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## Polluting thy neighbor: Unintended consequences of China's pollution reduction mandates



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### ABSTRACT

This paper studies how the pollution reduction mandates imposed by China's central government in 2001 triggered unanticipated responses from its provinces. We apply the difference-in-differences-in-differences (DDD) method to a unique dataset on industry-level activities in counties along 24 major rivers in China from 1998 through 2008. We find that the most downstream county of a province has up to 20 percent more water-polluting activities than otherwise identical counties since 2001. Moreover, we find that the enforcement of pollution fee collection is more lenient in the most downstream county of a province, and that private firms contribute more to the downstream effect than state-owned enterprises and foreign firms. These findings are consistent with the hypothesis that the provincial governments respond to the pollution reduction mandates by shifting their enforcement efforts away from the most downstream county.

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### Introduction

China's rapid growth over the past three decades has been accompanied by severe environmental pollution. Deteriorating water quality, pollution-related disputes and accidents, and haze has frequently plagued Chinese cities, raising serious concerns among both the public and the central government (Chan and Yao, 2008; vanRooij, 2010). River pollution is a particularly serious problem. A mere 28 percent of the country's 500 monitored river sections report drinkable water quality, and one-third are so contaminated that the water is unsuitable for drinking, agriculture, or any other common uses (World Bank, 2006). China's economic losses from water pollution are estimated to be around 150 billion yuan per year, and losses of health and life associated with water pollution are enormous but impossible to estimate (World Bank, 2007).

As a country with one of the lowest per capita fresh water availability rates in the world,<sup>1</sup> the Chinese central government became alarmed at the severe river pollution in recent years. In its Tenth Five-Year Plan, released in 2001, the central government for the first time added environmental protection and pollution reduction to its list of "national strategic goals" and set a target to reduce pollutant discharges by 10 percent by the end of 2005 (State Council, 2001). Each province was assigned a specific target, and the provincial government officials were to be evaluated on, among other things, how well these targets were met. Despite the central government's resolution, China's water quality saw almost no improvement over the 15 years between 1991 and 2005 (World Bank, 2006).

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<sup>1</sup> China's per capita renewable water resource availability was 2156 m<sup>3</sup>/year in 2007, one-fourth of the world average.

In this paper, we investigate the effects and consequences of the 2001 policy change by the Chinese central government that imposed pollution reduction mandates on its provinces. We identify 24 major rivers in China and study the polluting activities and location choices of industrial firms along the provincial borders. We aggregate firm information from the Annual Survey of Above-Scale Industrial Firms in China from 1998 through 2008 to the county level and the two-digit industry level; we also collect information about county characteristics from other sources. To control for confounding factors in firm location and production choices, such as transportation, geographical features, and industry characteristics, we take the difference-in-differences-in-differences (DDD) approach, constructing control groups using non-water-polluting industries and non-riverside counties. These control groups help us to eliminate many unobserved county and industry heterogeneities. In addition, we control for a range of county socioeconomic, demographic, and other characteristics, as well as a rich set of potentially time-variant two-digit industry effects and county group effects in order to mitigate selection based on unobservable variables.

Using the DDD method, we find strong evidence of the *downstream effect*. That is, all else being equal, the most downstream county of a province has up to 20 percent more water-polluting activities than otherwise identical counties. This leads to the phenomenon of “polluting thy neighbor” in that provinces concentrate water-polluting activities in the most downstream counties, thus shifting the burden of water pollution to their downstream neighbor provinces.

The downstream effect sheds light on why water quality has not improved even though the central government of China has been emphasizing environmental protection since 2001. At the time of the policy change, the central government set pollution reduction targets for each province (see [section “Institutional background”](#) for details) but failed to anticipate the provincial governments' responses in how they would meet the targets. Under the pressure from the central government to curb river pollution, growth-driven provincial governments responded by optimally allocating enforcement efforts among their counties: given the externalities inherent in river pollution, the provinces cannot reap the full benefits of pollution reduction, especially in the most downstream counties. At the same time, the crude pollution monitoring technology adopted by the central government gave the provincial governments considerable power over the enforcement of environmental regulations. Therefore, provinces tend to exert the least enforcement efforts in the most downstream counties, resulting in the increase of water-polluting activities at the downstream provincial border.

Our empirical analysis finds strong evidence that is consistent with the mechanism proposed above. Specifically, we find that (i) the downstream effect is absent among interior counties, and is much weaker before 2001; (ii) the enforcement of pollution fee collection is more lenient in the most downstream county of a province than in other counties; and (iii) private firms, which are more sensitive to the enforcement of environmental regulation than state-owned enterprises (SOEs) and foreign firms, contribute the most to the downstream effect. These findings suggest that the downstream effect is due to the *strategic polluting* of provincial governments in response to the central government's pollution reduction mandates.

Our paper is closely related to the literature on river pollution ([Sigman, 2002, 2005](#); [Bernauer and Kuhn, 2010](#); [Lipscomb and Mobarak, 2013](#)). Recognizing the unidirectional externalities in river pollution, [Sigman \(2002\)](#) uses cross-border comparisons to show that pollution levels are higher upstream of national borders in many countries. [Sigman \(2005\)](#) uses variations of when states were authorized to issue pollution permits in the U.S. to identify strategic polluting across state borders. Making use of county border changes in Brazil, [Lipscomb and Mobarak \(2013\)](#) study river pollution spillovers across riverside counties and investigate the overall effect of decentralization on water quality.

Our paper differs from previous studies in three ways. First, our identification strategy using the DDD approach offers a new way of controlling for unobserved county and industry characteristics. Second, unlike existing papers that focus on pollution outcomes or water quality (e.g., chemical oxygen demand (COD)) measured at monitoring stations, we use indirect measures, the amount of pollution-generating production activities (the industrial value added and the number of firms in water-polluting industries) and firm location choices (the number of new firms in water-polluting industries), as our dependent variables. This is not by choice, as we do not have water quality data from monitoring stations for the years we are studying. Nevertheless, our measures not only complement the use of water quality data but they also have several advantages. One advantage is that our measures are all county-specific, making it easy to perform cross-county comparisons. On the contrary, point observations of water quality at monitoring stations do not directly reflect the pollution level in the counties they belong to, as the water quality at any point depends on the cumulative effects of all polluting activities upstream. One would need very specific assumptions about the pollution decay function and about industry distributions to deduce the contribution of pollutants from the upstream counties. Another advantage of our measures is that they are less subject to misreporting than direct measures of water quality would be in China. Previous researchers ([Sigman, 2002](#); [Bernauer and Kuhn, 2010](#)) have warned of the strategic reporting of water quality in other countries. Third, our paper goes beyond identifying the downstream effect. The existing literature on pollution spillovers usually alludes to the strategic choice of enforcement efforts by local governments as the reason behind negative spillovers. But the connection is often not made explicit.<sup>2</sup> In this paper, we use information on pollution fees and take advantage of a policy change to make explicit the provincial governments' incentives as the driving force behind the downstream effect that we document.

<sup>2</sup> An exception is [Konisky and Woods \(2012\)](#), who use the number of environmental inspection visits to polluting facilities as a proxy for enforcement efforts. However, they find that there are *more* inspection visits in counties along the state borders in the U.S. than in interior counties.

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