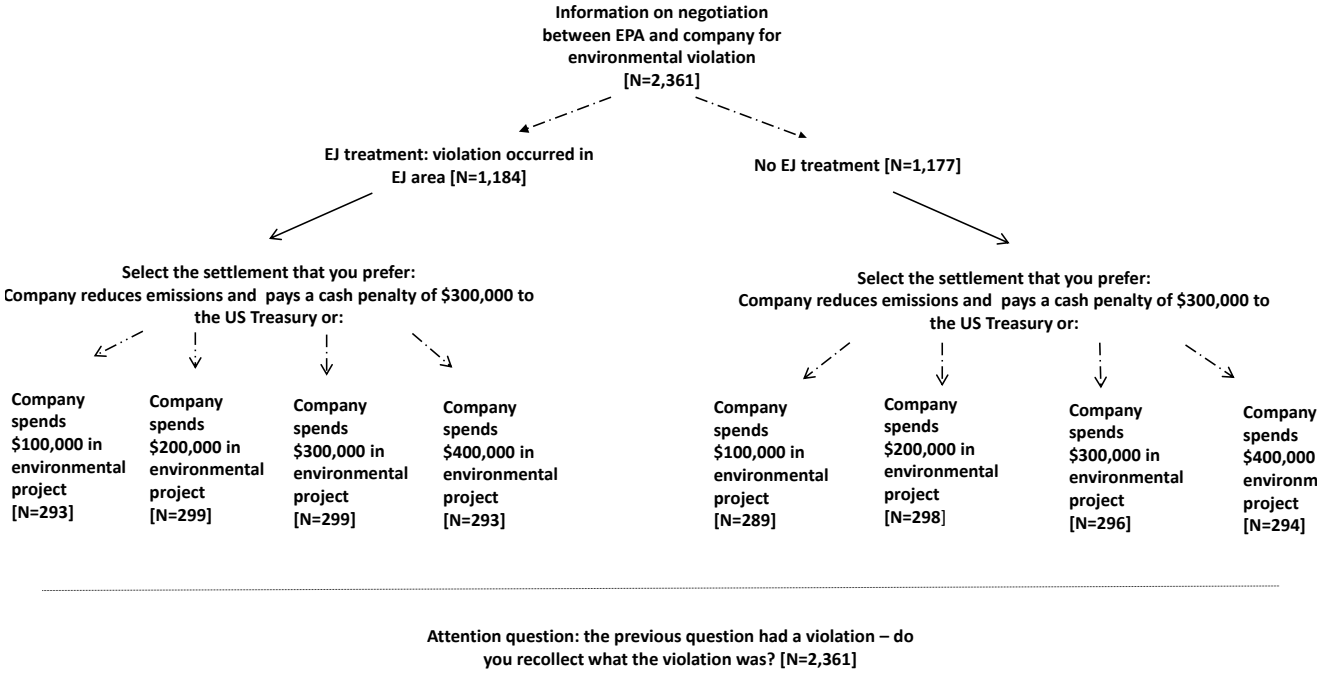
The initial sample that we receive from Prolific is made of 2,434 respondent with unique id. Of these, 39 withdrew their survey answers (i.e. completed the survey but withdrew the authorization to use it), 21 were timed-out, and for 13 we could not find a match in the Qualtrics sample, likely because of typos when the respondents inserted their unique id. As a result the attrition rate is of 2.5%.

The sample is broadly representative of the US population on a number of relevant characteristics, based on a comparison with the most recent estimates from the US Census Bureau.[74] There are some relatively small differences in terms of median age (42 against population median age of 38 in 2018) and percentage of foreign born (7% versus population percentage of 13.5% in 2019). For other characteristics, the representativeness is higher: 52% of the respondents are women (compared to the population share of 51%), 65% of those in working age are employed (compared to the OECD's estimate of the population employment rate in the third quarter of 2020 being 66%), and the percentage of White, Black and Asians is respectively 78%, 11% and 6 % (compared to 76%, 13% and 6% in the population.)

In Figure A1 we show the flow of the survey. We randomized the order of appearance of Part A and Part B, to address the concern that the content of the first part of the study would affect responses to the second. The Figure also outlines what part of the survey we randomized and the size of our samples. In Figure A3 we show screenshots of example questions.

[74] See https://www.census.gov/quickfacts/fact/table/US/PST045219.

(a) Part A: Choice experiment and an attention Question



(b) Part B: Randomized survey

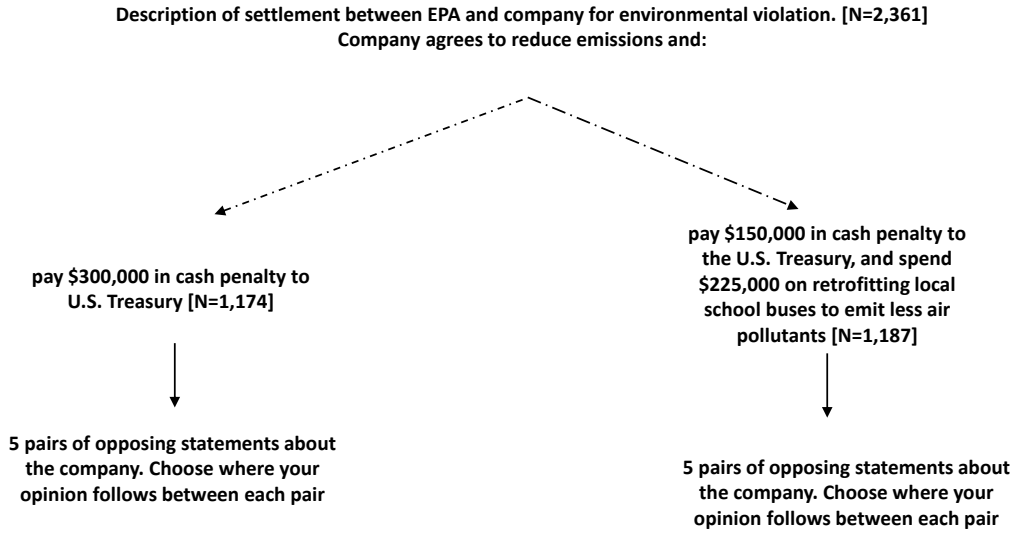


Figure A1: The structure of the survey experiments

Notes: Figure summarizes the survey design. Dashed arrows indicate random assignment of the treatment. The order in which participants answered Part A and Part B is also randomized across participants, and in Part B, the order in which the 5 pairs of statements are shown is also randomized. N is number of subjects that answered each question. Example screenshots from the survey are found in Appendix Figures A2 toA4.

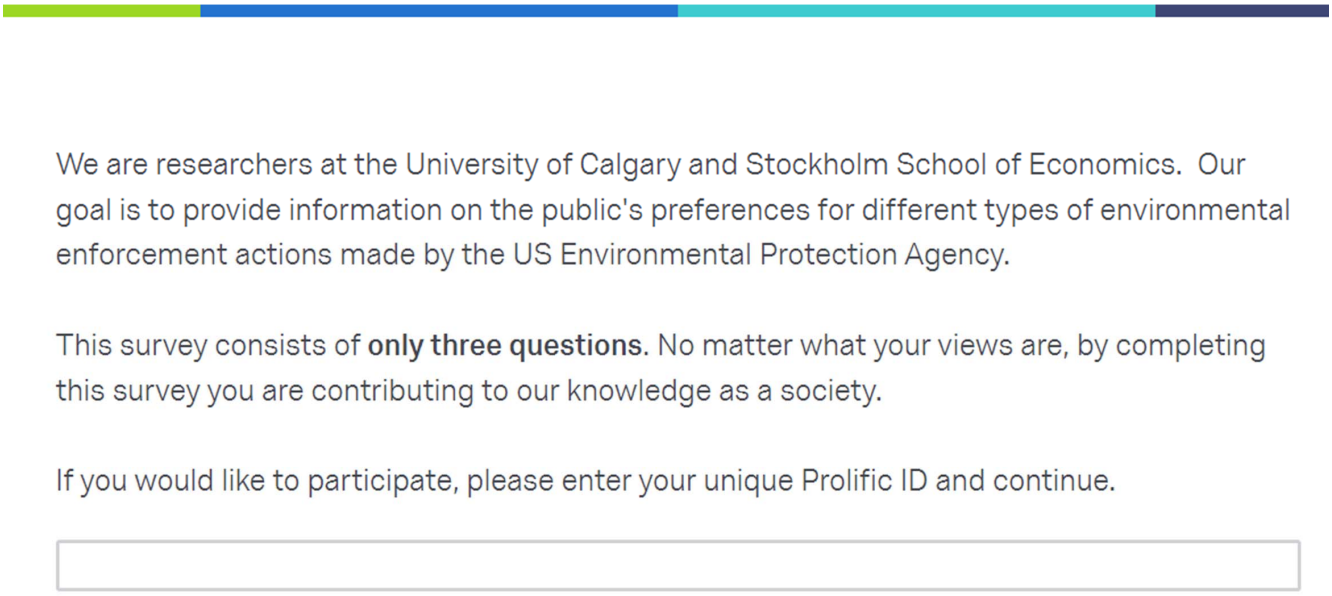


Figure A2: Screenshot of survey start page

(a) Survey Part A

The U.S. Environmental Protection Agency is negotiating a settlement with a company for exceeding regulatory limits on harmful air pollution emissions. The company's facility is located in a community vulnerable to Environmental Justice concerns, namely a community with a high share of low-income populations and minorities, that are both more prone and more susceptible to pollution. Select the settlement you prefer.
The company agrees to reduce emissions below regulatory limits and...

the company pays a cash penalty of $300,000 to the U.S. Treasury.

the company spends $100,000 on an environmental project in the community (e.g., retrofitting local school buses, implementing an environmental training program, or installing pollution-reduction equipment at their own plant).

(b) Survey Part B

Consider the following situation: the U.S. Environmental Protection Agency has announced a settlement with a company to resolve alleged Clean Air Act violations resulting from exceedances of emission limits. As a result of the settlement, the company agrees to reduce emissions and pay $300,000 in a cash penalty to the U.S. Treasury.

Please choose where your opinion about the company would fall within the following opposing statements:

I feel **negatively** toward the company.	○ ○ ○ ○ ○	I feel **positively** toward the company.
The company will have a **hard** time getting community approval to expand operations in the area.	○ ○ ○ ○ ○	The company will have an **easy** time getting community approval to expand operations in the area.
The company will have a **hard** time hiring workers.	○ ○ ○ ○ ○	The company will have an **easy** time hiring workers.
An investment in the company would be a **bad** investment.	○ ○ ○ ○ ○	An investment in the company would be a **good** investment.
The company is **unlikely** to comply with environmental regulations in the future.	○ ○ ○ ○ ○	The company is **likely** to comply with environmental regulations in the future.

Figure A3: Screenshot of the survey

Notes: The figures are screenshots of one version of the survey as seen by respondents. Order of appearance of Part A or Part B is randomized across respondents. In Part A we randomize (a) whether environmental justice concerns are mentioned and (b) the size of the proposed environmental project in dollar amounts. In Part B we randomize (a) whether the settlement description includes an in-kind project and (b) the order in which we list the pairs of opposing statements.

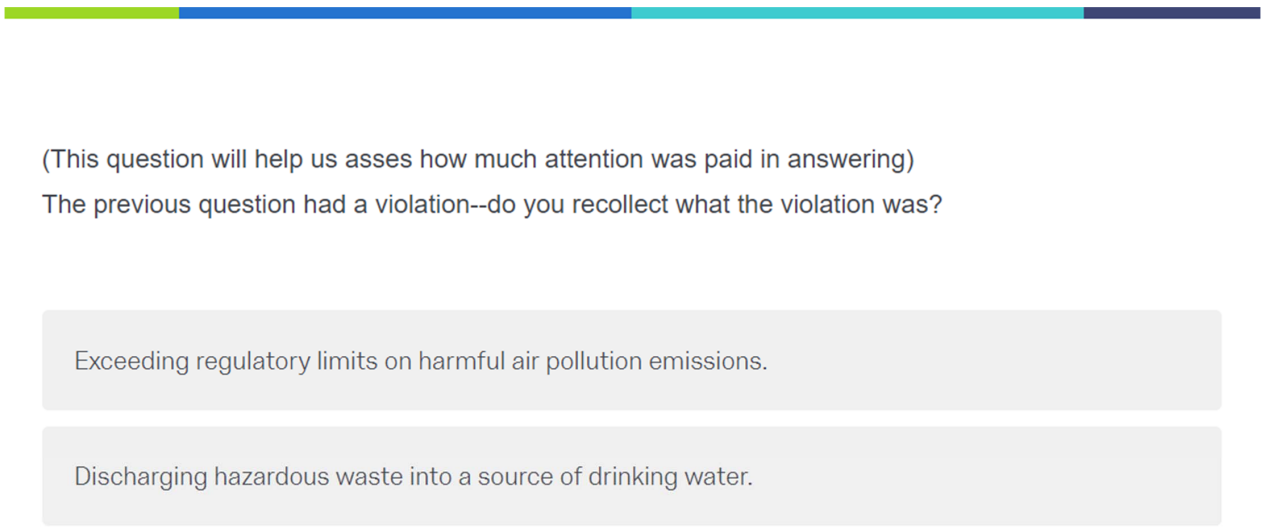


Figure A4: Attention question after Part A

A4 Additional stock-market analysis

A4.1 Selection criteria for the stock-market analysis

We match stock-market information for nearly 2,700 cases ($\approx$ 2.5% of the total), involving 781 firms. When the same company is cited as a defendant in multiple consecutive cases, we check that these cases are at least 31 days apart, not to confound the effects of different settlements. When the cases are less than 31 days apart we drop them. Additionally, throughout the analysis we always drop the BP Deep Horizon case, since it is an outlier in terms of size of the assessed monetary payments and type of violations involved (the violations were also prosecuted criminally). We also follow Dube et al. (2011) and drop companies that during the sample period have at least one of the following events: (a) company name change, (b) change in stock-market price larger than 50%, and (c) change in outstanding share by more than 5%. We are thus left with 2,165 cases, out of which 1,204 result in no monetary penalty, 867 result in a cash penalty only, and 94 result also in an in-kind penalty. Our goal is to compare cash versus in-kind decisions, and so we restrict the sample to those 961 cases with some financial penalty. We drop 54 cases with multiple defendants, since the information on penalties is available at the case-level rather than the defendant-level.[75] We also drop 206 cases where we find evidence of information about the settlement being released before the lodge/issue date, or of other newsworthy events involving the same firm occurring at around the same time as the settlement. The final sample consists of 678 cases.

A4.2 Robustness checks

A4.2.1 Identification

Concluding that the opposite stock-market response to in-kind and cash settlements is due to the settlement type requires assuming that in-kind and cash settlements are similar in characteristics that influence share prices upon the settlement announcement. In this Section we consider a number of potential violations of this assumption.

Previous stages of the enforcement action A concern is that the share price of defendants involved in in-kind settlements drops more in previous stages of the enforcement action; then, the more positive evaluations are only revisions upon the settlement announcement. However, in roughly 70% of the cases that we study, the complaint, that officially starts an enforcement action, was filed on the same day as the settlement announcement, implying that in most of the cases we actually likely capture the entire stock-market response to the enforcement action.

[75] In a few cases, the EPA data report that there was more than one defendant even though these are subsidiaries of the same parent company, or plants owned by the same parent company. In these cases, we proceeded as though they had one defendant.

Differences in firm- and settlement-level characteristics by settlement type Firms volunteering in-kind settlements might be systematically different in ways that make the stock market response to their wrong-doing different. For instance, the firms volunteering in-kind might also be better at spinning the settlement to the public, and could have observed a positive response even in absence of an in-kind project. However, in Table 3 we have shown that there is no evidence of significant differences between cases resulting in in-kind versus cash punishment, or between their respective defendants, based on a few observable measures.

Since some of the differences in Table 3 are large, albeit not statistically significant (see the variable *Other*), below we perform two additional tests, to address remaining concerns of differences in characteristics, namely we use a control-based strategy and estimate the intensive margin for the treatment.

For the control-based strategy, we consider the sample of large cases and estimate variations of equation 1 where we control for $\mathbf{1}[t \in \mathbf{W}] \cdot x$, where x stands for each of the control variables in Table 3. Figure A5 shows that the observed difference in stock-market response is not explained by any of the case-level and defendant-level characteristics that we consider, although in some specifications the estimates are less precise, likely due to the lower number of observations.[76]

[76]The defendant-level control variables are missing for a number of cases.

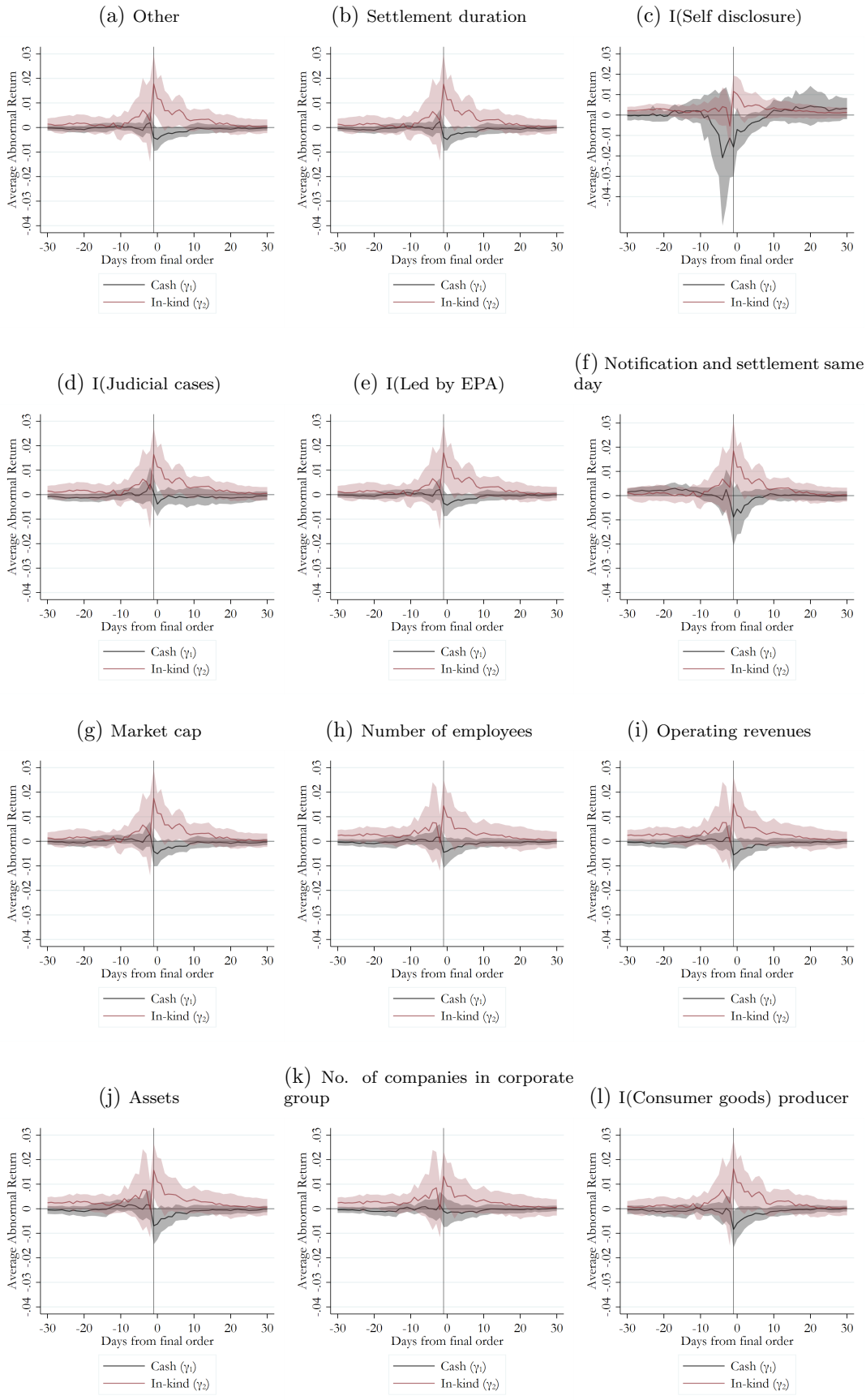


Figure A5: Robustness including interaction terms

Notes: We replicate the analysis in Figure 4d but also account for an interaction between $\mathbf{1}[t \in \mathbf{W}]$ and each of the characteristics listed in the subtitles (see equation 1). The figure I(Led by EPA) shows results from replicating the analysis in Figure 4d after excluding those cash settlements where the case was led by a State; this is because all in-kind settlements in our relevant sample are led by the EPA.

When we estimate the intensive margin of the treatment (e.g. cash and in-kind amount), we focus only on in-kind settlements. The advantage of this approach is two-fold: first we limit the comparison to a more homogeneous sample of cases, i.e. those that result in in-kind settlements, and second we let the stock-market response to the settlement announcement depend on cash and in-kind amounts, as suggested by the evidence in Section 6.2.[77] The estimated equation is:

$$R_{fjt} = \phi_j \cdot R_{mt} + \theta_1 cash_{fj} \cdot \mathbf{1}[t \in \mathbf{W}] + \theta_2 in\text{-}kind_{fj} \cdot \mathbf{1}[t \in \mathbf{W}] + \varepsilon_{fjt} \quad (2)$$

The variables $in\text{-}kind_{fjt}$ and $cash_{fjt}$ represent the estimated cost of the in-kind project and the cash penalty respectively. We set $in\text{-}kind_{fjt}$ and $cash_{fjt}$ to their respective dollar amount for all days in the window $\mathbf{W}$, and to zero for all days before the settlement.

As shown in Figure A6, the larger is the cash settlement the more negative is the stock-market response; the converse is true for in-kind settlements, whose size is associated with more positive variations in share prices. Notice that this specification allows estimating the impact of a larger in-kind settlement while accounting for the size of the cash penalty, and vice-versa. In sum, studying the intensive margin of the treatment on the sample of cases with in-kind settlements confirms the conclusion from the main analysis: the stock-market views a cash settlement as a bad news for the company, whereas the in-kind settlement is treated as a good news.

Defendants volunteer to perform in-kind projects because they benefit from them A threat to identification related to the discussion above is that defendants volunteer to perform an in-kind project when they expect a strong negative stock-market response to the punishment announcement. Importantly, if this were the case, our estimate of the difference in abnormal stock-market returns would be a lower bound of the positive stock-market response to in-kind settlements.

Alternatively, an hypothesis is that the defendants that volunteer to perform an in-kind project are those that expect the larger benefits from settling in-kind, for instance because their investors and stakeholders are particularly sensitive to green advertisement; such treatment-effect heterogeneity has implications only for the interpretation of our findings, and not for identification, as long as cash settlements provide a useful counterfactual for investors' response in absence of the in-kind project. In other words, one possibility is that in-kind projects benefit those defendants that volunteer to perform them, but were other defendants induced to settle in-kind the benefits to them would not be necessarily the same.

[77] Despite the advantages of studying the intensive margin of the treatment, we emphasize the extensive margin specification as our main analysis because (a) the point estimates are easier to interpret and to compare with the existing literature, and (b) identification of θ_1 and θ_2 is less straightforward given that cash amount and in-kind amount are jointly determined and thus endogenous to each other.

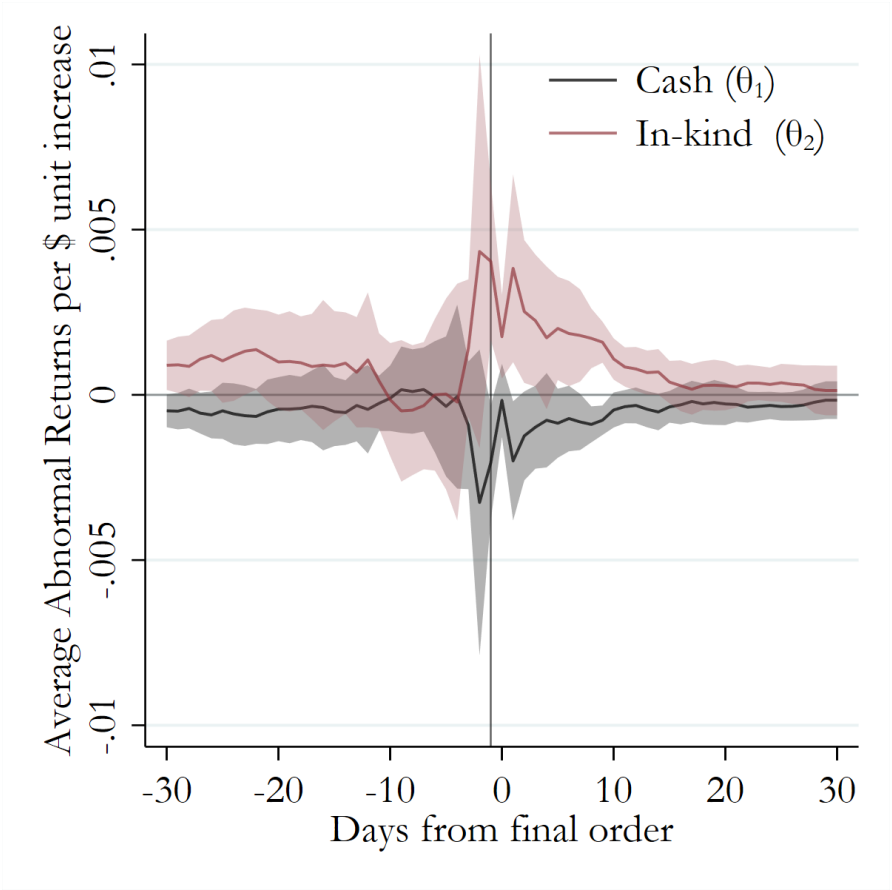


Figure A6: Average abnormal returns per unit increase in settlement amount

Notes: We replicate the analysis for Figure 4d but instead examine the intensive margin of the treatment, namely the stock-market impact of the dollar amount for cash and in-kind settlements. This corresponds to estimating to θ_1 and θ_2 in equation (2).

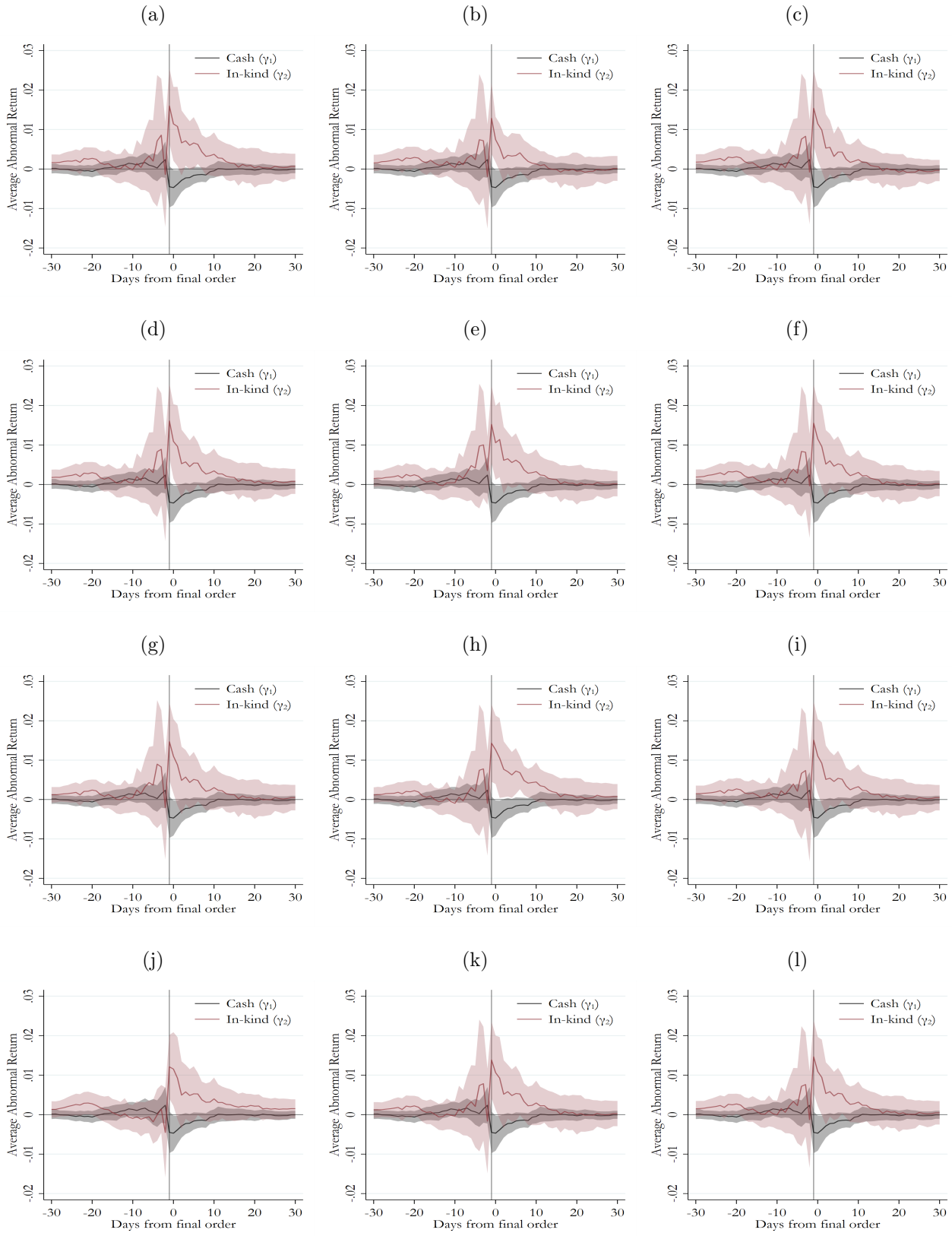
A4.2.2 Alternative samples of the large-settlement cases

Given that the 90th percentile sample includes relatively few in-kind settlements (13), a concern might be that the results are driven by a limited number of settlements. We thus re-estimate equation (1) in 13 alternative samples, each of which excludes one of the in-kind settlements at time, whereas the number of cash settlements remains the same (55). As shown in Figure A6, the conclusions from the analysis are unaffected.

A4.3 Media coverage of large settlements

While we find no stock-market response to settlement announcement when we consider all the cases in our stock-market sample, in a related study Karpoff et al. (2005) find a significant negative stock-market impact of press announcements disclosing environmental violations in the US between 1980 and 2000, nearly half of which are settlement announcements. We conjecture that the discrepancy between our results and Karpoff et al. (2005)'s is due to their focus on news in the press, which likely cover only the largest settlements.

To corroborate this conjecture, we conducted a manual search of the media coverage of the 68 largest settlements and show that coverage of these settlements is relatively large and increases with the settlement size. Specifically, we have proceeded through the following steps. First, we have simplified the name of the defendant (e.g., E.I. DU PONT DE NEMOURS AND CO. was modified to DUPONT). Second, we have searched hits for the name of the defendant and the word *EPA* 11 days around the event date (from day -1 to +10) in *Newslibrary* (as in Campa (2018)) and *Proquest* (as in Beattie (2020)); Newslibrary archives publications from around 7,000 US newspapers and other news sources, whereas Proquest is one of the largest databases available for researchers, and includes newspapers articles. Third, we have counted all the hits among the returned results that explicitly mentioned a settlement between the defendant and the EPA in the title or abstract. Our search returned media coverage, defined as at least one hit in Newslibrary or ProQuest, for more than half (54%) of the cases. For the cases with media coverage, we found an average of 11 hits from Newslibrary and 5 from ProQuest (a correlation of 0.70 across the two sources). Interestingly, the correlation between the total punishment (cash + in-kind) and media coverage is quite high at 0.31, confirming that larger cases tend to receive more media coverage.


(a)
(b)
(c)
(d)
(e)
(f)
(g)
(h)
(i)
(j)
(k)
(l)
Cash (γ_1)
In-kind (γ_2)
Average Abnormal Return
-.02
-.01
0
.01
.02
.03
-30
-20
-10
0
10
20
30
Days from final order

(m)

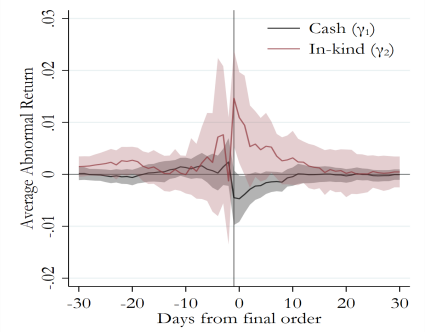


Figure A6: Average abnormal returns in alternative samples

Notes: Given the small sample of cases in the 90th percentile of penalty amount, we replicate the analysis for Figure 4d but each time omitting one case. Our results remain whether or not individual cases are included in the analysis.

A5 Details on the analysis on environmental quality

A5.1 Toxic concentration data

The Risk-Screening Environmental Indicators (RSEI) of the U.S. Environmental Protection Agency provide a screening measure of risks to human health associated to chemical releases. We focus on an environmental-quality indicator, which does not consider population exposure, given our focus on detecting occurrence of environmental violations. Such a measure is based on facility-level releases of toxic chemicals as self-reported by individual facilities to the Toxic Release Inventory (TRI).[78] The EPA calculates air concentrations resulting from these chemical releases using an EPA dispersion model which considers weather conditions, facility stack parameters, and chemical-specific air decay rate and destruction and removal efficiency (for off-site incinerators).[79] Each chemical is weighted by an inhalation toxicicy index based on human health effects associated with long-term exposure to chemicals.[80] For each chemical reported by a facility, RSEI estimates a toxicity-weighted concentration for each 810-meter grid cell around the facility for 49 kilometers, and then the information is aggregated at the zip-code level and summed over all chemicals impacting the zip-code.

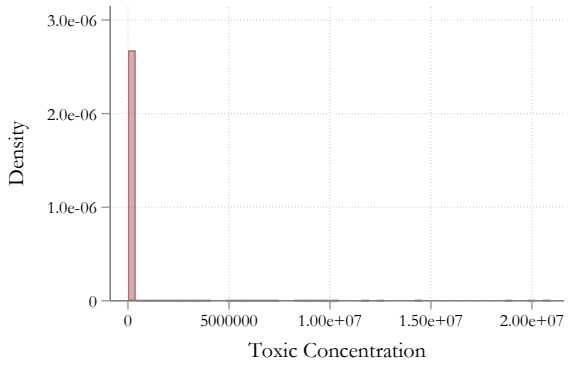
Below we show the distribution of the toxic concentration in our sample (left panel) and of its log transformation (right panel).

[78] Under the TRI program, US facilities in different industries that release, process or otherwise use an above-threshold amount of as many as 770 chemicals have to report yearly the amount of each of these chemicals that they release to the air, water and land. The chemicals are monitored because they are generally known or suspected to have health and environmental effects.

[79] For a more detailed description of how TRI data are converted in geographic concentrations, see https://www.epa.gov/rsei/modeling-air-releases-rsei.

[80] See https://www.epa.gov/rsei/rsei-toxicity-weights

(a) Toxic concentration



(b) Log Toxic concentration

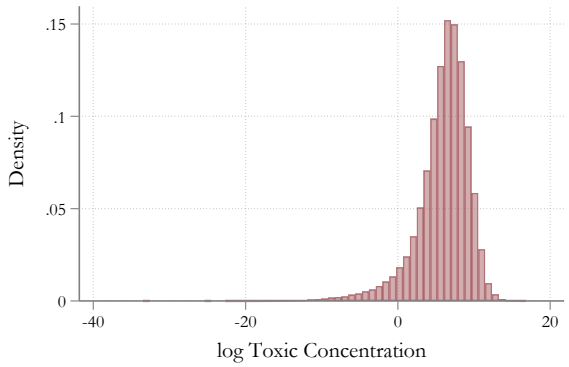


Figure A7: Distribution of toxic concentration across zip-codes (1997-2017)

A5.2 Difference-in-differences estimator

Following De Chaisemartin and D'Haultfoeuille (2022a), let F_z be the time that zip-code z is first involved in at least one cash or in-kind settlement. Then, let $\delta_{z,l}$, be the expected difference between zip code z's environmental quality at time F_z+l and the counterfactual environmental quality had its treatment status remained unchanged (i.e. no treatment) from the beginning of the panel to period F_z+l. The $DID_{z,l}$ estimator for $\delta_{z,l}$ proposed by De Chaisemartin and D'Haultfoeuille (2022a) compares the evolution of the toxicity index at zip code z from the year before its first settlement to year F_z+l with the evolution of the index at zip codes that during the same years have not yet had their first settlement. Then, the $DID_{z,l}$ estimators are aggregated across facilities and years to deliver a DID_l estimator for each post-treatment period l.

In Figure 5 we also show placebo coefficients that are based on the DID_l^{pl} estimator proposed De Chaisemartin and D'Haultfoeuille (2022a). The DID_l^{pl} estimator mimics the DID_l estimator. It is an average across units and years of $DID_{z,l}^{pl}$ estimators, where $DID_{z,l}^{pl}$ compares the evolution of the toxic concentration at zip-code z from F_z-l-2 to the year before treatment, F_z-1, and the comparison

group is the same as for the corresponding DID_l estimator, namely those zip-codes with no settlement from the beginning of the panel to period $F_z + l$. Practically speaking, DID^{pl} assesses whether first time treated and their corresponding control group are on parallel trends when untreated, for $l + 1$ periods, the number of periods over which parallel trends have to hold for DID_l to be unbiased.

A5.3 Standard event-study design

We employ a standard event-study design to estimate the effect of the first settlement on local toxic concentration up in a zip code to five years after the settlement. To be consistent with the main analysis, our treatment of interest is only the first time the zip code has a facility with a cash (or in-kind) settlement.We also test the parallel trend assumption up to six years before the settlement to be consistent with the number of placebos in the main analysis.[81] Moreover, to be consistent with the main analysis we examine one treatment at a time, examining cash in a separate regression from in-kind. Using the sample of ever-treated zip codes (e.g., ever had a cash settlement in the regression examining cash) we regress:

$$T_{z,t} = \phi_z + \lambda_t + \sum_{j=\underline{j}}^{\overline{j}} \beta_j D_{zt}^j + \varepsilon_{zt} \tag{3}$$

where $\underline{j} = -6$, $\overline{j} = 5$, and D_{zt}^j are indicators taking the value of 1 if zip code z is treated at time $t + j$.[82] The coefficient β_{-1} is normalized to zero, so that all the coefficients are to be interpreted in relation to one year before the treatment. The indicators at the endpoints, i.e. the last lag and lead, are "binned," namely treatment turns on if in any past year or future year the zip code is treated, to take into account all observable past (future) events going beyond the effect window.

We estimate model (3) twice, respectively for cash and in-kind settlements. The design accounts for zip-code-specific time-invariant characteristics that affect the toxic concentration (e.g. industrial mix) and economy-wide shocks in toxic concentration (e.g. business cycle-induced changes in output).[83] We show the estimated coefficients in Figure A8.

When we consider punishment of any size, the evidence would suggest that cash settlements are associated with worse environmental quality post-settlement, whereas the opposite is true for settlements in-kind, although for the latter only the first lag is statistically significant at conventional level. These results differ from the evidence in 7.3; the conclusions from the analysis on large punishment are instead

[81] For the outcome variable, we consider our entire sample period from 1997 to 2017; however, because for each zip-code-by-year we estimate 6 leads and 5 lags of the treatment variable, we can only consider settlements that occurred between 1997 + 5 and 2017 - 6.

[82] For instance, if zip code z is treated in 2000, the indicator D^2 for zip code z takes value of 1 in year 2002.

[83] Notice that our use of bins implies an implicit assumption that the effect of a settlement stabilizes from the fifth period after its occurrence.

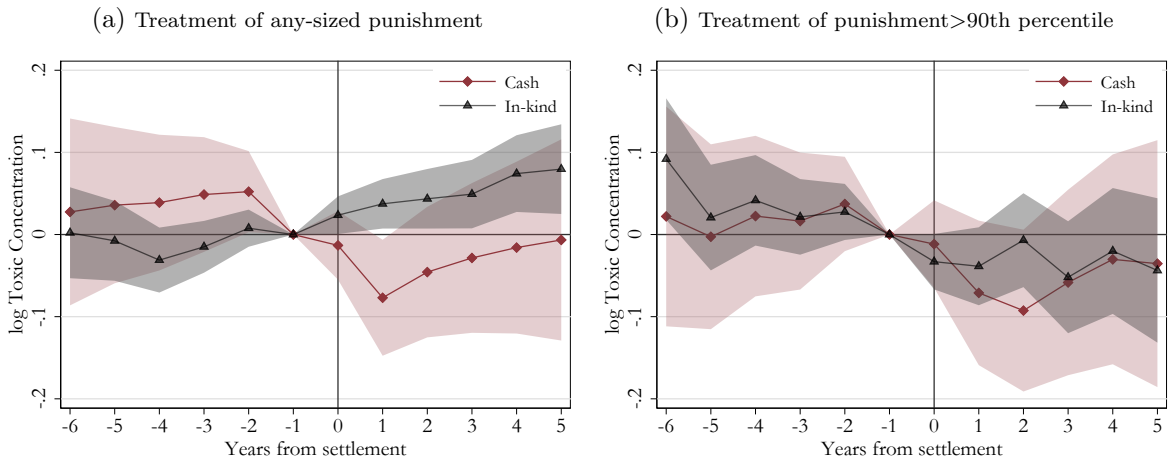


Figure A8: Toxic concentration

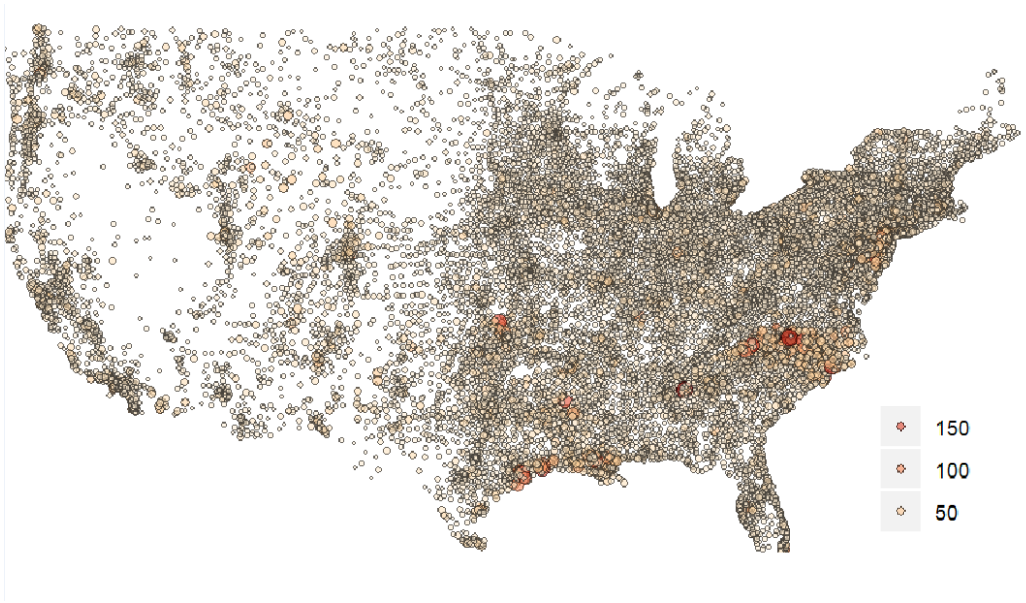
Notes: To the right of zero, the figure shows event-study estimates of the effect of the lag of a first settlement with penalty (cash or in-kind) on the logarithm of toxic concentration. To the left, the figure shows the placebo estimates based on leads of the treatment variable. At x = -1, the coefficient is normalized to 0. In-kind and cash settlements are analyzed separately, but plotted on the same figure. The shaded areas depict 95% confidence intervals. Standard errors are clustered at the zip-code level.

more consistent with those in 7.3, pointing toward a negative but not statistically significant association of both cash and in-kind settlements with toxic concentration.

A6 Location of cases

Figure A9 depicts the location of cases and in a different scale the location of in-kind settlements.

(a) Cases



(b) In-kind settlements

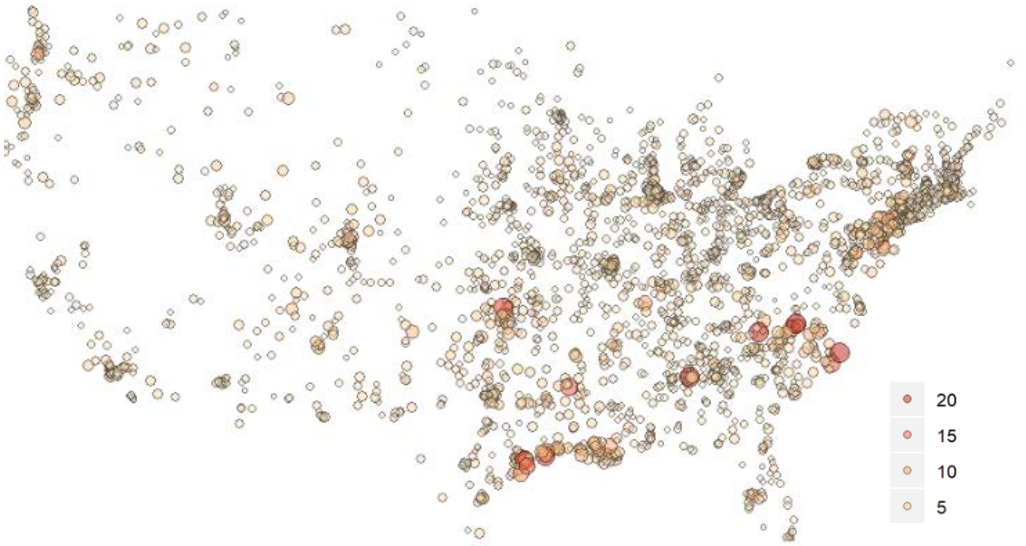


Figure A9: Location of cases and in-kind settlements (1997-2017)