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Recommended Citation
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The Unintended Consequences of Household Phosphate Bans*
by Alex Cohen and David Keiser
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In 2010, seventeen US states implemented mandatory bans on the sale of phosphates in automatic dishwasher detergent, due to concern over the adverse effects that arise from excess phosphorus loads to our lakes, rivers, and streams. Excess phosphorus can lead to harmful algal blooms, excessive aquatic plant growth, and alterations to the composition of aquatic species, among other changes. Accordingly, the US EPA considers nutrient pollution to be one of the most important environmental challenges we face in the twenty-first century (USEPA 2009). Effectively and efficiently addressing this challenge requires a sound understanding of phosphorus control policies. We find that the effectiveness of these bans to reduce phosphorus pollution is highly dependent upon regulations that are in place at wastewater treatment facilities and that pre-existing regulations at certain wastewater treatment facilities render these bans ineffective precisely in the areas in which phosphorus pollution is most problematic.

When a household runs its dishwasher, that waste travels through a sewer system to a wastewater treatment facility (as influent) where it is treated before being discharged into the environment (as effluent) (see Figure 1). The Clean Water Act requires that wastewater treatment facilities meet a basic level of treatment known as secondary treatment. However, where water quality fails to support state-designated uses of waterways, additional stringent effluent standards (limits) may be placed on particular pollutants such as phosphorus. With a fairly simple theoretical model of wastewater treatment behavior, it is easy to show that these “limit facilities” have little incentive to deviate from their current phosphorus effluent levels. The basic intuition is as follows: Removing phosphorus from wastewater treatment effluent is expensive. Wastewater treatment facilities find it in their own best interest to minimize costs of treating phosphorus subject to meeting regulated limits. Although the phosphorus ban lowers the amount of phosphorus entering a wastewater treatment facility, that facility faces no incentive to pass through these reductions. Instead, the bans provide a cost savings to the facility by lowering the amount of phosphorus influent it must treat to meet its limit. Consequently, in areas served by limit facilities, we expect that these bans will have little-to-no effect on phosphorus entering the rivers, streams, and lakes in which these facilities discharge.

Using detailed data on effluent at wastewater treatment facilities in states with mandatory phosphate bans, this is exactly what we find. We examine the difference in phosphorus effluent before and after the 2010 bans took place at limit versus no-limit facilities. We find that phosphorus effluent dropped 18 percentage points more at facilities without limits compared to facilities with limits after the bans were implemented—consistent with engineering estimates attributing

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*Note: This article is based on a working paper by Alex Cohen and David Keiser, “The Effectiveness of Overlapping Pollution Regulation: Evidence from the Ban on Phosphates in Automatic Dishwasher Detergent” https://sites.google.com/site/dkeiserecon/home/papers. Cohen is a Postdoctoral Associate in the School of Management at Yale University (alex.w.cohen@yale.edu). Keiser is an Assistant Professor in the Department of Economics and an affiliated faculty member in the Center for Agricultural and Rural Development at Iowa State University (dkeiser@iastate.edu). We thank Becky Olson for providing graphics for Figure 1.

1These states are Illinois, Indiana, Maryland, Massachusetts, Michigan, Minnesota, Montana, New Hampshire, New York, Ohio, Oregon, Pennsylvania, Utah, Vermont, Virginia, Washington, and Wisconsin.
from 9 to 34 percent of phosphorus influent to automatic dishwasher detergent. We show that phosphorus effluent at limit and no-limit facilities had very similar trends prior to the bans taking hold in 2010. This gives us confidence in attributing the differential drop in phosphorus at limit facilities as arising from these facilities reacting differently to the ban.

To provide further evidence of this predicted behavior, we use a unique dataset from the state of Minnesota that records both phosphorus influent as well as phosphorus effluent. We use these data for three main purposes. First, by observing phosphorus influent at wastewater treatment facilities, we show that the differential drop in phosphorus effluent at limit versus no-limit facilities over the ban period is not due to a differential drop in phosphorus influent over that time period. In other words, these data provide further evidence that the differential change in influent is due to differences in behavior at limit and no-limit facilities, not a differential change in the amount of phosphorus entering these facilities.

Second, we use the Minnesota data to estimate what we term the elasticity of phosphorus effluent with respect to influent. This elasticity is the percentage change in phosphorus effluent with respect to a percentage change in phosphorus influent. These estimates tell us how responsive these types of facilities are to any influent policy, not just bans. Our estimates place a lower bound of 0.5 on this elasticity at no-limit facilities. For limit facilities, the magnitude is approximately 0.1 and insignificant, suggesting that, as expected, effluent from limit facilities responds very little to changes in influent.

Finally, we use the Minnesota data to quantify how effective these bans are at reducing phosphorus effluent. Using our econometric estimates and theoretical predictions, we bound elasticity at no-limit facilities between 0.5 and 1.0 and elasticity at limit facilities between 0 and 0.1. Using the share of influent at limit and no-limit wastewater treatment facilities in Minnesota, we find that for every one percent decrease in phosphorus influent, phosphorus effluent across all facilities falls by 0.41 to 0.76 percent. However, when we examine waterways that were impaired by nutrients in 2014, for every one percent decrease in phosphorus influent, phosphorus effluent falls by only 0.18 to 0.21 percent. If Minnesota is representative of other ban states, these results imply that phosphate bans in aggregate yield 41 to 76 percent of the expected effluent reductions. More striking is the fact that these bans yield only 20 percent of the expected effluent reductions in the most polluted waterways. This occurs because limits to control phosphorus effluent have already been implemented in many impaired waterways.

Finding efficient and effective solutions to phosphorus pollution is not easy—the US has struggled with cultural eutrophication for several decades. At first blush, banning phosphates in automatic dishwasher detergent may appear to be a clear solution to this problem. Common intuition is that banning a pollutant leads to an improvement in environmental quality. This was the case when phosphates in household laundry detergent were banned in the 1970s. However, since that time, phosphorus limits have been introduced at many wastewater treatment facilities. The effectiveness of phosphate bans is now tempered by regulations in place at wastewater treatment facilities. If the goal of the bans is as stated—to reduce phosphate entering US waters—we argue that these bans are misplaced.

Economists have argued for several decades that market-based approaches to pollution management have many advantages over command-and-control policies. Indeed, in our setting, our theory suggests that a tax on phosphorous effluent would incentivize wastewater treatment facilities to pass through influent reductions, avoiding the unintended consequences that we find. Yet, water quality policy in the US remains largely reliant on command-and-control policies such as effluent standards, technology standards, and bans. Part of this reason is that these policies are often thought to provide a guaranteed means to improve the environment. However, when there are overlapping policies, even this advantage of command-and-control policies is muted. Even if the adoption of market-based approaches remains limited, at the very least, policymakers ought to take into account how pre-existing regulations might mitigate the effect of potential policies.

References