# Hazardous Waste Cleanup, Neighborhood Gentrification, and Environmental Justice: Evidence from Restricted Access Census Block Data

Shanti Gamper-Rabindran and Christopher Timmins

Abstract

We test for residential sorting and changes in neighborhood characteristics in response to the cleanup of hazardous waste sites using restricted access fine-geographical-resolution block data. We examine changes between 1990 and 2000 in blocks within 5km of sites that are proposed to the National Priority List that fall in a narrow interval of Hazardous Ranking Scores, comparing blocks near sites that were cleaned with those near sites that were not. Cleanup leads to increases in population density and housing unit density; increases in mean household income and shares of college-educated; but also to increases in the shares of minorities.

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## 1. Provision of localized public goods and neighborhood effects

The provision of spatially delineated public goods and environmental amenities can induce residential sorting. This has important consequences for environmental justice policy. In particular, evidence of sorting provides an alternative to discriminatory siting as an explanation for the greater likelihood that poor and less educated residents are exposed to environmental bads (Trudy Ann Cameron and Ian McConnaha, 2006; Spencer H. Banzhaf and Randall P. Walsh, 2008). Evidence of sorting also suggests that the remediation of contaminated sites under a host of programs – Superfund, Resource Conservation and Recovery Act, brownfields re-development – may not help the households that were originally exposed to the environmental bads, but instead benefit the richer households that migrate into the area. (Holger Sieg et al., 2008)

## 2. Superfund remediation and changes to local neighborhoods

This study uses restricted access data recorded at the census block level, the smallest geographical unit tracked by the Census Bureau, to study changes in neighborhood composition resulting from the provision of an important environmental amenity – the cleanup of a national sample of hazardous waste sites under the Superfund program. Under this program, established

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by the CERCLA Act of 1982, sites are proposed to the National Priority List (NPL) based on a preliminary risk assessment conducted by the Environmental Protection Agency (EPA). They are listed on the NPL if found to pose a significant risk, and deleted from that list when cleanup is completed (Hilary Sigman, 2001). Our previous study revealed that cleanup of Superfund sites causes significant appreciation in median housing values – by 18.5 % and 5.6% in census blocks lying <1km and < 3km from these sites. (Shanti Gamper-Rabindran and Christopher D. Timmins, 2010) Here we test for evidence of residential sorting and changes in neighborhood characteristics in response to Superfund cleanup by comparing blocks located near similar NPL sites that received the cleanup treatment with those near NPL sites that that were not cleaned. Our identification assumption is that blocks around these sites, which were chosen because they received Hazardous Ranking Scores within a narrow interval at the inception of the Superfund program, are likely to be similar aside from their proximate sites' receipt or non-receipt of the cleanup treatment.

We build upon the leading study to-date of residential sorting in response to changes in an environmental amenity. (Banzhaf and Walsh, 2008) In particular, our study of Superfund cleanup is less-prone towards (although not immune from) the endogeneity concerns that arise in that study's analysis of pollution reported to the Toxic Release Inventory (TRI).[2] Our results, on the other hand, could be biased if the EPA's choice of which proposed sites to clean up were influenced by anticipated changes in neighborhood attributes of income or ethnicity (or if both changes were driven by a common unobservable). However, previous studies report that levels

[2] The entry-exit and production decisions of plants may be influenced by local labor and land markets, which in turn are related to neighborhood attributes. Therefore, Banzhaf and Walsh's finding that total population increases in neighborhoods that face relative declines in plant pollution or plant exits (which they interpret as evidence of sorting) could arise instead from plants' decisions not to locate in or expand production in neighborhoods where rising population increases housing demand and, subsequently, property values.

of neighborhood income and minority share do not influence EPA's cleanup decisions. For example, tract-level median household income does not influence the pace of progress of sites between listing on the NPL and cleanup (Sigman, 2001).[3] Moreover, the EPA did not choose less-permanent cleanup options for sites with lower median household income or with greater shares of non-white residents at the zipcode level (Shreekant Gupta et al., 1996). Finally, expenditure to avert an average cancer case in NPL sites is not influenced by mean income or minority population within a 1-mile ring of NPL sites. (James T. Hamilton and W. Kip Viscusi, 1999)

Our study of neighborhood effects using restricted access block-level data can better detect the effects of environmental amenities that are highly localized in space; for example, housing values appreciate by 18.5% in blocks lying 0-1 km from an NPL site that was cleaned, and by only 8.2% in blocks lying 2-3km from that site. (Gamper-Rabindran and Timmins, 2010) Similarly, housing values depreciate by 3-7% within 2 miles (≈3km) of new power plants. (Lucas Davis, forthcoming) In contrast, Michael Greenstone and Justin Gallagher's (2008) analysis may have failed to detect underlying changes in neighborhood attributes in response to Superfund cleanup as a result of their use of coarse-resolution tract-level data.

**3. Identification Strategy: Sample Restrictions and Panel Model**

Greenstone and Gallagher (2008) exploit the institutional history of the Superfund program to create a regression discontinuity (RD) sample, which enables the comparison of sites that narrowly made the cutoff for listing on the NPL with those that narrowly missed the cutoff. In particular, in the early 1980s, the EPA had identified 687 potential sites but had funds to clean

[3] County-level voter turnout does influence the progress of sites between the ROD and cleanup (Sigman, 2001) and the cleanup intensity among low risks sites, but not in high risks sites. (Hamilton and Viscusi, 1999)

only 400 of them. The sites were subsequently ranked according to their Hazardous Ranking Scores (HRS), and the HRS of 28.5 separated the 400th site (which was listed on the NPL at that time) from the 401st site (which was not). Greenstone and Gallagher's RD sample is restricted to sites with a 1982 HRS score within [16.5, 40.5].

Our strategy, detailed in Gamper-Rabindran and Timmins (2010), builds upon Greenstone and Gallagher's (2008) RD design. Drawing from EPA's NPL database, we begin with sites that had been proposed to the NPL before January 1, 2010.[4] We then restrict our analysis to an RD sample of blocks (i.e., blocks within tracts that are overlap with 3km buffer surrounding 221 sites whose HRS scored in 1982 (HRS-1982) falls within the narrow interval [16.5, 40.5]).[5] Our identification of the effect of deletion relies on two strategies. First, the RD strategy ensures that a comparison is made among similar sites by narrowing of the range of unobservables.[6] Second, we use block panel data to control for time-invariant unobservables that may influence neighborhood attributes. With these controls, our estimation model does not require detailed control variables.[7] We do, however, control for blocks' exposure to proposed and listed NPL sites, as these time-varying factors may also induce sorting. Proposal to the NPL signals that the site is contaminated enough to warrant consideration for placement on the NPL.

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[4] Blocks around sites that are proposed to the NPL – whether these sites remain proposed or had been cleaned – are likely to be more similar than the set that includes blocks that are nowhere near a site. This is illustrated, at the tract level, in Greenstone and Gallagher (2008) Table II.

[5] Results are similar if we use the "strict" RD sample definition described in Gamper-Rabindran and Timmins (2010), which controls for exposure of RD sample blocks to sites besides those in the 1982-scored group.

[6] While Greenstone and Gallagher (2008) used the RD strategy to identify the effect of NPL listing, the RD's narrowing of unobservables also helps with identifying the effect of deletion from that list.

[7] In contrast, Davis' (forthcoming) study of sorting resulting from power plant siting requires an extensive list of control variables because it uses cross-sectional data to compare blocks that lie near power plants with other blocks across the United States. Of course, our panel approach requires an assumption about the stability of the function relating Superfund treatment to socio-demographics over time.

Listing underscores that the contamination is indeed serious, but also implies that cleanup will be undertaken in the future.[8]

Our estimation model is based on a first-difference of a simple equation relating sociodemographic variables to Superfund treatment:

$$(1) \quad Y_{k,2000} - Y_{k,1990} = \beta_1 \left(P_{k,2000} - P_{k,1990}\right) + \beta_2 \left(L_{k,2000} - L_{k,1990}\right) + \beta_3 \left(D_{k,2000} - D_{k,1990}\right) + (\varepsilon_{k,2000} - \varepsilon_{k,1990})$$

where *Y* is a measure of a neighborhood attribute for block *k*. Block *k* fixed effects have been differenced out of this equation. *P*, *L*, and *D* are counts of Superfund sites that are proposed to the NPL, listed on the NPL, and deleted from the NPL, respectively (located within 3km from the centroid of block *k*). The coefficient $\beta_3$ measures the change in a neighborhood attribute between 1990 and 2000 resulting from deletion of one site. This change is measured relative to neighborhood attributes during pre-proposal baseline. The coefficients for proposal and listing are defined analogously. Block-level housing and neighborhood attributes are from the 1990 and 2000 Decennial Census.

**4. Empirical Findings: Residential Sorting and Neighborhood Changes**

In describing our results, we report percent-changes in parentheses in the text so as to give the reader a sense of the magnitude of the level changes described in Table 1. Table 1 Panel A reveals that Superfund cleanup increases population density and housing unit density. We see two times greater increase in population density with deletion than with proposal (i.e., 18% compared to 9%, as a percentage of the baseline). The increase in housing density with deletion is about thrice that related to proposal (i.e. 17% compared to 6%), and the point estimate for proposal is statistically insignificant at conventional levels. As seen in Panel B, deletion results

[8] Listing and deletion are examined as separate milestones in other Superfund studies (Sigman, 2001; Katherine Kiel and Michael Williams, 2007).

in significant appreciation in block median owner-occupied housing values by $16,900 (25%). This sizable appreciation includes both the direct effects of cleanup on housing prices and its indirect effect, through changes in neighborhoods characteristics, on housing prices. In contrast, proposal results in a total depreciation of $8,470 (12%).

Panel C reveals that deletion changes neighborhood composition toward richer and more educated households. Deletion results in an increase of $10,020 (26%) in mean household income, as well as a decline of 2.8 percentage points (22%) in the share of households below the poverty line. The share of households receiving public assistance also declines by 3.7 percentage points (47%); this decline is larger in magnitude than the 0.68 percentage point decline caused by the proposal of a site. The deletion of a site results in an increase in the share of college-educated by 5.7 percentage points (31%), while the share of high school dropouts declines by 7.1 percentage points (28%). This decline is larger in magnitude than the 2.3 percentage point decline caused by the proposal of the site.

Looking at demographic variables, Panel D reveals that deletion causes a larger increase in the share of Blacks than proposal (i.e., 3 and 2.1 percentage points, respectively). Deletion causes thrice the increase in the share of Hispanic than proposal (i.e., 17.3 compared to 6.3 percentage points, respectively). We plan to test, in future, if higher-income minority households in-migrate in response to the deletion of sites, while low-income minority households in-migrate in response to the proposal of sites.[9] When compared with proposal, deletion leads to a bigger increase in the percentage of female headed households (i.e., 3.0 percentage points as opposed to 1.2).

[9] We are exploring the possibility of generating income-race cross tabulations at the block level from the raw census data. These results would provide a direct test of the predictions about race and income described in Banzhaf and Walsh (2008).

As seen in Panel E, deletion and listing both result in a reduction in vacancy rates – the share of occupied units increases by 1.2 and 1.1 percentage points with each treatment. Deletion results in a slight shift towards owner-occupied housing and strong shift away from mobile homes. In particular, deletion raises the share of owner-occupied housing by 2.4 percentage points (3.6%), while proposal reduced this share by 1.1 percentage points (1.7%). We see a thrice greater decline in the share of mobile homes with deletion than with proposal – i.e. 1.5 and 0.5 percentage points (23% and 8%), respectively.

**5. Conclusion: Sorting in response to localized public goods**

Superfund cleanup is perceived to eliminate a significant source of contamination; it may not, therefore, be surprising that it leads to more sizable in-migration (i.e., an 18% increase in population density) than reduced exposure to TRI pollution (5-7% increase in population). (Banzhaf and Walsh, 2008) Moreover, Superfund cleanup also leads to the in-migration of richer and more educated households – a composition effect not observed in the TRI study. (Banzhaf and Walsh, 2008) The neighborhood compositional change from this in-migration (i.e., a 26% increases in mean household income and a 31% increase in share of college graduates) is larger than the out-migration observed in response to new power plant siting (i.e., a 6% and 2% decline in the mean household income and share of college graduates, respectively). (Davis, forthcoming)

We take these results as strong evidence that deletion induces sorting, resulting in "environmental gentrification". (Sieg et al, 2004) This confirms many of the concerns (particularly with respect to poverty and education) expressed by environmental justice advocates. (NEJAC, 2006) The one dimension where our data do not support those concerns, however, is race – minorities do not appear to be driven out of gentrifying neighborhoods. It remains to be seen, however, whether this result is masking a process whereby low-income minorities are being replaced by higher-income minorities.

Our results have three important implications. First, we find that Superfund cleanup is able to overcome the stigma effect suffered in neighborhoods surrounding sites. (Kent Messer et al., 2006) Second, household income, not ethnicity, drives sorting. Contrary to concerns that Whites may displace minorities, we find that cleanup raises the shares of Blacks and Hispanics. If the sizable displacement of poor households by the richer and more educated is considered undesirable from an equity perspective, complementary policies to cleanup, such as targeted housing subsidies specifically aimed at poorer households, should be investigated. Third, compositional change accompanying sorting in response to cleanup may be an important determinant of the appreciation of housing prices detected in our hedonic analysis. (Gamper-Rabindran and Timmins, 2010)

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Table 1: The effect of changes in exposure to hazardous waste sites proposed, listed, and deleted from the NPL on changes in neighborhood composition between 1990 and 2000.

| | Mean [Std Dev] | Counts of Sites Within 3km | | |
|---|---|---|---|---|
| | | Proposed | Listed | Deleted |
| Panel A: Housing Supply and Population | | | | |
| Population Density (1000 people per km2) | 2.911<br>[4.181] | 0.265**<br>(0.116) | 0.437***<br>(0.083) | 0.533***<br>(0.092) |
| Housing Unit Density (1000 units per km2) | 1.182<br>[2.15] | 0.070<br>(0.047) | 0.143***<br>(0.037) | 0.199***<br>(0.044) |
| Panel B: House Prices | | | | |
| Median House Price ($10,000) | 7.034<br>[4.816] | -0.847***<br>(0.175) | 0.825***<br>(0.130) | 1.690***<br>(0.148) |
| Panel C: Income and Educational Attainment | | | | |
| Mean HH Income ($1000) | 37.9<br>[1.6] | -0.426<br>(0.774) | 5.842***<br>(0.685) | 10.02***<br>(0.759) |
| Share HH Below Poverty Line | 0.127<br>[0.117] | -0.001<br>(0.006) | -0.018***<br>(0.005) | -0.028***<br>(0.006) |
| Share HH With Public Assistance | 0.078<br>[0.072] | -0.007***<br>(0.002) | -0.019***<br>(0.002) | -0.037***<br>(0.002) |
| Share College Educated | 0.185<br>[0.131] | -0.005<br>(0.004) | 0.039***<br>(0.004) | 0.057***<br>(0.004) |
| Share High School Dropout | 0.253<br>[0.128] | -0.023***<br>(0.005) | -0.041***<br>(0.005) | -0.071***<br>(0.005) |
| Panel D: Demographics | | | | |
| Share Black | 0.118<br>[0.226] | 0.022***<br>(0.002) | 0.013***<br>(0.002) | 0.030***<br>(0.002) |
| Share Hispanic | 0.054<br>[0.105] | 0.063***<br>(0.004) | 0.106***<br>(0.003) | 0.173***<br>(0.004) |
| Share Female Headed HH | 0.237<br>[0.160] | 0.012***<br>(0.003) | 0.017***<br>(0.003) | 0.030***<br>(0.003) |
| Panel E: Housing Unit Characteristics | | | | |
| Share Occupied Units | 0.922<br>[0.067] | 0.004**<br>(0.002) | 0.011***<br>(0.002) | 0.012***<br>(0.002) |
| Share Owner Occupied Units | 0.661<br>[0.214] | -0.011***<br>(0.003) | 0.016***<br>(0.002) | 0.024***<br>(0.003) |
| Share Mobile Homes | 0.064<br>[0.114] | -0.005***<br>(0.001) | -0.009***<br>(0.001) | -0.015***<br>(0.001) |

The table reports coefficients and robust standard errors (in parentheses) from fourteen separate regressions. The dependent variables are changes in levels between 1990 and 2000. Summary statistics for most variables describe tracts containing RD blocks in 1990. Summary statistics for population density and housing unit density describe blocks surrounding the full set of 1722 NPL sites proposed before 2010. Summary statistics for the RD sample at the block level have not been released by the Census Bureau because of confidentiality restrictions. N = 98,088. Statistical significance is indicated by: *** 1%, ** 5%, * 10%.