Enforcement and Deterrence with Certain Detection: An Experiment in Water Conservation Policy

Oliver Browne, The Brattle Group, +1.415.299.2653, Oliver.Browne@Brattle.com
Ludovica Gazze, The University of Chicago, +1.773.834.1190, lgazze@uchicago.edu
Michael Greenstone, The University of Chicago, +1.773.702.8250, mgreenst@uchicago.edu
Olga Rostapshova, The University of Chicago, +1.773.834.4292, oro@uchicago.edu

Overview

Monitoring and enforcement of government regulations generally rely on costly and labor-intensive manual inspections. Consequently, agencies often balance regulatory priorities against budget considerations when scheduling inspections. Infrequent inspections undermine the deterrence power of these regulations, resulting in widespread non-compliance in many different contexts. However, recent technological advances are poised to change environmental enforcement. Remote sensing and real-time monitoring technologies are becoming cheap and ubiquitous, and the adoption of these technologies can drive the marginal cost of monitoring to zero. In turn, improved monitoring allows near-perfect detection of violations, often from a near-zero baseline. This improved monitoring strengthens the incentive to comply with environmental regulations, potentially offering large environmental benefits.

We conduct a randomized field experiment to study this transformation in the context of the enforcement of outdoor water use restrictions. Growing populations and rising costs of developing new water supply increase the need for utilities to control the demand for water and reduce the pressure on existing sources. Moreover, this dynamic becomes more pertinent as climate change increases the frequency and severity of droughts in arid regions worldwide. However, utilities typically do not price water at marginal cost, for a variety of political, regulatory and ethical reasons. As a result, they often resort to non-price mechanisms to manage demand. Residential outdoor watering restrictions are one such mechanism that are ubiquitous in arid regions. For example, in April 2015, California Governor Jerry Brown mandated that all utilities in the State introduce these restrictions to reduce the impacts of the worst drought in the State's history. These regulations only permit customers to use water outdoors during specified hours at night and only for a few nights each week.

We partner with a large Californian city that had recently installed smart meters in all single-family homes. These smart meters enabled the introduction of automated enforcement of outdoor water use violations – offering perfect violation detection at a minimal cost. Prior to the introduction of automated enforcement, 68% of households had violated the restrictions; however, water cops performing visual lawn inspections caught less than 1% of these violators. The adoption of automated enforcement implies changes in the optimal design of water use regulations; if rates of detection are higher, then lower fines may be able to achieve similar levels of deterrence. Furthermore, real-time data requires regulators to redefine what constitutes a violation; utilities need to set an excessive water use threshold above which households are presumed to be irrigating outdoors and fined. A lower threshold may lead to larger reductions in water use but may also increase calls and complaints to the city's customer service line, a hidden cost of such an enforcement strategy.

Methods

We study these tradeoffs by implementing a three-month randomized field experiment across all single-family homes in our partner city. In the summer of 2018, we randomized over 80,000 homes into 12 treatment groups defined by a) automatic detection of excess water use violations through smart meters (relative to visual detection), b) the fine size for such violations (baseline fines or a 50% or 75% discount), and c) the water use threshold that defines a violation and triggers a fine (300, 500, or 700 gals/hr). We study the effect of varying these parameters on two primary outcomes: water use and customer service requests. First, we measure the impact of automated enforcement on water use at different times of day and days of the week. Second, we collect data on customer service calls to the city and on requests for free services to improve water schedule compliance, such as free water use audits and timer setting tutorials. Thus, our unique setting allows us to estimate the opportunity cost of time spent by city officials to answer calls and visit households to provide compliance assistance, enabling us to perform a more realistic assessment of the cost-effectiveness of automated enforcement.

Results

We find that automated enforcement has both benefits and costs. First, automated enforcement decreases water use by 2.8% and increases compliance, reducing the total number of violations by 17%. On the extensive margin, 8% fewer households violate regulations in the treatment groups relative to the control. Second, automated enforcement increases calls to customer service by over 500% and doubled the number of service requests received by the city, such as requests that staff visits a household to perform leak audits or timer tutorials. Responding to all of these phone calls and service requests posed substantial costs on the city. Surprisingly, we do not find significant evidence that households assigned to treatment groups with lower fines increase water use and violations; however, they are less likely to call customer service. Moreover, we find that higher users of water do not conserve proportionally more water under automated enforcement compared to low baseline users; however, higher users are more likely to call customer service. This pattern suggests that policymakers can make automated enforcement more palatable to constituents by having more frequent but lower fines. Third, we still observe 9.1 violations per household in the automated enforcement group, suggesting a low ex-ante `general deterrence' effect of perfect detection. In contrast, we do observe `specific deterrence' effects of enforcement, that is households reducing water use after receiving notices of violation.

Conclusions

This paper presents results from the first field experiment to study the impact of automating the enforcement of local environmental regulations. It is also the first experiment to randomize both detection methods and sanctions for violations of such regulations, and it is the first to do so in a context where compliance can be perfectly observed, and on a representative population at the city level.

As environmental agencies and private actors increase adoption of remote sensing and continuous monitoring technologies, policymakers must adapt old regulations to these new tools. This experiment provides empirical evidence on how households respond to different policy levers, such as `excessive water use' thresholds and fines. This type of evidence is crucial for policymakers to consider when they balance the costs and benefits of designing policy around automated enforcement.