Internet Appendix for "Do Property Rehabs Affect Neighboring Property Prices?"

This internet appendix is divided into five sections. The first section describes the sample selection procedure. The second section provides variable descriptions. The third section describes details of the empirical derivative method. The fourth section briefly describes the theory behind the welfare estimation. The fifth section presents supplementary figures and tables.

A. Sample selection

NCST data filters

- Original dataset: 23,710 NCST properties from 2008–2017.
- Keep single-family homes: 3,696 properties dropped.
- Drop properties with missing rehabilitation start and end dates: 10,115 properties dropped.
- Drop properties with rehabilitation end dates before rehabilitation begins: 28 properties dropped.
- Drop properties with rehabilitation start dates before the property sale through the NCST: 274 properties dropped.
- Drop properties with no reliable data on neighboring transactions: 2,745 properties dropped.
- Final NCST properties in the sample: 6,852 NCST properties.

Neighboring transactions filters following Campbell et al. and Adelino et al.

- Drop if the transaction price of the neighboring property is zero or missing.
- Drop if the buyer's or seller's name is missing.

- Drop if the buyer's name matches the seller's name.
- Dropping non-arms-length transactions (e.g., transfer of partial interest, intrafamily transfer, interspousal transfer, transfer on death).
- Drop if the mortgage loan amount is greater than the transaction price.
- Drop non-single-family homes (e.g., mobile homes, condos, townhomes, unclassified).
- Drop if interior area is missing or negative.
- Drop if house age is missing.
- Drop if number of bathrooms is less than 0.5 or missing.
- Drop if number of total bedrooms is zero or missing.
- Drop transactions with extreme (< 0.5 and > 99.5 percentile) house prices or extreme prices per square foot.
- Keep transactions that occur between 1 year before the NCST property rehabilitation and 1 year after the rehabilitation.

Summary statistics

- Homes closer to NCST homes have lower prices and lower prices per square foot.
- All transactions within 0.1 miles have only one NCST property.
- Only two transactions within 0.33 miles have two NCST properties. The remainder have only one NCST property.
- Top 10 states in descending order of NCST transactions: FL (802), CA (801), IL (457), OH (355), TX (266), GA (254), MI (237), MN (177), NV (132), and PA (86).

B. Variable description

This section describes the control variables associated with a property transaction in the neighborhood of a rehabilitated property using the ring method estimation described in Section 2.1.

Property controls

- *Square footage*: The transacted property's interior area in square feet.
- *Age*: The age of the transacted property in years from its build year to the transaction year.
- *Bedrooms*: Indicator variables for the transacted property's number of bedrooms: 1, 2, 3, 4, or >4 bedrooms.
- *Bathrooms*: Indicator variables for the transacted property's number of bathrooms: a half-bath to 1 bathroom, 1.5, 2, 2.5, and >2.5 bathrooms.
- *Building quality*: Indicator variables for the six categories of the transacted property's building quality: excellent, fair, good, average, poor, or missing/uncategorized.

Neighborhood controls

- *Number of foreclosures* (before, 0.1 mi): The number of foreclosures that occurred within 0.1 miles from the property, six months before the sale of the property.
- *Number of foreclosures* (after, 0.1 mi): The number of foreclosures that occurred within 0.1 miles from the property, six months after the sale of the property.
- *Number of foreclosures* (before, 0.33 mi): The number of foreclosures that occurred within 0.33 miles from the property, six months before the sale of the property.
- *Number of foreclosures* (after, 0.33 mi): The number of foreclosures that occurred within 0.33 miles from the property, six months after the sale of the property.
- *Number of arms-length transactions* (before, 0.1 mi): The number of arms-length transactions that occurred within 0.1 miles from the property, six months before the sale of the property.

- *Number of arms-length transactions* (after, 0.1 mi): The number of arms-length transactions that occurred within 0.1 miles from the property, six months after the sale of the property.

- *Number of arms-length transactions* (before, 0.33 mi): The number of arms-length transactions that occurred within 0.33 miles from the property, six months before the sale of the property.

- *Number of arms-length transactions* (after, 0.33 mi): The number of arms-length transactions that occurred within 0.33 miles from the property, six months after the sale of the property.

- *Number of other rehabilitations* (before, 0.1 mi): The number of other property rehabilitations that occurred within 0.1 miles from the property, six months before the sale of the property. We measure other property rehabilitations using other neighboring NCST transactions, including those that were dropped during our sample selection process due to missing data.

- *Number of other rehabilitations* (after, 0.1 mi): The number of other property rehabilitations that occurred within 0.1 miles from the property, six months after the sale of the property. We measure other property rehabilitations using other neighboring NCST transactions, including those that were dropped during our sample selection process due to missing data.

- *Number of other rehabilitations* (before, 0.33 mi): The number of other property rehabilitations that occurred within 0.33 miles from the property, six months before the sale of the property. We measure other property rehabilitations using other neighboring NCST transactions, including those that were dropped during our sample selection process due to missing data.

- *Number of other rehabilitations* (after, 0.33 mi): The number of other property rehabilitations that occurred within 0.33 miles from the property, six months after the sale of the property. We measure other property rehabilitations using other neighboring NCST transactions, including those that were dropped during our sample selection process due to missing data.

C. Empirical derivative procedure

We follow the nonparametric estimation procedure of Diamond and McQuade (2019) to estimate the empirical derivative for a property in the neighborhood of a rehabilitated property. The nonparametric method relies on expressing house prices in the neighborhood of a rehabilitated property N using polar coordinates (r, θ), where r and θ are the distance and direction of the neighboring property, respectively, relative to its nearest rehabilitated property:

$$log(P_{i,t}) = m_N(r_i, \tau_i) + \phi_N(r_i, \theta_i) + \gamma_N(\theta_i, t_i) + \varepsilon_{i,t}, \tag{IA.1}$$

where $log(P_{i,t})$ is the logarithm of the transaction price of neighboring property i at time t, and $m_N(r_i, \tau_i)$ is the nonparametric function of interest to be estimated. This function captures the spillover effect of property N's rehabilitation on a nearby property i located at a distance of r_i miles, and occurring τ_i months after the rehabilitation. The nonparametric functions $\phi_N(r_i, \theta_i)$ and $\gamma_N(\theta_i, t_i)$ allow for house prices to vary across locations and to trend differently across time in multiple directions from the rehabilitated property, for reasons that are unrelated to the property's rehabilitation.

The idea behind the empirical derivative method is to empirically estimate the derivative of $m_N(r_i, \tau_i)$ with respect to the distance r. Below, we replicate the estimating equations in Diamond and McQuade (2019) for identifying $m_N(r_i, \tau_i)$. This is accomplished in two steps. In the first step, an empirical partial derivative of the house price with respect to r is estimated at each transaction (r_i, θ_i, t_i) in the neighborhood of the rehabilitated property. Equations IA.2–IA.6 below provide the estimating equations for this first step. In the second step, the partial derivative estimates are smoothed using a kernel regression to obtain a smooth surface, namely, the derivative of $m_N(r_i, \tau_i)$. Equations IA.7–IA.9 below provide the estimating equations for this second step.

Let $\tilde{Y}_{i,N}$ be the empirical derivative at (r_i, θ_i, t_i) within the neighborhood of the rehabilitated property N. Then, $\tilde{Y}_{i,N}$ is estimated as:

$$\tilde{Y}_{i,N} = \sum_{k=1}^{k_n} \omega_k \frac{\log p_{a(k,i,r)} - \log p_{b(k,i,r)}}{r_{a(k,i,r)} - r_{b(k,i,r)}} \tag{IA.2}$$

$$\omega_k = \frac{k}{k_n(k_n+1)/2} \quad , \tag{IA.3}$$

where $a(k,i,r)$ and $b(k,i,r)$ are defined as:

$$a(1,i,r) = \arg \underset{\{d \in L_{r,i}: r_d > r_i + l_n\}}{min} r_d, \qquad b(1,i,r) = \arg \underset{\{d \in L_{r,i}: r_d < r_i - l_n\}}{max} r_d, \tag{IA.4}$$

$$a(k,i,r) = \arg \underset{\{d \in L_{r,i}: r_d > r_{a(k-1,i,r)}\}}{min} r_d, \qquad b(k,i,r) = \arg \underset{\{d \in L_{r,i}: r_d < r_{b(k-1,i,r)}\}}{max} r_d, \tag{IA.5}$$

where $l_n = 0.01$ miles away from r_i. This ensures the exclusion of extremely close transactions to compute the empirical derivative so that the numerical derivative does not become unbounded due to the denominator in IA.2. The bow tie region, which consists of the above transactions to compute the empirical derivative, is given the set $L_{r,i}$:

$$L_{r,i} = \left\{ z \in 1, \ldots, n : \frac{(t_z - t_i)^2}{(r_z - r_i)^2} < \upsilon_n^t, \frac{(\theta_z - \theta_i)^2}{(r_z - r_i)^2} < \upsilon_n^\theta \right\}, \tag{IA.6}$$

where the bow tie width in years is $\upsilon_n^t = 1.6$, and the bow tie width in θ is $\upsilon_n^\theta = 0.4$.

After computing the house price derivative $\tilde{Y}_{i,N}$ for every neighboring property transaction around the rehabilitated property, we smooth these derivatives using the Nadaraya-Watson kernel to obtain

$$\widehat{\Phi}_N(r,t) = \frac{n^{-1} \sum_{i=1}^n K_{H_n}((r,t) - (r_i,t_i)) \tilde{Y}_{i,N}}{n^{-1} \sum_{i=1}^n K_{H_n}((r,t) - (r_i,t_i))}, \tag{IA.7}$$

where

$$K_{H_n}((r,t) - (r_i,t_i)) = \frac{1}{h_{r,n} h_{t,n}} K\left(\frac{r - r_i}{h_{r,n}}, \frac{t - t_i}{h_{r,n}} \right), \tag{IA.8}$$

where $K(\cdot,\cdot)$ is the two-dimensional Epanechnikov kernel with bandwidths $h_{r,n} = 0.25$ and $h_{t,n} = 1.5$.

Finally, we obtain an estimate of the empirical derivative by averaging across rehabilitated NCST properties:

$$\frac{\widehat{\partial m(r,\tau)}}{\partial r} = \frac{1}{\mathbf{N}} \sum_{N \in \mathbf{N}} \left[\widehat{\Phi}_N(r, T_N + \tau) - \widehat{\Phi}_N(r, T_N - 1) \right], \tag{IA.9}$$

where $\mathbf{N}$ is the number of rehabilitated NCST properties.

D. Welfare analysis

Rosen's (1974) model provides the theoretical underpinnings for hedonic valuation. Let $P = P(\mathbf{H}, r)$ be the price of a house as a function of its characteristics $\mathbf{H}$ and distance r from a rehabilitated property. Let $U = U(c, \mathbf{H}, r)$ be the household's utility, where c is the household's consumption and numeraire with price equal to 1. The household's budget constraint is $P + c \leq I$, where I represents the household's income.

If housing markets are competitive and in equilibrium, maximizing the household's utility with respect to the household's budget constraint equates the household's marginal willingness to pay (MWTP) to live at a distance r from the rehabilitated property with the slope of the house price surface:

$$\frac{\partial U}{\partial r} / \frac{\partial U}{\partial c} = \frac{\partial P}{\partial r}. \tag{IA.10}$$

House prices in our setting are defined as

$$log(P) = m(r, \tau) + \phi(r, \theta) + \gamma(\theta, t) + \varepsilon, \tag{IA.11}$$

where τ is the time that has elapsed since the rehabilitation, θ represents the direction from the rehabilitated property (which along with r defines its location in polar coordinates), and t is time. Thus, the above expression reduces to

$$\frac{\partial U}{\partial r} / \frac{\partial U}{\partial c} = P \times \frac{\partial m_N(r, \tau)}{\partial r}. \tag{IA.12}$$

It is important to note that the derivative of the house price surface with respect to the distance from the rehabilitated property (i.e., $\partial P / \partial r$) yields the MWTP for consumers *only* at their optimal choice of house characteristics $\mathbf{H}$ and consumption c. Thus, the derivative of the house price surface yields the MWTP for consumers only for *marginal* changes in r.

To conduct welfare analysis for non-marginal changes in r, we follow the generalized hedonic model developed by Diamond and McQuade (2019). The idea of this analysis is to first use the house price gradient, $\partial m_N(r, \tau)/\partial r$, which is estimated using the empirical derivative method (see Section 2.2), to structurally back out household preferences for living close to a rehabilitated property. Next, these household preferences are used to compute the welfare effects associated with property rehabilitations for non-marginal changes in r. We compute the welfare effects associated with owner-occupied and renter-occupied properties separately.

We assume a log-linear utility function $U_i(c, \mathbf{H}, r)$ for household i as follows:

$$U_i(c, \mathbf{H}, r) = \pi_i \log(1 + R_0 - r)\mathbb{I}[r \leq R_0] + u_i(\mathbf{H}) + c, \tag{IA.13}$$

where π_i captures household i's preference to live close to the rehabilitated property and R_0 is the distance beyond which households no longer derive utility from the rehabilitated property. The indicator function $\mathbb{I}[r \leq R_0]$ ensures that households located at $r \geq R_0$ derive utility only based on house characteristics $\mathbf{H}$ and consumption c.

Given the log-linear form of Equation (IA.13), we can recover household preference parameters, π_i, using the expression for the MWTP in Equation (IA.12):

$$\pi_i = -(1 + R_0 - r) \times P_i(\mathbf{H}, r) \times \frac{\partial m(r, \tau)}{\partial r}. \tag{IA.14}$$

Household choice before and after the property rehabilitation

Households in proximity of the rehabilitated property maximize their utility subject to their budget constraints. We assume that households do not anticipate the rehabilitation of the property. That is, house prices in the pre-rehabilitation period reflect only the hedonic preference associated with house characteristics, which include its structural attributes (e.g., number of bedrooms and bathrooms) and the broader neighborhood characteristics (e.g., crime, school district). The relatively flat house price surface in the pre-rehabilitation period in Figure 3 provides support for this assumption. As a result, the proximity to the rehabilitated property does not enter the household's utility function in the pre-rehabilitation period. The household's maximization problem is given by

$$\begin{aligned} &\max \; u_i(\mathbf{H}) + c \\ &\text{s.t.} \quad p_0(\mathbf{H}) + c \leq I_i, \end{aligned}$$

where $p_0(\mathbf{H})$ reflects the value associated with house characteristics $\mathbf{H}$ in the pre-rehabilitation period. In our setting, which defines house prices as in Equation (IA.11), $p_0(\mathbf{H}) = \phi(r, \theta) + \gamma(\theta, t)$ for households located at (r, θ). Since we do not have property-level data on rents, we assume that the discounted present value of rents is equal to the house price. Thus, a household that rents a property also faces the same utility maximization problem described above.

The household's maximization problem in the post-rehabilitation period accounts for the household's proximity to the rehabilitated property. After accounting for the rehabilitation of the property and assuming that moving costs are zero, neighboring households will re-optimize based on their hedonic preference to live close to the rehabilitated property. This maximization problem for the owner-occupied household is given by

$$\begin{aligned} &\max\ \pi_i \log(1 + R_0 - r)\mathbb{I}[r \le R_0] + u_i(\mathbf{H}) + c \\ &\text{s.t.} \quad m(r) + p_1(\mathbf{H}) + c \le I_i + m(r_{i,pre}), \end{aligned}$$

where $m(r_{i,pre})$ is the additional proceeds from the sale of the house located at a distance of r_{pre} from the rehabilitated property and $m(r) + p_1(\mathbf{H})$ is the amount spent to purchase the new home located at a distance of r from the rehabilitated property.

Renters have the same objective function as home-owners in their maximization problem in the post-rehabilitation period. However, their budget constraint is different as they cannot obtain proceeds from home sales:

$$\begin{aligned} &\max\ \pi_i \log(1 + R_0 - r)\mathbb{I}[r \le R_0] + u_i(\mathbf{H}) + c \\ &\text{s.t.} \quad m(r) + p_1(\mathbf{H}) + c \le I_i. \end{aligned}$$

For the tractability of the model, we assume that $p_1(\mathbf{H}) = p_0(\mathbf{H})$. That is, the hedonic price associated with house characteristics $\mathbf{H}$ in the neighborhood of the rehabilitated property remains the same after the rehabilitation. This assumes that household preferences for house characteristics are stable across geographies and do not change with the sorting of households following the rehabilitation.

Given the optimization problems above, the change in household utility for owners, renters, and landlords for different scenarios is presented in the following table. Note that landlords just benefit from rent transfers. The variable r^* is the optimal distance of a household after the rehabilitation.

Scenario	ΔU_i: Owners
$r_{i,pre} > R_0$, $r_i^* > R_0$	0
$r_{i,pre} > R_0$, $r_i^* < R_0$	$\pi_i \log(1 + R_0 - r_i^*) - m(r_i^*)$
$r_{i,pre} < R_0$, $r_i^* > R_0$	$m(r_i^*)$
$r_{i,pre} < R_0$, $r_i^* < R_0$	$\pi_i \log(1 + R_0 - r_i^*) + m(r_{i,pre}) - m(r_i^*)$
Total:	$\sum_i \pi_i \log(1 + R_0 - r_i^*)\mathbb{I}[r_i^* \leq R_0]$

Scenario	ΔU_i: Renters	ΔU_i: Landlords
$r_{i,pre} > R_0$, $r_i^* > R_0$	0	0
$r_{i,pre} > R_0$, $r_i^* < R_0$	$\pi_i \log(1 + R_0 - r_i^*) - m(r_i^*)$	0
$r_{i,pre} < R_0$, $r_i^* > R_0$	0	$m(r_i^*)$
$r_{i,pre} < R_0$, $r_i^* < R_0$	$\pi_i \log(1 + R_0 - r_i^*) - m(r_i^*)$	$m(r_i^*)$
Group total:	$\sum_i (\pi_i \log(1 + R_0 - r_i^*) - m(r_i^*)\mathbb{I}[r_i^* \leq R_0])$	$\sum_i m(r_i^*)\mathbb{I}[r_i^* \leq R_0]$
Total:	$\sum_i \pi_i \log(1 + R_0 - r_i^*)\mathbb{I}[r_i^* \leq R_0]$	

After summing over all households across the various scenarios, the aggregate utility is given by

$$\text{Aggregate Utility} = \sum_i \pi_i \log(1 + R_0 - r_i^*)\mathbb{I}[r_i^* \leq R_0].$$

Thus, the aggregate welfare depends only on the utility gained from households that optimally choose to live close to the rehabilitated property. The remaining terms are netted out across households. Consequently, to estimate aggregate welfare effects, one needs to only back out the preference parameters of households that have moved close to the rehabilitated property after the rehabilitation, which is what we observe in the data.

Implementation

We compute the aggregate welfare for homeowners using the preference parameter (π) and the optimal distance from the rehabilitated property (r^*) for each homeowner who chooses to live close to the rehabilitated property. The aggregate welfare for homeowners is computed as

$$\Delta U^H_{agg} = N_H \int \pi \log(1 + R_0 - r) q^H(\pi, r | r < R_0) \mathrm{d}\pi \mathrm{d}r, \tag{IA.15}$$

where the integral computes the mean of $\pi\log(1+R_0-r)$, with $q(\cdot)$ representing the joint density of π and r. N_H is the mean number of homeowners within R_0 miles from the rehabilitated property. We compute N_H using the 5-year American Community Survey (ACS) focusing on the intersection of census block groups with the R_0 mile ring around the rehabilitated property.

We cannot measure the aggregate welfare for renter-occupied households in the same manner because we do not have property-level data on rents. Instead, we follow Diamond and McQuade (2019) and assume that conditional on income, owners and renters have the same preference to live close to a rehabilitated property. Given this assumption, the aggregate renter-occupied household welfare can be computed as

$$\Delta U^R_{agg} = N_R \int \pi \log(1 + R_0 - r) \frac{q^R(I | r < R_0)}{q^H(I | r < R_0)} q^H(\pi, r, I | r < R_0) \mathrm{d}\pi \mathrm{d}r, \tag{IA.16}$$

where $q^R(I|r < R_0)$ and $q^H(I|r < R_0)$ represent the densities of renter income and owner income within the R_0 ring, respectively. These densities are computed using the 5-year ACS by focusing on the intersection of census tracts with the R_0 mile ring around the rehabilitated property.[1] As income data are required to compute the welfare for renter-occupied households, we merge our data with HMDA data. We use this merged sample to compute the aggregate welfare associated with both owner-occupied and renter-occupied properties. Moreover, since HMDA data consist only of mortgage transactions, we make one final adjustment to obtain the joint density function $q^H(\pi, r, I|r < R_0)$. We again assume that, conditional on income, homeowners have the same preference to live close to a rehabilitated property, regardless of whether they purchase their homes with mortgages or cash. This assumption results in the re-writing of the joint density function of the owner-occupied households ($q^H(\pi, r, I|r < R_0)$) in terms of the joint density function of owner-occupied households with a mortgage ($q^{MH}(\pi, r, I|r < R_0)$), which we observe in the HMDA-merged sample:

$$q^H(\pi, r, I | r < R_0) = q^{MH}(\pi, r, I | r < R_0) \left[Q(MH | r < R_0) + \frac{q^{NH}(I | r < R_0)}{q^{MH}(I | r < R_0)} Q(NH | r < R_0) \right],$$

[1] Data on the number of owner-occupied and renter-occupied homes is available only at the census-tract level as opposed to the census-block-group level.

where $Q(MH|r < R_0)$ and $Q(NH|r < R_0)$ represent the fraction of mortgaged and non-mortgaged owner-occupied homes within R_0 miles, respectively. The terms $q^{MH}(I|r < R_0)$ and $q^{NH}(I|r < R_0)$ represent the densities of homeowner income for mortgaged and non-mortgaged properties within the R_0 ring, respectively, which are calculated using the 5-year ACS at the census-tract level.

E. Supplementary figures and tables

Figure IA.1: Example of property rehabilitation

This figure shows before-and-after photographs of a property rehabilitation facilitated by the NCST in Pontiac, MI.

Panel A: Before rehabilitation

Panel B: After rehabilitation

Figure IA.2: HUD's risk score

This figure plots the Department of Housing and Urban Development's (HUD's) risk score for all census tracts in the U.S. and for the census tracts that contain the rehabilitated properties in our study. The HUD risk score indicates the risk of foreclosures and abandonment of homes in a neighborhood (e.g., a census tract). The HUD's Risk for a neighborhood is computed based on: (a) the home vacancy rate as of June 2008, (b) the fraction of high-cost mortgages issued between 2004 and 2006, (c) the unemployment rate as of June 2008, and (d) the house price decline as of June 2008 relative to the peak house price since 2000. We obtain the HUD risk scores and the data used to compute those risk scores from HUD. See `https://www.huduser.gov/portal/datasets/NSP_target.html`.

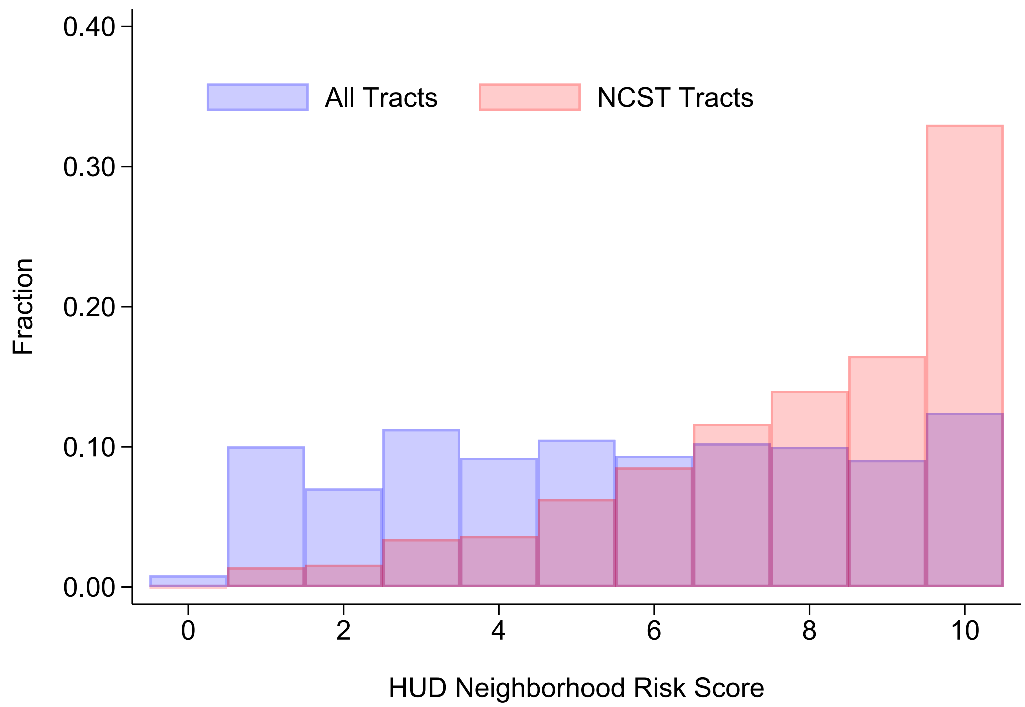
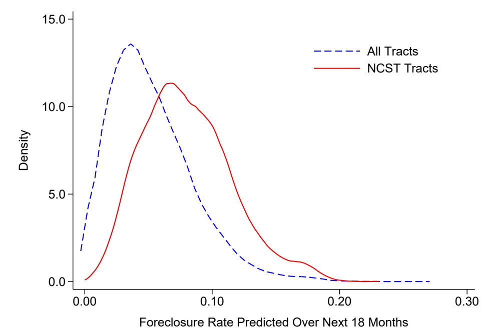


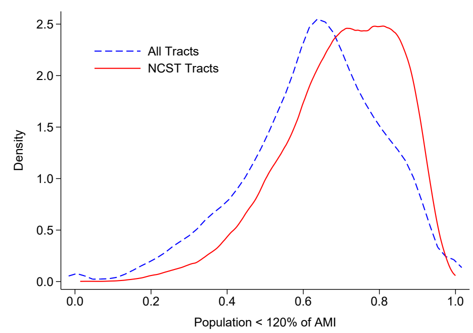
Figure IA.3: Density plots for components of HUD's risk score

This figure plots individual components of the HUD's risk score for all census tracts in the U.S. and for the census tracts that contain the rehabilitated properties in our study. The HUD risk score indicates the risk of foreclosures and abandonment of homes in a neighborhood (e.g., a census tract). The HUD's risk for a neighborhood is computed based on: (a) the home vacancy rate as of June 2008, (b) the fraction of high-cost mortgages issued between 2004 and 2006, (c) the unemployment rate as of June 2008, and (d) the house price decline as of June 2008 relative to the peak house price since 2000. We obtain the HUD risk scores and the data used to compute those risk scores from HUD. See `https://www.huduser.gov/portal/datasets/NSP_target.html`.

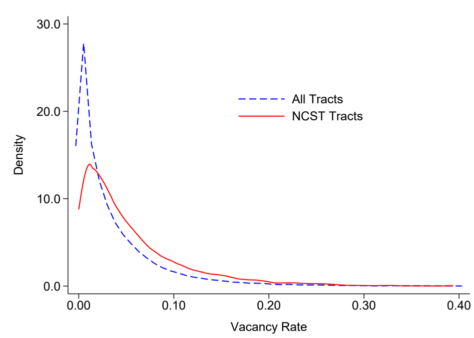
Panel A: Predicted foreclosure rates



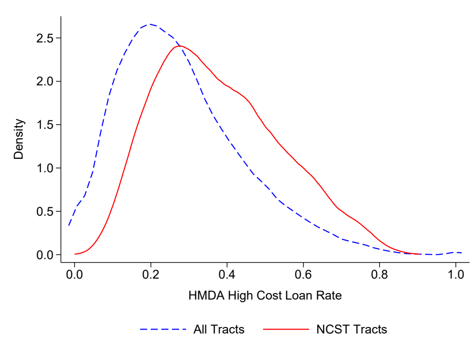
Panel B: Fraction of low-income households



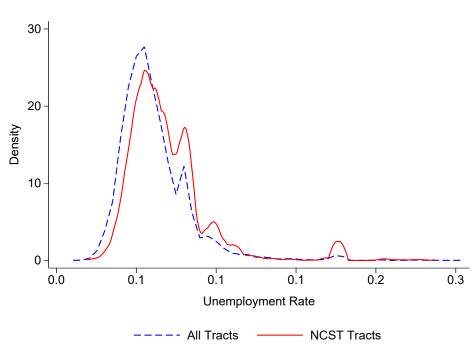
Panel C: Vacancy rates



Panel D: Fraction of high-cost mortgages



Panel E: Unemployment rates



Panel F: House price drop

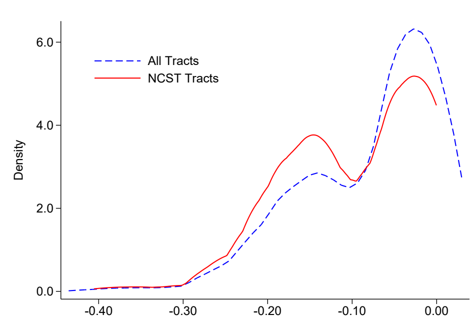


Figure IA.4: Geographic distribution of in-sample NCST transactions

This figure plots the geographic distribution of 6,852 NCST properties in our final sample across the U.S.

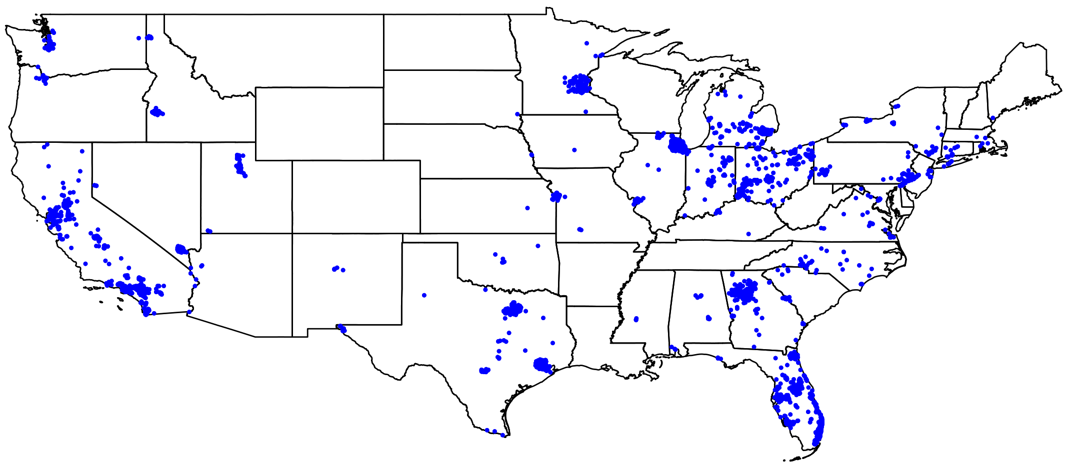
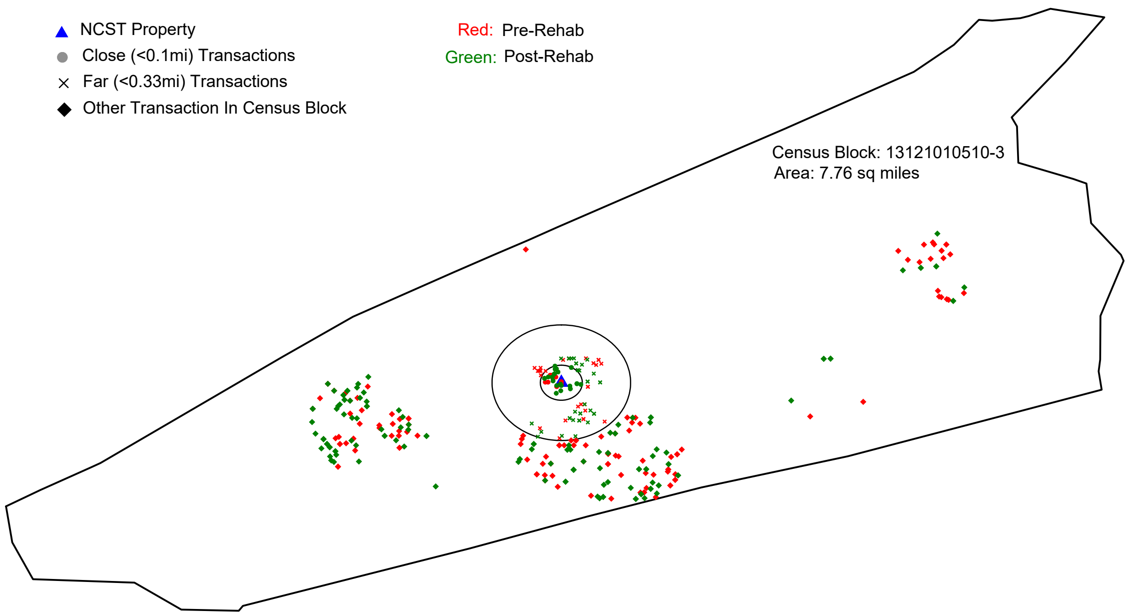


Figure IA.5: Identification strategy

This figure displays a visual representation of the ring method described in Section 2.1.

Panel A: Census-block View



Panel B: Zoomed View

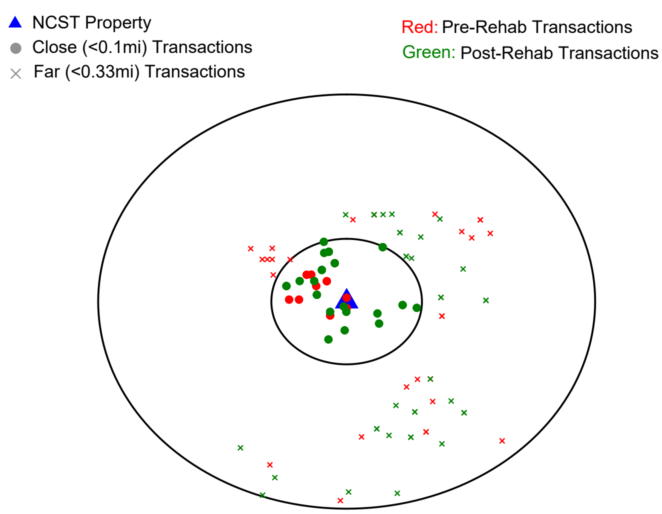


Figure IA.6: Bow tie region used in the empirical derivative method

This figure displays a visual representation of the 3-dimensional bow tie region used in the empirical derivative method described in Section 2.2.

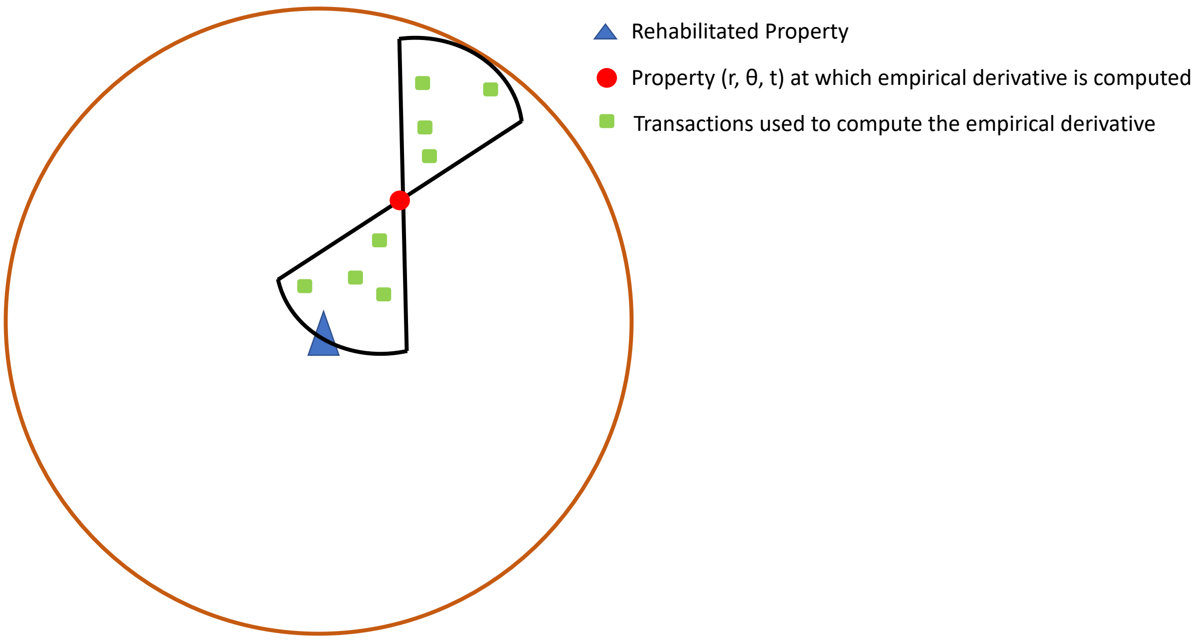


Figure IA.7: House price surface before property rehabilitation

This figure plots the house price surface in the neighborhood of a rehabilitated property obtained using the nonparametric empirical derivative method described in Section 2.2. The house price surface is plotted for the 1-year period before the property rehabilitation. Each point on the house price surface represents the logarithm of house prices at a specific distance and time from the rehabilitated property relative to the logarithm of house prices one mile from, and one year before, the property's rehabilitation. Distance is measured in miles and time is measured in years. Time 0 represents the rehabilitation period. The median rehabilitation period in the sample is 70 days.

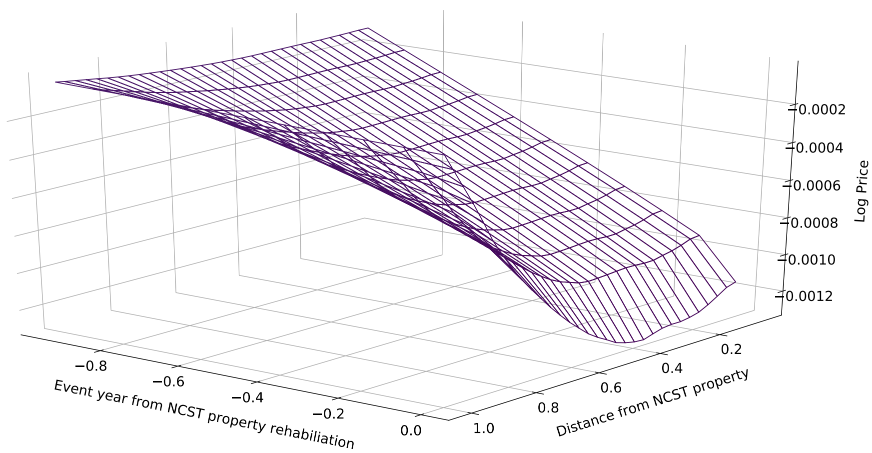


Figure IA.8: Example of property rehabilitation work order

This figure shows the work order for the rehabilitation facilitated by the NCST in Pontiac, MI shown in Figure IA.1

[redacted], Pontiac, MI	
DEMO	$2,000
DUMPSTERS	$900
TREE REMOVAL	$1,350
NEW DRYWALL AND INSULATION	$1,988
NEW GARAGE BUILD	$0
PATCH/PRIME/PAINT (INCL EXTERIOR)	$3,464
ELECTRICAL - PANEL AND FIXTURES	$2,180
PLUMBING - KITCHEN AND BATHROOMS PLUS MISC	$1,560
MECHANICAL/HVAC - DUCTWORK/WATER HEATER/AC	$1,800
CITY FEES - PERMITS AND INSPECTIONS	$440
BATHROOM SUPPLIES	$3,211
KITCHEN SUPPLIES/APPLIANCES/COUNTERS - PLUS KITCHEN MOD	$7,800
BASEMENT SUPPLIES/DRYLOCK WATERPROOFING	$1,450
FLOORING/TILE	$2,855
ADDITIONAL MATERIAL COSTS	$0.00
INTERIOR/EXTERIOR DOORS	$950
CLEANING	$450
ROOFING	$0
CHIMNEY REPAIR - CAP AND TUCKPOINTE	$0
WINDOW REPAIRS/REPLACEMENT	$5,850
DRIVEWAY REPAIRS/REPLACEMENT	$1,350
GUTTERS	$1,080
SIDING REPLACEMENT	$2,990
LANDSCAPE/GRADING	$450
MOLD/WATER/SMOKE REMEDIATION	$0
POWERWASHING	$750
FOUNDATION REPAIRS	$0
NEW GARAGE DOOR	$1,600
DECK	$3,150
BASEMOARD/TRIM/MOLDINGS	$1,880
INSURANCE	$0
INSPECTION REPAIRS	$1,551
TOTAL COST FOR LABOR AND MATERIALS	$53,049

Table IA.1: Effect of rehabilitation on nearby properties: Robustness

This table presents the robustness tests for Table 3 in the main paper. Column (1) re-estimates the fully saturated specification in Table 3, Column (4), when limiting the sample to property transactions that occur within the same census tract as their closest rehabilitated property. Column (2) further restricts the sample to property transactions within the inner and outer circles around the rehabilitated property. Columns (3) and (4) include both narrower (e.g., census block group–year–quarter) and broader (e.g., county–year–quarter) time-varying geographic fixed effects, respectively. Column (5) includes NCST property–buyer fixed effects. Standard errors are clustered at the census-tract level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Depvar: log(Sales price)	(1)	(2)	(3)	(4)	(5)
Close×Post	0.038***	0.042***	0.036***	0.043***	0.040***
	(4.38)	(4.68)	(3.92)	(4.56)	(4.76)
Close	-0.017***	-0.015**	-0.016***	-0.021***	-0.017***
	(-2.90)	(-2.48)	(-2.59)	(-3.04)	(-2.96)
Far×Post	0.005		0.005	-0.020***	0.005
	(0.94)		(0.99)	(-3.52)	(1.00)
Far	-0.081***		-0.074***	0.066***	-0.077***
	(-6.60)		(-6.26)	(3.24)	(-7.10)
Post	0.021**	0.029***	0.011**	0.030***	0.012**
	(2.16)	(3.42)	(2.01)	(5.88)	(2.36)
Census-tract×Year-qtr FE	Yes	Yes	No	No	Yes
Census-block group× Year-qtr FE	No	No	Yes	No	No
County× Year-qtr FE	No	No	No	Yes	No
Buyer FE	No	No	No	No	Yes
Program FE	Yes	Yes	Yes	Yes	Yes
Property controls	Yes	Yes	Yes	Yes	Yes
Neighborhood controls	Yes	Yes	Yes	Yes	Yes
N	416,891	199,861	884,128	929,961	928,434
Adj. R^2	0.653	0.639	0.679	0.544	0.663

Table IA.2: Effect of rehabilitation on nearby properties: Robustness

This table presents the robustness tests for Table 3 in the main paper by estimating the regression specification in Campbell et al. (2011) and Anenberg and Kung (2014). We estimate the following specification:

$$log(P_{i,c,t}) = \beta_{C,B} \cdot N_{C,B} + \beta_{C,A} \cdot N_{C,A} + \beta_{F,B} \cdot N_{F,B} + \beta_{F,A} \cdot N_{F,A} + \alpha_{ct} + f(\mathbf{X}_{i,t}) + \varepsilon_{i,c,t},$$

where the number of rehabilitated properties N in the neighborhood of a property transaction $P_{i,c,t}$ are indicated by C (close, < 0.1 mile), F (far, < 0.33 miles), B (1 year before), and A (1 year after). The table presents coefficients on $\beta_{C,B} - \beta_{C,A}$ indicated by *Close (Before minus After)*, and coefficients $\beta_{F,B} - \beta_{F,A}$ indicated by *Far (Before minus After)*. Standard errors are clustered at the census-tract level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Depvar: log(Sales price)	(1)	(2)	(3)	(4)
Close (Before minus After)	0.050***	0.048***	0.046***	0.045***
	(5.88)	(5.94)	(5.71)	(5.43)
Far (Before minus After)	0.011***	0.007*	0.005	0.004
	(2.40)	(1.65)	(1.22)	(0.90)
Census-tract×Year-qtr FE	Yes	Yes	Yes	Yes
Program FE	Yes	Yes	Yes	Yes
Property controls	No	Yes	Yes	Yes
Neighborhood controls (1)	No	No	Yes	Yes
Neighborhood controls (2)	No	No	No	Yes
N	928,434	928,434	928,434	928,434
Adj. R^2	0.594	0.663	0.663	0.663

Table IA.3: Effect of rehabilitation on nearby properties using a continuous measure of proximity

This table presents rehabilitation spillover effect estimated using the ring method described in Section 2.1. The dependent variable is the logarithm of the transaction price of single-family arms-length property transactions in the neighborhood of the 6,852 rehabilitated properties in our sample in the 1-year prior to the rehabilitation start date and 1-year after the rehabilitation end date. *Proximity* is defined within 0.1 miles of the rehabilitated property as $\frac{0.1-Distance}{0.1}$, where *Distance* is the distance in miles between a transacted property and the rehabilitated property. *Far* is an indicator variable for whether a transacted property is within 0.33 miles of the rehabilitated property. *Post* is an indicator variable equal to 1 for the year after the property rehabilitation is completed and equal to 0 for the year before the property rehabilitation begins. Property controls include square footage, age, and their squared terms, and indicator variables for the number of bedrooms, bathrooms, and building condition. The row labeled Neighborhood controls (1) includes the number of foreclosures and arms-length transactions that occur between 0.1 and 0.33 miles from the rehabilitated property. The row labeled Neighborhood controls (2) includes property rehabilitations that occur between 0.1 and 0.33 miles of the rehabilitated property. A detailed description of all variables is available in Internet Appendix B. Standard errors are clustered at the census-tract level. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Depvar: log(Sales price)	(1)	(2)	(3)	(4)
Proximity×Post	0.187***	0.180***	0.176***	0.174***
	(11.41)	(11.69)	(11.46)	(11.20)
Proximity	-0.107***	-0.081***	-0.073***	-0.070***
	(-8.85)	(-7.37)	(-6.57)	(-6.16)
Far×Post	0.003	0.001	0.000	-0.001
	(0.65)	(0.17)	(0.08)	(-0.16)
Far	-0.053***	-0.022***	-0.067***	-0.072***
	(-11.96)	(-6.38)	(-6.37)	(-6.68)
Post	0.009	0.008*	0.008*	0.008*
	(1.46)	(1.77)	(1.76)	(1.74)
Census-tract×Year-qtr FE	Yes	Yes	Yes	Yes
Program FE	Yes	Yes	Yes	Yes
Property controls	No	Yes	Yes	Yes
Neighborhood controls (1)	No	No	Yes	Yes
Neighborhood controls (2)	No	No	No	Yes
N	928,433	928,433	928,433	928,433
Adj. R^2	0.594	0.663	0.663	0.663

Table IA.4: Cross-sectional analysis: Rehabilitation characteristics

This table corresponds to the cross-sectional analysis presented in Figure 5. This table presents the average log house prices at various distances over the one year *after* the rehabilitation relative to the one year *before* the rehabilitation. These are computed using the empirical derivative method described in Section 2.2. The average house prices at a given distance from the rehabilitated property are computed by integrating the house price surfaces in Figure 5 over the 1-year period before and after the rehabilitation of the NCST property. Standard errors are estimated using the block-bootstrap method with 500 simulations. Sampling is carried out over neighborhoods corresponding to rehabilitated NCST properties (i.e., blocks). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: High rehabilitation intensity NCST properties

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
House price (log)	0.0500*	0.0476*	0.0412*	0.0380*	0.0294	0.0245	0.0211	0.0143	0.0015
	(1.89)	(1.88)	(1.75)	(1.69)	(1.38)	(1.25)	(1.27)	(1.26)	(0.82)

Panel B: Low rehabilitation intensity NCST properties

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
House price (log)	-0.0054	-0.0054	-0.0049	-0.0056	-0.0062	-0.0063	-0.0045	-0.0035	-0.0005
	(-0.34)	(-0.34)	(-0.33)	(-0.37)	(-0.43)	(-0.47)	(-0.40)	(-0.51)	(-0.55)

Panel C: Long rehabilitation duration NCST properties

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
House price (log)	0.0623***	0.0603***	0.0528**	0.0489**	0.0377**	0.0259	0.0077	-0.0032	-0.0017
	(2.77)	(2.75)	(2.57)	(2.45)	(1.99)	(1.48)	(0.54)	(-0.36)	(-1.38)

Panel D: Short rehabilitation duration NCST properties

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
House price (log)	-0.0034	-0.0051	-0.0066	-0.0066	-0.0070	-0.0053	-0.0012	0.0027	0.0013
	(-0.20)	(-0.31)	(-0.41)	(-0.42)	(-0.46)	(-0.37)	(-0.11)	(0.38)	(1.53)

Table IA.5: Cross-sectional analysis: Neighborhood characteristics

This table corresponds to the cross-sectional analysis presented in Figure 6. This table presents the average log house prices at various distances over the one year *after* the rehabilitation relative to the one year *before* the rehabilitation. These are computed using the empirical derivative method described in Section 2.2. The average house prices at a given distance from the rehabilitated property are computed by integrating the house price surfaces in Figure 6 over the 1-year period before and after the rehabilitation of the NCST property. Standard errors are estimated using the block-bootstrap method with 500 simulations. Sampling is carried out over neighborhoods corresponding to rehabilitated NCST properties (i.e., blocks). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: High-distress NCST neighborhoods

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
House price (log)	0.0225	0.0207	0.0195	0.0198	0.0193	0.0189	0.0138	0.0082	0.0002
	(1.34)	(1.27)	(1.29)	(1.35)	(1.40)	(1.51)	(1.36)	(1.27)	(0.24)

Panel B: Low-distress NCST neighborhoods

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
House price (log)	0.0537**	0.0536**	0.0515**	0.0496**	0.0432**	0.0381*	0.0255	0.0111	0.0012
	(2.32)	(2.36)	(2.37)	(2.33)	(2.09)	(1.95)	(1.60)	(1.14)	(0.94)

Panel C: High illiquidity NCST neighborhoods

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
House price (log)	0.0125	0.0130	0.0123	0.0123	0.0093	0.0057	-0.0013	-0.0020	-0.0006
	(0.43)	(0.46)	(0.45)	(0.47)	(0.37)	(0.24)	(-0.07)	(-0.18)	(-0.41)

Panel D: Low illiquidity duration NCST neighborhoods

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
House price (log)	0.0410**	0.0412**	0.0391**	0.0375**	0.0313**	0.0248*	0.0127	0.0039	0.0007
	(2.23)	(2.31)	(2.32)	(2.27)	(1.99)	(1.74)	(1.06)	(0.49)	(0.59)

Table IA.6: Welfare effects of property rehabilitation using alternate definition for the rehabilitated property's neighborhood

This table is identical to Table 5 except that it uses an alternate definition for the neighborhood around the rehabilitated property. The neighborhood around the rehabilitated property is defined based on the maximum distance at which the rehabilitation spillover effect for each subsample gets close to zero. A rehabilitation spillover effect is considered close to zero if it is drops below 1 pp in magnitude.

	Welfare per household ($)		Aggregate welfare ($)		
Sample	Owner-occupied (1)	Renter-occupied (2)	Owner-occupied (3)	Renter-occupied (4)	Total (5)
Full sample	1,302.33	950.22	896,256.60	402,164.30	1,298,420.90
High-distress	1,033.58	727.18	1,910,048.00	877,908.60	2,787,956.60
Low-distress	4,383.30	3,079.66	10,206,303.00	4,736,814.00	14,943,117.00
High-Illiquidity	191.57	141.78	28,547.98	12,274.30	40,822.28
Low-Illiquidity	3,231.57	2,296.69	4,554,478.00	2,078,658.00	6,633,136.00

Table IA.7: Cross-sectional analysis: Rehabilitation salience

This table corresponds to the cross-sectional analysis presented in Figure 8. This table presents the average log house prices at various distances over the one year *after* the rehabilitation relative to the one year *before* the rehabilitation. These are computed using the empirical derivative method described in Section 2.2. The average house prices at a given distance from the rehabilitated property are computed by integrating the house price surfaces in Figure 8 over the 1-year period before and after the rehabilitation of the NCST property. Standard errors are estimated using the block-bootstrap method with 500 simulations. Sampling is carried out over neighborhoods corresponding to rehabilitated NCST properties (i.e., blocks). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: High salience

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
House price (log)	0.0469*	0.0466*	0.0448*	0.0445*	0.0414*	0.0374*	0.0317*	0.0154	0.0014
	(1.85)	(1.87)	(1.87)	(1.90)	(1.85)	(1.78)	(1.82)	(1.31)	(0.90)

Panel B: Low salience

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
House price (log)	0.0243	0.0234	0.0148	0.0119	0.0051	0.0004	-0.0132	-0.0130	-0.0015
	(0.93)	(0.92)	(0.62)	(0.52)	(0.23)	(0.02)	(-0.70)	(-1.05)	(-0.85)

Table IA.8: Income of incoming homebuyers

This table corresponds to the income analysis presented in Figure 9. This table presents the average log income of homebuyers who purchased properties in the neighborhood of rehabilitated properties at various distances over the one year *after* the rehabilitation relative to the one year *before* the rehabilitation. These are computed using the empirical derivative method described in Section 2.2. The average incomes at a given distance from the rehabilitated property are computed by integrating the income surfaces in Figure 9 over the 1-year period before and after the rehabilitation of the NCST property. Standard errors are estimated using the block-bootstrap method with 500 simulations. Sampling is carried out over neighborhoods corresponding to rehabilitated NCST properties (i.e., blocks). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
Income (log)	0.0027	0.0035	0.0041	0.0043	0.0045	0.0040	0.0030	0.0010	0.0002
	(0.15)	(0.20)	(0.25)	(0.27)	(0.30)	(0.30)	(0.29)	(0.20)	(0.34)

Table IA.9: Cross-sectional analysis: Weather damage

This table corresponds to the cross-sectional analysis presented in Figure 10. This table presents the average log house prices at various distances over the one year *after* the rehabilitation relative to the one year *before* the rehabilitation. These are computed using the empirical derivative method described in Section 2.2. The average house prices at a given distance from the rehabilitated property are computed by integrating the house price surfaces in Figure 10 over the 1-year period before and after the rehabilitation of the NCST property. Standard errors are estimated using the block-bootstrap method with 500 simulations. Sampling is carried out over neighborhoods corresponding to rehabilitated NCST properties (i.e., blocks). *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: High weather damage area

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
House price (log)	0.0770***	0.0717***	0.0574***	0.0519***	0.0414**	0.0334**	0.0200*	0.0102	0.0011
	(3.59)	(3.45)	(2.99)	(2.84)	(2.50)	(2.23)	(1.68)	(1.30)	(0.89)

Panel B: Low weather damage area

Distance from NCST property (mi)	0.025 (1)	0.05 (2)	0.1 (3)	0.15 (4)	0.2 (5)	0.3 (6)	0.5 (7)	0.75 (8)	1.0 (9)
House price (log)	0.0135	0.0120	0.0101	0.0094	0.0090	0.0089	0.0083	0.0048	-0.0003
	(0.66)	(0.61)	(0.54)	(0.52)	(0.52)	(0.56)	(0.66)	(0.62)	(-0.32)