Research Note
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Firm relocation as environmental policy: impacts on firms and air quality

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We evaluate a policy which relocated over 20,000 firms identified as polluting from central Delhi to industrial areas on the outskirts of the metro area. Roughly 58% of these firms ceased operation as a result of having been relocated. We do not find evidence that the relocation policy resulted in significant decreases in air pollution levels.

As developing countries industrialise, the trade-offs between promoting economic growth while minimising externalities such as pollution become more binding. Government policy often seeks to influence this trade-off in the social interest. Understanding the impact of these policies on environmental outcomes is important; however, since the policies also directly impact firm decisions, they provide a lens to test theories of firm interactions that contribute to our understanding of firm behaviour and economic development.

In this project we examine the effects of a policy which relocated over 20,000 firms from high-population-density areas in central Delhi to industrial areas on the outskirts of the metro area, with the stated goal of reducing aggregate exposure to air pollution. We study how the policy impacted the relocated firms, and whether the effects of firm interactions revealed by its design imply that the design could have been improved. We also evaluate whether the policy achieved its desired goal of improved air quality.

Location restrictions that seek to limit pollution exposure have a long history, starting with the first zoning laws introduced in the early 20th century in New York in part to improve environmental quality (Wilson et al 2008). Harrison et al (2019) study how Indian Supreme Court-ordered Action Plans for 17 cities affected firm decisions in corresponding districts to exit or invest in pollution abatement. A primary means to reduce pollution mentioned in these action plans was relocation of polluting industries to certain designated areas. 14 of 17 Action Plans in major cities mention industrial relocation. Industrial relocation policies to combat pollution are also an increasingly popular policy tool across the developing world, such as China's industrial relocation policy to move polluting industries outside of Beijing city limits by 2017.

Policy and Research Design

Due to a shortage of industrial plots in the industrial areas when the Delhi policy we study began, allotment of these plots was done via a series of lotteries spanning 2000 through 2011. These lotteries provide a unique source of random variation to answer our research questions.

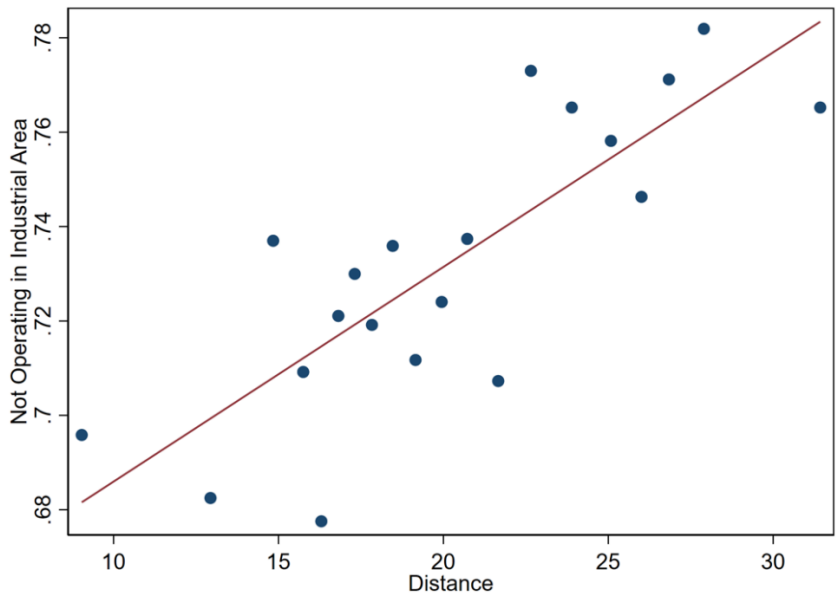
Since each plot in the industrial areas was assigned to a random firm, a relocated firm's distance from its original location is random when compared to other firms from the same location. A firm's neighbours are also random, generating independent variation in neighbour characteristics and allowing us to determine how each neighbour characteristic impacts economic performance. To take advantage of this historical randomised experiment, we combine administrative data from the Delhi State Industrial and Infrastructure Development Corporation Ltd. (DSIIDC) and digitised maps of the industrial areas to identify each firm's precise location and neighbours. Using a combination of natural language processing and manual assignment, we determine each firm's industry based on a free text description the owner provided to DSIIDC.

The lotteries also mean that different concentrations of eligible firms left neighbourhoods throughout Delhi at different (random) times, creating variation in polluting firm presence by neighbourhood. To identify a firm's origin location we geocoded the addresses they provided to DSIIDC, making on-the-ground visits to roughly half the sample to validate our approach.

Effects on Relocated Firms

DSIIDC data from 2018 shows that 74% of firms in the largest industrial area were no longer operating in their assigned plot, roughly 10 years after firms first set up shop there. The probability of exiting is increasing in the distance between a firm's original address and their location in the industrial area, as shown in Figure 1 below. Using the random variation in relocation distance, we can infer that only between 9 and 16%[1] of firms would have ceased operating in their original location: this implies that at least 58% of relocated firms exited the market because they were relocated.

Figure 1: The Majority of Relocated Firms Were Not Operating in the Industrial Area 10 Years Later



Note: binscatter of relocated firm exit rates as a function of the distance between assigned plot in the Bawana industrial area and original location, along with a best-fit regression line. Source: DSIIDC (2018), Authors' calculations.

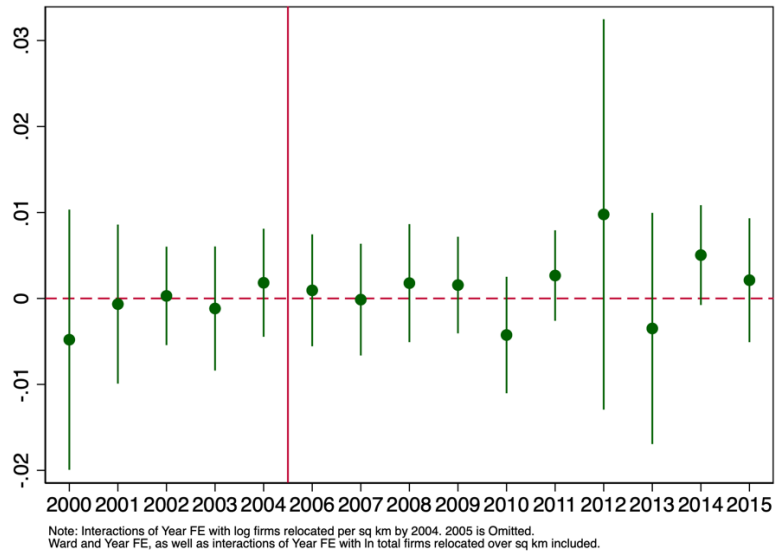
[1] This estimate is inclusive of a fixed cost of relocation.

Given that firms typically form geographic clusters by industry, how damaging was the policy's random assignment of plots to firms, which spread all industries evenly across industrial areas? We take advantage of the random assignment to identify the impact of different neighbour industrial compositions on a firm of any industry. This shows us that 1 - 3% of the effect of relocation on exit is attributable to the uniform random assignment of firms to plots. Using recent developments in non-convex optimisation theory (Xia, Vera, and Zuluaga 2020), we show that an optimal assignment of firms to parts of industrial areas would eliminate this policy design effect on exit.

Effects on the Neighbourhoods Firms Departed

Using the fact that polluting firms left their original neighbourhoods at different, random times we identify the effect of firm departure on neighbourhood-level air quality measures. We primarily measure pollution using the satellite-based Aerosol Optical Depth (AOD) indicator used in Gendron-Carrier et. al. (2022), which increases as less of the light reflected in the top of the atmosphere is ultimately reflected at the ground level. When less light makes it to the ground, it is indicative of more particulate matter between the atmosphere and surface. Figure 2 below shows the effect, by year, of having one percent more lottery winners in a neighbourhood by 2004. We do not see a systematic decrease in pollution from having more lottery winners, including after 2008 when most lottery winners had executed a lease in an industrial area. This may be rationalised by our finding that remaining firms become less likely to exit neighbourhoods which saw more relocation.

Figure 2: We Find No Evidence that Firm Relocation Decreased Pollution



Note: points show the effect on AOD of 1% more polluting firms in a neighborhood having won a plot by 2004, relative to the 2005 level. Bars are 95% confidence intervals. Mean AOD across neighborhoods was 0.61 in 2005.

Moving forward

At this point in our analysis we are not able to detect any air pollution benefits from Delhi's industrial relocation policy, and rule out large effects. To improve our ability to detect small effects, should they be present, we are developing a refined measure of local air pollution which takes AOD as an input and adds information from daytime satellite images.

The costs the policy imposed on relocated firms, however, are sufficiently high that the large majority of firms were not found operating in the industrial area about 10 years after executing their leases. We are in the process of refining our estimates of the effects of neighbouring firms' characteristics using information about production networks, and translating this improved precision into our findings on optimal industrial area design.

References

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