Property Tax Sales, Private Capital, and Gentrification in the U.S.

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Local govts. in U.S. rely on property tax revenues to fund public goods and services

Govt. has recourse and places super senior lien on delinquent properties
  ▶ Real property implicitly serves as collateral for tax debt in most regimes worldwide

Tax sales: forced sales resulting from severely delinquent local taxes
  ▶ Other types of forced sales: mortgage foreclosure, estate, and bankruptcy auctions
**Property Tax System and Distressed Housing Markets Are Linked**

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- **Tax sales**: forced sales resulting from severely delinquent local taxes
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- Tax authority charges interest, sends reminders to property owner, and finally sells claims to investors at (semi-)annual auctions to recoup lost revenues
  - Surplus revenues generated by auction but still sold for pennies on dollar
  - Entity who redeems the debt has low-cost opportunity to acquire property
  - ⇒ **opportunistic developers** enter new neighborhoods
Tax bill overdue as of October 1st, 2021.

Average unredeemed tax debt = $3,700.
Debt redeemed before July 19th, 2022 tax lien auction.

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Interest (1.5% monthly) + one-time penalty (10%) accrues.

Interest and penalties stop accruing once redeemed by taxpayer or by title transfer.
TIMELINE OF TAX SALES BY THE NUMBERS

- Data from Washington, D.C. (real 2012 $), but representative of lien auction format
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- Unlike most types of mortgage foreclosure and bankruptcy, equity gets forfeited
  - In many states, taxpayer has no clear legal claim to exceed proceeds at auction!

  Implied haircut is much larger than the 20-25% at mortgage foreclosure auctions

  Look at non-repeat delinquency, arms-length, non-REO title transfers

  Scale market value of property by observed 11% arms-length tax foreclosure prob.

  \[ \frac{E[V]}{\text{bid}} = 11\% \times \left( \frac{\$578,100}{\$17,400} \right) \approx 3.5 \text{ times auction price!} \]

  If restrict to only court foreclosures (<1/3), then 3% prob.\[ \Rightarrow \text{approx. actuarially fair} \]

Underpricing of tax foreclosure options amplifies property development relative to what might occur via mortgage foreclosures

Option pricing
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Option pricing
2.2% of taxable properties become delinquent each year.


- Represents 2.3 million taxable residences each year
- Some states have much higher rates due to “revolving” liens (e.g. FL, GA)
**Motivation:** concerns about affordability within booming markets

*Source:* Washington Post, “Pushed out,” September 21, 2019. Figure shows how two blocks on 13th St. NW in Washington, D.C. became steadily redeveloped over the last twenty years.
This paper: gentrification through cheap foreclosure options

- Tax sale investment acts as a vehicle for neighborhood demographic change
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  - Characterize strategies of banks, taxpayers, and investors

    - Intermediaries sell foreclosure options on secondary market to large private funds

- Reduced-form model of population flows to tag gentrifying areas

  - Application: show investors target tax liens in gentrifying areas

- Use state-of-art spatial DiD methods to document local pricing spillover effects

  - On average, values of neighboring homes 2-3% ↓ after tax sale

  - Heterogeneity: due to redevelopment, in gentrifying areas prices 10% ↑ within 3 years

- Document demographic changes resulting from tax sales

  - Gentrification: new homebuyers 2 p.p. less likely to be underrepresented minorities (URMs) after nearby tax sale to institutional investors (relative to baseline 12% URM buyer prob.)
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     - D.C.  Baltimore  Indy  Detroit

- Use state-of-art spatial DiD methods to document local pricing spillover effects
  - On average, values of neighboring homes $\downarrow$ 2-3% after tax sale
  - Heterogeneity: due to redevelopment, in gentrifying areas prices $\uparrow$ 10% within 3 years

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Cameron LaPoint (Yale SOM)
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NEW STYLIZED FACTS ABOUT TAX SALE MARKETS

- Little prior quantitative work on tax sales
  - Whitaker & Fitzpatrick (2013) on Chicago; Alm et al. (2016) on Cleveland
  - Large sociology literature on abandonment in Detroit (e.g. Akers & Seymour 2019)

- Property tax regressivity might contribute to delinquency outcomes
  - Hodge et al. (2017); Berry (2018, 2021); McMillen & Singh (2020); Amornsiripanitch (2023)
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- This paper: who is buying the tax claims, how, and why?

  1. Who? A small handful of investors acting as intermediaries
  2. How? Bidding for tax liens on properties without a mortgage lien
  3. Why? Relatively cheap redevelopment option in high CoL areas and high statutorily guaranteed yield on lien even without moving to foreclose
Other related work

- **Knock-on effects of distressed/affordable housing development**
  - Distressed sales: Campbell, Giglio, Pathak (2011); Anenberg & Kung (2014); Gerardi et al. (2015); Favara & Giannetti (2017); Gupta (2019); Ganduri & Maturana (2022)
  - Affordable housing: Autor, Palmer, Pathak (2014); Diamond & McQuade (2019), Asquith, Mast, Reed (2019); Boustan et al. (2019); Pennington (2021); Soltas (2022)

- **Corporate retail & “institutional” real estate investors**
  - Allen et al. (2018); Mills, Molloy, Zarutskie (2019); Bayer, Geissler, Mangum (2020); Bayer et al. (2021); Garriga, Gete, Tsouderou (2021); Buchak et al. (2021); Ganduri, Xiao, Xiao (2022); Gurun et al. (2022); Seiler & Yang (2022); Austin (2023); Billings & Soliman (2023)

- **Racial disparities in homeownership**
  - Brookings (2018); Kahn (2021); Kermani & Wong (2021); Bayer, Charles, Park (2021); Avenancio-León & Howard (2022); Zhang (2022); Gupta, Hansman, Mabille (2023)

- **Empirically identifying gentrification**
  - Brueckner & Rosenthal (2009); Guerrieri, Hartley, Hurst (2013); Glaeser, Kim, Luca (2018); Couture & Handbury (2019); Baum-Snow & Hartley (2020); Ding & Hwang (2020)
Other related work

- Knock-on effects of distressed/affordable housing development
- Corporate retail & “institutional” real estate investors
- Racial disparities in homeownership
- Empirically identifying gentrification patterns

Beyond new tax sale database, my contribution is to...

Establish links between distressed sales → intermediaries → developers, and how investors’ strategies drive neighborhood change within municipal finance system.
Legal & Institutional Background
**Property tax delinquency: basic principles**

- By default, lien placed on property once a local tax obligation is delinquent
  - *In rem* instead of *in personam* taxation
  - ⇒ **debt follows property**, so cannot be discharged via bankruptcy
  - ⇒ not dominated by federal tax lien, so IRS has to buy out the lienholder

- Suppose property tax bill becomes overdue...
  - Household then begins to receive delinquency notices and penalties/interest accrue
  - Final notice to taxpayer usually sent 2-4 weeks before an annual tax sale event
  - If not paid by final due date, lien or deed sold to investors to recover revenue
  - Generally, same process for other local liens (e.g. sanitation or “weed” liens)
Example: Penultimate Notice with Bill Breakdown

In D.C., statutory 10% penalty rate + 18% annualized interest on the tax bill

<table>
<thead>
<tr>
<th>Square</th>
<th>Suffix</th>
<th>Lot</th>
<th>Property Address</th>
<th>Mtg. No.</th>
<th>Assessment</th>
<th>Tax Rate/$100</th>
<th>Annual Tax</th>
</tr>
</thead>
<tbody>
<tr>
<td>3310</td>
<td>0102</td>
<td></td>
<td>4306 3RD ST NW</td>
<td></td>
<td>$525,650</td>
<td>0.85</td>
<td>$4,468.02</td>
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<tr>
<th>DESCRIPTION</th>
<th>TAX</th>
<th>PENALTY</th>
<th>INTEREST</th>
<th>PAYMENT</th>
<th>TOTAL</th>
</tr>
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<tbody>
<tr>
<td>2018</td>
<td>$4,309.16</td>
<td>$430.92</td>
<td>$711.01</td>
<td></td>
<td>$5,451.09</td>
</tr>
</tbody>
</table>

Total Payment due by May 31, 2019: $5,451.09
Example: Final Notice Payment Stub for Delinquent Taxpayer

**Payment:** Payment to the "DC Treasurer" may be made online at www.taxpayerservicecenter.com or at any DC branch of Wells Fargo Bank or mailed (with payment coupon from below) to the Office of Tax and Revenue, Real Property Tax Administration, PO Box 98095, Washington DC 20090-8095 (please write your square, suffix and lot numbers on the check).

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Notice Number: 0731014190701
Notice Date: July 1, 2019

DCN #: 191207655

Amount Enclosed: $                      

OFFICE OF TAX AND REVENUE
REAL PROPERTY TAX ADMINISTRATION
P.O. BOX 98095
WASHINGTON, DC 20090-8095

PAYMENT DUE BY: Jul 15, 2019
AMOUNT DUE: $5,580.37
How is this related to mortgage foreclosures?

- Short answer: mortgage foreclosures & tax sales are (nearly) disjoint events
  - 0.9% of tax liens result in a mortgage foreclosure in merged CoreLogic/tax sale sample
  - Compared to 4.1% foreclosure rate for all CoreLogic title exchanges

- Banks w/capital stake in property would step in to redeem super senior tax debt
  - Due process considerations require that lenders be notified of delinquency (Alexander 2000)
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- On the taxpayer side: most lenders require escrow account with monthly payments used to cover local tax bill
  - HOs w/long tenure less likely to have escrow accounts, so payment not automatic
  - Potential elderly incapacitation channel (Moulton et al. 2022 NTJ)
  - Even within tract category, foreclosed properties further from elderly care sites
  - Result is price haircuts well below a mortgage foreclosure
Most lenders have no money on table by auction date

- 54.8% of tax sale properties have no mortgage for last transaction prior to auction
- Of remaining 45.2%, 5.1 p.p. have a loan with term ending before the auction
- For remaining properties, use 30-year amortization schedule
- \( \leq 0 \) or \( \approx 0 \) \( \Rightarrow \) not profitable for lender to redeem the tax lien

Individual mean = 25778
Institutional mean = 28432
p-value on mean diff = .548
K-S test p-value = .001

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Why wouldn’t a lender step in to redeem debt?

- **Answer:** ≈ 70% of tax sale properties are owned outright
  - Escrow puts tax payments on autopilot
  - Also means more equity at stake if eventual foreclosure event

- Why do some lenders have skin in the game but not foreclose?
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1. Homeowner (or other interested party) pays off their debt after the auction
2. Lender pays off debt and then works with the homeowner to restructure their mortgage repayment schedule
Case Study: Washington, D.C. Tax Lien Market
Why is D.C. a good market to study?

- Main reason: detailed auction records merged with CoreLogic and Zillow, but also...
  - Major RE market with high CoL
    - $240 bil. housing stock, or #11 ranked city globally (CBRE 2017)
  - City is heavily reliant on property tax revenues
    - 32% of local tax revenues compared to 3% national average (FY 2019 Census ASSLGF)
  - Auction system follows majority of U.S. jurisdictions

- In progress: expand the analysis to all major metros w/records
  - Tax sales not systematically recorded in standard datasets → create new database
    - ZTRAX has auction flag, CoreLogic Involuntary Liens records just the lien event
  - Otherwise, rely on scraping, FOIA requests, geocoding tools → 300k liens collected
Surplus = bid amount − (back taxes + interest + penalties owed)
**Surplus bids at D.C. auction not given back to homeowner**

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- Surplus is zero for OTC sales
  - “Take it or leave it” offers
- In most cases investors bid more than the tax debt (surplus > 0)

- Surplus is 63% of auction revenues
- 2020 auction cancelled due to COVID
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  - Investor gets surplus back once debt is eventually paid off or cancelled
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- Gap between tax debt and subsequent sale prices is not rebated back to HO
- Subsequent foreclosure results in home equity forfeiture
Bidding strategies vary by investor type

Classify auction bidders into three types using keyword strings:

1. **Investors**: e.g. “LLC”, “FUND”, “INC”, “BANK”, “REALTY”, “PARTNERS”, “CAPITAL”, “TRUST”, “CORPORATION”, “PLLC” (Lambie-Hanson, Li, Slonkosky 2022)


3. **Individuals**: lienholders with (first name, surname) format + not containing keywords in above two lists

In D.C. tax lien auctions, retail/institutional investors...

- Purchase liens on more valuable properties in gentrifying areas
- Obtain higher “foreclosure yields” (lower bid-to-value)
- Are more likely to bid in contested auctions

Maps Distribution

Price index Distribution
**Bid-to-value (“foreclosure yield”) by investor type**

**VTB**

**YTM**

**Fraction of liens**

- **Back taxes to assessment ratio**
  - Individual mean = .023
  - Institutional mean = .016
  - p-value on mean diff = 0
  - K-S test p-value = 0

- **(Debt + interest + penalties) to assessment ratio**
  - Individual mean = .034
  - Institutional mean = .021
  - p-value on mean diff = 0
  - K-S test p-value = 0

- **Surplus bid to assessment ratio**
  - Individual mean = .043
  - Institutional mean = .031
  - p-value on mean diff = 0
  - K-S test p-value = 0

- **Overall bid to assessment ratio**
  - Individual mean = .081
  - Institutional mean = .052
  - p-value on mean diff = 0
  - K-S test p-value = 0
Investors more likely to buy in gentrifying D.C. areas

A. Using 1990-2005 tract definitions

B. Using 2005-2019 tract definitions

- Excluding sales to non-profit buyers, 72% of all sales within initially gentrifying tracts were to institutional investors (57% before Lehman crash)
Tax sale investors act as intermediaries to preserve corporate veil

Who ultimately owns properties sold at tax auction?

Several challenges in answering this question:

- Acquiring properties through tax foreclosure generates social opprobrium
- Bidders need only provide an SSN/EIN, name, and address to bid
- Strategic tax defaults to preserve anonymity: “repeat delinquency” events involving quick transfers between shell LLCs which appear in sample only once

Some defaulted properties can be linked to subsequent private equity deals

- Merge set of currently held properties to single-asset RE deals in Preqin — 696 deals spanning 493 unique addresses in D.C., 2000-19
- Hand-match to auction roster — 19 residential + 24 mixed-use properties (59 deals)
- Total PE deal value involving tax sale assets > $5 billion (matched sample)
26 of the 59 matched deals originate from “unidentified seller(s),” but some big names

Intermediaries who buy at auction instead have amorphous names like HEARTWOOD 20 LLC, CAPITOL TAX SERVICES LLC, TIDEWATER ASSETS LLC, etc.
Clear racial disparities in incidence of tax delinquency

- Severe delinquency 2 p.p. more likely among Black homeowners (HOs) \( \Rightarrow \) 33% higher incidence than overall Black share of HOs

- Hispanics 27%, Asians 20% less likely to be delinquent than their HO share

- Method: Bayes’s rule with Census common surnames list and voter registration

- **Disparate impact** from regressive assessments (Avenancio-León & Howard 2022)
Local spillover effects of tax liens on house prices
**Key Empirical Challenges in this Context**

- Location of tax sales is endogenous to outcomes of interest
  - Owners more likely to become delinquent in struggling neighborhoods
  - Investors more likely to purchase in areas with higher expected returns

- **Typical solution: control for “very local” time trends**

- The timing of tax sales is also endogenous to counterparty decisions
  - Depends on whether tax authority can find a buyer (special OTC sales)
  - Owners may “strategically default” when redemption cost is low (O’Flaherty 1990)

- Possible solution on timing side: in national cross-section use differential pass-through of shocks to municipal budgets (reforms uncommon)
  - Weak second stage: state govt. redistributes across munis
Methods for isolating tax sale spillovers

- Compare several existing approaches in the literature:
  - Ring DiD: compare outcomes in inner ring to those in outer ring around sale event
  - Foreclosure wave regressions à la Campbell, Giglio, Pathak (2011)
  - Empirical derivatives estimator (Diamond & McQuade 2019): semi-parametric ring DiD by tracing out slope of conditional mean w.r.t. distance

Problem: need to guess “correct” radius to identify treatment effects
▶ Parallel trends has to hold at every distance in the outer ring (Butts 2021)
▶ Overlapping rings here makes it tricky to define distance running variable
Alternative solutions:
▶ Define control group using something other than distance
▶ Identify delinquent properties which were redeemed right before auction
▶ ML methods to identify counterfactual tax lien sale locations (Pollmann 2021)
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- **Alternative solutions**: define control group using something other than distance
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Standard method: foreclosure wave regressions

- Parametric version of ring analysis via POLS where include geography × time FEs, controls $X_{i,t}$ for property characteristics:

$$\log(p_{i,c,t}) = \alpha_{c,t} + \gamma_m + \beta' \cdot X_{i,t} + \delta_{C,B} \cdot g(N_{C,B}; D_{C,B})$$

$$+ \delta_{C,A} \cdot g(N_{C,A}; D_{C,A}) + \delta_{F,B} \cdot h(N_{F,B}) + \delta_{F,A} \cdot h(N_{F,A}) + \varepsilon_{i,c,t}$$

Key estimate of interest: $\delta_{C,B} - \delta_{C,A}$ captures how one additional tax sale transfer influences values of nearby properties.
STANDARD METHOD: FORECLOSURE WAVE REGRESSIONS

- Parametric version of ring analysis via POLS where include geography \( \times \) time FEs, controls \( X_{i,t} \) for property characteristics:

\[
\log(p_{i,c,t}) = \alpha_{c,t} + \gamma_m + \beta' \cdot X_{i,t} + \delta_{C,B} \cdot g(N_{C,B}; D_{C,B}) + \delta_{C,A} \cdot g(N_{C,A}; D_{C,A}) + \delta_{F,B} \cdot h(N_{F,B}) + \delta_{F,A} \cdot h(N_{F,A}) + \varepsilon_{i,c,t}
\]  

- \( g(\cdot) \): distance-weighted sum of tax sales where the weight is \( \omega = \frac{0.1 - D(i)}{0.1} \)
- \( h(\cdot) \): unweighted sum of tax sales
- \( \{B, A\} \) subscripts indicate before (B) vs. after (A) tax sale event
- \( \{C, F\} \) subscripts indicate whether \( i \) is "close" (\( r < 0.1 \) mi.) or "far" (\( r < 0.25 \) mi.)
Standard Method: Foreclosure Wave Regressions

- Parametric version of ring analysis via POLS where include geography × time FEs, controls $X_{i,t}$ for property characteristics:

$$\log(p_{i,c,t}) = \alpha_{c,t} + \gamma_m + \beta' \cdot X_{i,t} + \delta_{C,B} \cdot g(N_{C,B}; D_{C,B})$$

$$+ \delta_{C,A} \cdot g(N_{C,A}; D_{C,A}) + \delta_{F,B} \cdot h(N_{F,B}) + \delta_{F,A} \cdot h(N_{F,A}) + \epsilon_{i,c,t}$$

$\triangleright$ $g(\cdot)$: distance-weighted sum of tax sales where the weight is $\omega = \frac{0.1-D(i)}{0.1}$

$\triangleright$ $h(\cdot)$: unweighted sum of tax sales

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- Key estimate of interest: $\hat{\delta}_{C,B} - \hat{\delta}_{C,A}$ captures how one additional tax sale transfer influences values of nearby properties
On average, (−) pricing spillover of 2-3%

- Small spillover at “far” distance

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- Tract × year FEs
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- Property controls
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But (+) in areas with many, but not too many, tax sales

- “Bulk buy” strategy of institutional investors (Ganduri, Xiao, Xiao 2022)

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But (+) in areas with many, but not too many, tax sales  
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Tax sales more common and geographically clustered than mtg. foreclosures or bankruptcy  
  ▶ 99.9th percentile to the maximum is 64.12–94.11 tax sales

Can ≈ match (\(\hat{\delta}_{C,B} - \hat{\delta}_{C,A}\)) in mtg. foreclosure literature if I use exact same set of controls/sampling

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Method #3 (illustration): the “bowtie” in the ED method

- Idea: account for very local time trends by tracing out how outcomes continuously evolve w.r.t. time/distance to event
  - Compare property pairs ±δ away in Polar coordinate plane for fixed θ

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Method #3 (illustration): the “bowtie” in the ED method

- **Idea:** account for very local time trends by tracing out how outcomes continuously evolve w.r.t. time/distance to event
  - Compare property pairs $\pm \delta$ away in Polar coordinate plane for fixed $\theta$

- **Event:** house in the center is a tax sale property transferred to investor after redemption period ends

- **Semi-parametric:** pick ring radius and “smoothing” parameters to determine size of shaded area

$\Delta P >> 0$ in up-and-coming areas after tax sales to investors

Sales in recently gentrifying tracts

- Focus on arms-length transfers to investors after tax auction

ED method produces flat price surface prior to foreclosure event

Sales prices up 10% at close distances within 5 years

Price differences decay towards zero around 0.5 miles away

$r = 0.5$ mi.

Inner ring

Similar effects whether define event as foreclosure sale to LLC vs. non-LLC investor

Individuals
\[ \Delta P >> 0 \text{ in up-and-coming areas after tax sales to investors} \]

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Heterogeneous effects by neighborhood type

A. Sales in previously gentrifying tracts

B. Sales in previously non-gentrifying tracts

- Price $7\%\downarrow$, decaying with distance in non-gentrifying areas

C. Sales in recently gentrifying tracts

D. Sales in recently non-gentrifying tracts

Placebo: re-estimate pop. flows model to identify ex ante vs. ex post gentrification

- ex ante: 1990 – 2005
- ex post: 2005 – 2019

Insignificant responses in Panels A/B $\Rightarrow$ investors not just amplifying pre-existing trends towards gentrification

Definition

Tax sale investors act as opportunistic developers
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- Insignificant responses in Panels A/B \implies investors not just amplifying pre-existing trends towards gentrification
- Tax sale investors act as \textit{opportunistic developers}
Evidence in favor of blight reduction channel

A. Most foreclosures (top quartile)

B. Least foreclosures (below median)

- Consistent with the (+) effects of non-profit rehabs in Ganduri & Maturana (2022)
- Holds even if exclude tax sales involving properties w/mortgage lien
Evidence also goes against strong supply channel

A. Thinnest markets

B. Thickest markets

- Tax sales might improve very local housing supply by inc. inventory \( \Rightarrow P \downarrow \)
- Here demand effects (blight reduction + amenities + sorting) dominate supply effects
NEIGHBORHOOD DEMOGRAPHIC CHANGES THROUGH TAX SALES
Do tax sales drive local demographic change?

- Two ("push-pull") forces through which this might happen in SFH market:
  - **Gentrification:** pos. pricing externalities $\Rightarrow$ neighborhood becomes more inaccessible to lower-income, non-white residents (URM buyer share ↓)
  - **Displacement:** besides delinquency-related turnover, changing neighborhood demographics/amenities might induce current residents to sell (URM seller share ↑)

Mechanisms: property tax hikes (He 2022), homophily (Ihlanfeldt & Scafidi 2002), preferences over amenities (Waldfogel 2008), liquidity constraints (Wong 2020)

Look at racial composition of nearby homeowners imputed from surname × location

Evidence here consistent with gentrification channel

- URM buyer prob. declines by 2 p.p. (relative to a 12% baseline prob.)
- But URM seller prob. also declines by 3 p.p. (relative to a 10% baseline prob.)
- No consistent patterns around tax sales to individual investors
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- ED method does not converge for areas which are highly segregated (corner solutions)
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- ED method does not converge for areas which are highly segregated (corner solutions)
- Event study with fine distance bins to approximate empirical derivatives method:

\[
URM_{i,r,t} = \sum_{k=-3}^{+5} \left\{ \sum_{d=\text{0.05 mi}} \beta_{d,k}^{\text{close},a} \cdot TaxSale_{\text{Close}}_{i,t,d,k} \right\} + \alpha_{r,t} + \gamma_{m} + \eta' \cdot X_{i,t} + \nu_{i,r,t}
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(2)
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+ \sum_{d=0.5 \text{ mi}}^{1 \text{ mi}} \beta_{d,k}^{\text{far},a} \cdot TaxSale_{\text{Far}}^{a}_{i,t,d,k} + \alpha_{r,t} + \gamma_{m} + \eta' \cdot X_{i,t} + \nu_{i,r,t}
\]

- e.g. \(TaxSale_{\text{Close}}^{a}_{i,2005,0.1,-1} = 1\) if house \(i\) purchased within 0.1 mi. of tax sale property w/title change to investor of type \(a\) in 2006
- \(\alpha_{r,t}\): ring, block group, or 9-digit zip code \(\times\) year FE
- Controls \(X_{i,t}\): lat/lon, \# bed/baths, floor space, lot size, house age quadratic
2% ↓ in URM buyer prob. after tax sale foreclosure

Cont. prob.  Ind. rings

Miles to Property

- estimated $\beta_d$
- 95% confidence interval
URM seller prob. \( \downarrow \) \( \implies \) more white-to-white sales

Cont. prob. Ind. rings

Miles to Property

- Estimated \( \beta_d \)
- 95% confidence interval
Policy Implications
Recently concluded legal battle over “home equity theft”

**States Are Not Entitled to Windfalls in Tax Disputes, Supreme Court Rules**

In an unanimous decision, the justices sided with a 94-year-old woman who got nothing when a Minnesota county sold her condominium to recoup unpaid taxes.

- **Tyler v. Hennepin County**: 94 year-old Minnesota widow who had $40k home seized to pay off $15k in local tax debts

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*States Are Not Entitled to Windfalls in Tax Disputes, Supreme Court Rules*

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  - In 7 other states (CT, FL, MO, MT, ND, SC, VA), taxpayer still has only a few months to file claim for excess proceeds

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Ongoing issues over “disparate impact”

What does this paper have to say about property tax reform?

1. Valuation of excess proceeds: use *ex ante* prices to the extent that auction process undervalues properties and *ex post* properties may amplify inequality
   - *Tyler* ruling does not take a stance on what constitutes legally fair value
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   - Payments column in ledgers empty in % of cases = not just a liquidity story
   - Incidence of Alzheimer's/related dementia (AD/RD) cases plays a role

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   - create escrow-mimicking account with opt-in provision that automatically pays taxes, even if no mortgage loan attached
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Using delinquency to detect early memory impairment

Source: LaPoint et al. (2024): “Losing more than memory: a study of Alzheimer’s disease and property tax delinquency to improve human health”
Using delinquency to detect early memory impairment

Strong (+) association of delinquency with future deaths from Alzheimer’s Disease & dementias (AD/RD)

Placebo: not true if look at death rates from acute causes (e.g. heart attacks)

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Using delinquency to detect early memory impairment

- Strong (+) association of delinquency with future deaths from Alzheimer’s Disease & dementias (AD/RD)
- Placebo: not true if look at death rates from acute causes (e.g. heart attacks)
- Missing payments as an indicator of memory impairment
- Nationwide database of mortality records linked to CoreLogic
- Precision public health initiatives using publicly available data

**Source:** LaPoint et al. (2024): “Losing more than memory: a study of Alzheimer’s disease and property tax delinquency to improve human health”
Conclusion

- Municipalities hold tax sales to recoup lost revenue
  - Buyer composition strongly tilted towards institutional investors around 2008
  - Non-REO intermediaries target high-value properties in gentrifying areas

- Local price spillover effects: (−) on average, but (+) in gentrifying areas
  - Investors accelerate demographic trends by redeveloping delinquent properties
  - Blight reduction: stronger (+) effects in areas with more foreclosures
  - Tax sales amplify within-city racial inequality by crowding out URM buyers

- Finance-based microfoundation for gentrification waves within cities

- Policy: rebate surplus revenues to delinquent taxpayer instead of the foreclosing entity while (barely) hurting investors’ profits → use ex ante price basis
THANK YOU!
Appendix
Spatial distribution of property tax lien delinquency rates


- Residualize on state FE to hold fixed property tax legal regime
Jurisdictions divided into three types based on how they sell claims:

1. Lien sales: interest-bearing certificate with foreclosure option sold at auction or OTC
2. Deed sales: local authority – tax or sheriff’s office – directly forecloses and then sells deed at auction or OTC (“special sale”)
3. Hybrid sales: like a deed sale, except redemption period needs to pass before investor can convert deed to title

No clear political divide in how jurisdictions arbitrate delinquency

Since redemption periods in deed states can be long, **not much economic distinction between a lien sale and deed sale system**

- Difficult for homeowner to redeem in hybrid states because need to pay back both outstanding tax debt + penalties/fees + whatever premium the investor bid

“credit bid”
Some common tax sale procedures across states...

1. Local authority sets auction date and lists properties on website for investors to review
   - This usually happens when the final notice is sent to the taxpayer ➞ properties redeemed at last minute as potential control group
   - Govt. might also allocate funds to advertise the tax sale

2. Almost all tax sales held in person – cancelled in 2020-21 due to COVID
   - Online sales conducted as sealed price auctions with very little time between lots

3. Bidders register with an SSN or EIN for W-9 filing and ownership record
   - Corporate veil: easy to preserve anonymity, since can create a shell or hire an intern

4. Investors place security deposit + fees with clerk prior to placing bids
There are five types of tax auctions, with some limited within-state variation in rules...

1. **Premium bid**: investors bid a premium relative to the outstanding tax bill

2. **Bid down interest**: Dutch auction where buyers pay off the tax debt and bid minimum interest they are willing to accept

3. **Random/rotational bid**: tax authority sets “buy it now” price for each property and bidder numbers randomly called for each lot until someone buys

4. **Bid down price**: same as bid down interest (IL and LA)

5. **Sealed first price (Vickrey)**: currently only in Maine

- Premium bid by far most common method used by 39 out of 51 states
- Starting bid typically set so the tax authority breaks even
Valuing tax liens as a financial asset (Part #1)

- Extend hybrid option models of Stanton (1995) and Jarrow & Tyagi (2007)
- NPV of a tax lien given foreclosure date \( \chi \) is then the expected value from the coupons + the property’s liquidation value in foreclosure less the bid

\[
NPV_0(\chi) = \mathbb{E}_Q \left( \mathbb{1}_{0 \leq \tau \leq \chi} \cdot C \cdot \exp \left( \lambda \cdot \max\{r, i, \tau\} \times \mathbb{1}_A \right) \times \exp \left( - \int_0^\tau rds \right) \right)
\]

interest coupons to lienholder

\[
+ \left( \mathbb{1}_{T^* \leq \chi \leq \tau} \left[ \min\{P_\chi, C \cdot \exp \left( \lambda \cdot \max\{r, i, \chi\} \times \mathbb{1}_A \right) \} - K \right] \right) \times \exp \left( - \int_0^\chi rds \right) \right) - C - S
\]

liquidation value in foreclosure

- Foreclosure date \( \chi \), where option vests once redemption period of length \( T^* \) passes
- \( C \) is the tax debt, \( S \) is surplus, where total bid is \( C + S \)
Valuing tax liens as a financial asset (Part #2)

\[ NPV_0(\chi) = \mathbb{E}_Q \left( \mathbb{1}\{0 \leq \tau \leq \chi\} \cdot C \cdot \exp \left( \lambda \cdot \max\{r, i, \tau\} \times \mathbb{1}_A \right) \times \exp \left( -\int_0^\tau rds \right) \right) \]

interest coupons to lienholder

\[ + \left( \mathbb{1}\{T^* \leq \chi \leq \tau\} \left[ \min\{P_\chi, C \cdot \exp \left( \lambda \cdot \max\{r, i, \chi\} \times \mathbb{1}_A \right) \right] - K \right) \times \exp \left( -\int_0^\chi rds \right) \]

liquidation value in foreclosure

- \( A = (i \neq 0) \) and indicator \( \mathbb{1}_A \) indicator function for set \( A \)
- Delinquent HO picks intensity \( \lambda \) by deciding on redemption time
- Minimum interest rate embedded in tax lien if not redeemed = \( r \times \mathbb{1}_A \)
- Exercise foreclosure option whenever \( P_\chi > C + S + K \)
  - \( K \) is opportunity cost from the PV of (legal) costs incurred over the foreclosure process as of \( \chi \)
## Example: Returns on a Multi-State Tax Lien Portfolio

<table>
<thead>
<tr>
<th></th>
<th>Washington, D.C.</th>
<th>Florida</th>
<th>Massachusetts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sale method</td>
<td>Lien</td>
<td>Lien</td>
<td>Hybrid</td>
</tr>
<tr>
<td>Bid method</td>
<td>Premium bid</td>
<td>Bid down interest</td>
<td>Premium bid</td>
</tr>
<tr>
<td>Redemption period</td>
<td>6 months</td>
<td>2 years</td>
<td>6 months</td>
</tr>
<tr>
<td>Maturity/expiration</td>
<td>6 months</td>
<td>7 years</td>
<td>6 months</td>
</tr>
<tr>
<td>One-time penalty rate</td>
<td>0%</td>
<td>5% minimum</td>
<td>0%</td>
</tr>
<tr>
<td>Annual interest rate</td>
<td>12%</td>
<td>18%</td>
<td>16%</td>
</tr>
<tr>
<td>Assumed total bid value</td>
<td>$16,000</td>
<td>$1,000</td>
<td>$100,000</td>
</tr>
<tr>
<td>Assumed premium bid</td>
<td>$2,000</td>
<td>N/A</td>
<td>$75,000</td>
</tr>
</tbody>
</table>

- Suppose investor holds each lien until redemption period ends
- Without exercising foreclosure option, guaranteed yields to maturity would be 5.1% on D.C., 18% on FL, and 7.7% on MA lien
  - Ex: for D.C., \((16k - 2k) \times [(1 + 0.0095)^6 - 1]/16k = 816.21/16k = 5.1\%\)
Value-to-bid ratio spiked around GFC

- Unconditional value-to-bid (VTB) without adjusting for redemption or collateral risk
  - Similar discrete spike if adjust for both
  - Court foreclosure prob. ↓, but quiet foreclosure prob. ↑ over time
- Not solely driven by mortgage foreclosures where bank let the property go
  - Exclude special OTC auctions
- Even with covariate-adjustment, no decline in VTB over time
- Suggests information asymmetry (Zillow) not driving spreads
Yield-to-maturity also spiked around GFC

\[ YTM = (bid - surplus) \times (1 + r)^n / bid \]
Average annualized YTM for holding liens is $\approx 4\%-5\%$

\[ \text{YTM} = (\text{bid} - \text{surplus}) \times (1 + r)^n / \text{bid} \]

- Monthly interest rate $r$ high across all lien states ($10\% - 20\%$ p.a.)
- Redemption period $n$ varies from 6 months (MD/D.C.) to 48 months (WY)
- Example: in D.C., YTM maxes out at $(1 + 0.015)^6 = 9.34\%$
- YTM higher for individual investors
  - Less likely to compete in contested auctions or file for foreclosure
  - If condition on surplus $> 0$, institutions earn 10 bps. higher YTM
Algorithm for determining mortgage lien status

- **Basic idea:** match tax sale properties to loan contracts repoted in CoreLogic...
  - For D.C. sample, match on address/square combo

1. Determine main contract features: FRM vs. ARM, origination amount $C_0$, quoted rate $i$, term $N$, payment frequency, etc.

2. Drop properties matched to a refinancing or second mortgage event

3. For FRMs, use standard accounting formulas (see next slide) to obtain $C_n$ balance, where $n$ is # months into the loan when tax sale occurs

4. For ARMs ($< 10\%$ of loans), assume standard contract features consistent with HMDA/FHFA MIRS (e.g. 5/1 loan with 1-year T-bill index)

5. For remaining loans with $i$ but missing term and contract type, assume 30-year FRM $\implies$ overestimate balance $C_n$
Loan fully with quoted rate $i$ amortizes over $N$ months, so expand the geometric series to obtain monthly payment ($PMT$)

Then iterate on the initial law of motion $C_1 = (1 + i/12) \times C_0 - PMT$ to find balance after $n$ months of payments

$$C_0 = \sum_{t=1}^{N} \frac{PMT}{(1 + i/12)^t} \implies PMT = C_0 \times \left( \frac{i/12}{1 - (1/(1 + i/12))^N} \right)$$

$$C_n = (1 + i/12)^n \times C_0 - \sum_{t=0}^{n-1} (1 + i/12)^t \times PMT$$

$$\implies C_n = (1 + i/12)^n \times C_0 - \frac{PMT \cdot ((1 + i/12)^n - 1)}{i/12}$$
## Summary statistics: Most auction revenues from surplus bids

### Table: Tax auction variables

<table>
<thead>
<tr>
<th>Year</th>
<th># liens sold</th>
<th>Back taxes</th>
<th>Interest/penalties</th>
<th>Surplus</th>
<th>Auction revenues</th>
<th>Surplus-revenue ratio (%)</th>
<th>Total tax revenues</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>2,181</td>
<td>3.52</td>
<td>1.04</td>
<td>32.76</td>
<td>37.35</td>
<td>87.71%</td>
<td>1,136</td>
</tr>
<tr>
<td>2006</td>
<td>1,997</td>
<td>3.81</td>
<td>1.07</td>
<td>23.06</td>
<td>28.77</td>
<td>80.16%</td>
<td>1,212</td>
</tr>
<tr>
<td>2007</td>
<td>2,083</td>
<td>4.31</td>
<td>1.65</td>
<td>45.11</td>
<td>51.82</td>
<td>87.06%</td>
<td>1,542</td>
</tr>
<tr>
<td>2008</td>
<td>1,366</td>
<td>6.05</td>
<td>2.27</td>
<td>12.46</td>
<td>21.31</td>
<td>58.46%</td>
<td>1,727</td>
</tr>
<tr>
<td>2009</td>
<td>1,068</td>
<td>5.91</td>
<td>2.11</td>
<td>2.33</td>
<td>10.61</td>
<td>21.99%</td>
<td>1,839</td>
</tr>
<tr>
<td>2010*</td>
<td>1,622</td>
<td>8.06</td>
<td>2.90</td>
<td>2.13</td>
<td>22.27</td>
<td>9.56%</td>
<td>1,891</td>
</tr>
<tr>
<td>2011***</td>
<td>1,998</td>
<td>6.13</td>
<td>2.27</td>
<td>4.04</td>
<td>13.49</td>
<td>29.93%</td>
<td>1,734</td>
</tr>
<tr>
<td>2012*</td>
<td>1,248</td>
<td>5.17</td>
<td>2.06</td>
<td>5.93</td>
<td>14.72</td>
<td>40.32%</td>
<td>1,880</td>
</tr>
<tr>
<td>2013</td>
<td>965</td>
<td>4.48</td>
<td>1.61</td>
<td>11.82</td>
<td>17.91</td>
<td>66.00%</td>
<td>1,951</td>
</tr>
<tr>
<td>2014</td>
<td>316</td>
<td>2.08</td>
<td>0.74</td>
<td>5.53</td>
<td>8.57</td>
<td>64.56%</td>
<td>2,035</td>
</tr>
<tr>
<td>2015*</td>
<td>534</td>
<td>2.62</td>
<td>1.00</td>
<td>8.77</td>
<td>12.73</td>
<td>68.91%</td>
<td>2,267</td>
</tr>
<tr>
<td>2016**</td>
<td>1,040</td>
<td>3.47</td>
<td>1.33</td>
<td>8.32</td>
<td>16.32</td>
<td>50.94%</td>
<td>2,364</td>
</tr>
<tr>
<td>2017*</td>
<td>675</td>
<td>2.31</td>
<td>0.93</td>
<td>9.54</td>
<td>13.92</td>
<td>68.49%</td>
<td>2,579</td>
</tr>
<tr>
<td>2018</td>
<td>516</td>
<td>3.51</td>
<td>1.21</td>
<td>5.89</td>
<td>10.66</td>
<td>55.23%</td>
<td>2,591</td>
</tr>
<tr>
<td>2019</td>
<td>810</td>
<td>5.99</td>
<td>3.08</td>
<td>12.58</td>
<td>21.93</td>
<td>57.37%</td>
<td>2,807</td>
</tr>
<tr>
<td>Total</td>
<td>18,419</td>
<td>67.42</td>
<td>25.26</td>
<td>190.28</td>
<td>302.39</td>
<td>62.92%</td>
<td>29,556</td>
</tr>
</tbody>
</table>

### Notes
- All monetary values in millions of nominal dollars. Surplus-revenue ratio is surplus divided by auction revenues. The number of stars indicates the number of special OTC sales in that year. Tax auction variables sourced from the buyer’s books for 2005 – 2019 available through the Washington, D.C. OTR.
Bid components (real 2012 $) by investor type

Back taxes on lien
- Individual mean = 3282
- Institutional mean = 3757
- p-value on mean diff = 0
- K-S test p-value = 0

Starting bid
- Individual mean = 4483
- Institutional mean = 5060
- p-value on mean diff = 0
- K-S test p-value = 0

Surplus bid
- Individual mean = 8282
- Institutional mean = 11519
- p-value on mean diff = 0
- K-S test p-value = 0

Last assessed value of property
- Individual mean = 447217
- Institutional mean = 531472
- p-value on mean diff = 0
- K-S test p-value = 0
<table>
<thead>
<tr>
<th>Deal date</th>
<th>Buyer(s)</th>
<th>Seller(s)</th>
<th>Property name</th>
<th>Current use</th>
<th>Dual size</th>
<th>Square footage</th>
<th>Tax sale date</th>
<th>Auction price</th>
<th>Lion buyer(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/2010</td>
<td>The Goldstar Group</td>
<td>Unidentified</td>
<td>The Floridian Condominiums</td>
<td>Multi-family</td>
<td>N/A</td>
<td>N/A</td>
<td>12/2009</td>
<td>$4,472</td>
<td>CAPITAL SOURCE BANK FBO</td>
</tr>
<tr>
<td>2/2010</td>
<td>CBRE Investment Management</td>
<td>PGM Real Estate</td>
<td>Mass Court</td>
<td>Multi-family</td>
<td>$100,5 M</td>
<td>200,000</td>
<td>9/2008</td>
<td>$35,005</td>
<td>US BANK-CUST/SASS MUNI V DTR</td>
</tr>
<tr>
<td>4/2010</td>
<td>Somerset Development Co.</td>
<td>Unidentified</td>
<td>Webster Gardens Apartments</td>
<td>Multi-family</td>
<td>N/A</td>
<td>N/A</td>
<td>7/2006</td>
<td>$7,768</td>
<td>CAPITOL TAX SERVICES, LLC</td>
</tr>
<tr>
<td>7/2010</td>
<td>Cadillac Healthcare Ltd.</td>
<td>Aikrige</td>
<td>1016 16th St</td>
<td>Mixed-use</td>
<td>N/A</td>
<td>38,250</td>
<td>11/2009</td>
<td>$8,548</td>
<td>ETS DC LLC</td>
</tr>
<tr>
<td>6/2011</td>
<td>JCR Companies</td>
<td>Unidentified</td>
<td>301 Massachusetts Ave NW</td>
<td>Retail</td>
<td>N/A</td>
<td>4,000</td>
<td>9/2008</td>
<td>$11,986</td>
<td>REDEMPTOR LITIUM LLC</td>
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<tr>
<td>8/2011</td>
<td>JCR Companies</td>
<td>Unidentified</td>
<td>1723 Connecticut Ave NW</td>
<td>Residential</td>
<td>N/A</td>
<td>N/A</td>
<td>7/2011</td>
<td>$52,144</td>
<td>US BANK/CUST/RMP SV, CAP ONE</td>
</tr>
<tr>
<td>7/2012</td>
<td>Host Hotels &amp; Resorts</td>
<td>Quadrangle Development Corporation</td>
<td>Grand Hyatt Washington</td>
<td>Hotel</td>
<td>$400 M</td>
<td>N/A</td>
<td>9/2010</td>
<td>$9,505</td>
<td>REDEMPTOR LITIUM LLC</td>
</tr>
<tr>
<td>6/2013</td>
<td>The Goldstar Group</td>
<td>Unidentified</td>
<td>425-427 8th St SE</td>
<td>Mixed-use</td>
<td>$1.7 M</td>
<td>3,155</td>
<td>7/2012</td>
<td>$23,880</td>
<td>REDEMPTOR LITIUM</td>
</tr>
<tr>
<td>9/2013</td>
<td>Rose Green Cities Fund</td>
<td>Unidentified</td>
<td>Porter Flats</td>
<td>Multi-family</td>
<td>N/A</td>
<td>40,860</td>
<td>7/2016</td>
<td>$15,596</td>
<td>HEARTWOOD 88, LLC</td>
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<td>11/2013</td>
<td>Lone Star Funds</td>
<td>Wernewhove</td>
<td>1401 New York Ave NW</td>
<td>Office</td>
<td>N/A</td>
<td>$71 M</td>
<td>10/2010</td>
<td>$371,957</td>
<td>WCF DC23 HOLDINGS, LLC</td>
</tr>
<tr>
<td>12/2013</td>
<td>Urban Investment Partners</td>
<td>Unidentified</td>
<td>Capitol Park Tower</td>
<td>Multi-family</td>
<td>N/A</td>
<td>N/A</td>
<td>9/2008</td>
<td>$8,507</td>
<td>REDEMPTOR LITIUM LLC</td>
</tr>
<tr>
<td>12/2013</td>
<td>Hines</td>
<td>Lehman Brothers Real Estate Private Equity</td>
<td>55 M St</td>
<td>Mixed-use</td>
<td>$141.9 M</td>
<td>266,566</td>
<td>7/2006</td>
<td>$8,661</td>
<td>AEON PROPERTIES, LLC</td>
</tr>
<tr>
<td>6/2014</td>
<td>Rezross Investment Group LLC</td>
<td>Deltiah Capital</td>
<td>2209 Massachusetts Ave NW</td>
<td>Office</td>
<td>N/A</td>
<td>9,000</td>
<td>7/2012</td>
<td>$50,494</td>
<td>RED AMERICA INC CUST AS</td>
</tr>
<tr>
<td>12/2014</td>
<td>PRP</td>
<td>Unidentified</td>
<td>2601 Residences on Street</td>
<td>Condominiums</td>
<td>$31.6 M</td>
<td>100,000</td>
<td>9/2011</td>
<td>$4,873</td>
<td>RICHARD T. COCKERILL</td>
</tr>
<tr>
<td>6/2015</td>
<td>Mill Creek Residential</td>
<td>Potomac Construction Group</td>
<td>2700 16th St</td>
<td>Office</td>
<td>$16.2 M</td>
<td>35,000</td>
<td>7/2012</td>
<td>$160,842</td>
<td>ABBOTT DEVELOPMENT GROUP</td>
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A. Institutional lien buyers

\[
\log B_{i,t} = \delta_t + \gamma_m + \tilde{\alpha}_i + \beta' \cdot X_{i,t} + \epsilon_{i,t}
\]

\[
B_t = \exp(\delta_t)
\]

B. Individual lien buyers
**Tax foreclosure option value index (surplus value)**

\[ \log(1 + S_{i,t}) = \delta_t + \gamma_m + \tilde{\alpha}_i + \beta' \cdot X_{i,t} + \epsilon_{i,t} \]

\[ S_t = \exp(\delta_t) \]

- **Matching estimator:** \( \tilde{\alpha}_i \) address fixed effects (units within same building)
- **Idea:** surplus bid proxies for tax foreclosure option value because it does not accrue interest

**Notes:** \( \tilde{\alpha}_i \) are address fixed effects. All bid values in real 2012 dollars, converted from nominal terms using the PCE deflator.
Targeting of gentrifying areas in Baltimore similar to D.C.
Some targeting of gentrifying areas in Indianapolis

- Abandoned, gentrifying, and LI concentration tracts all over-represented relative to all arms-length, non-tax deed transactions

- But gentrifying tracts are 5x over-represented

- On a scale from D.C. to Detroit, cities like Indy which experienced bad subprime foreclosure crisis generally fall in the middle
Compare to the foreclosure crisis in Detroit...

- 85% of tax deed sales occur in low-income concentration/abandoned areas, many involving realty companies and non-profits

**Geocoded data infrastructure**

### Real estate data
- Proprietary databases: CoreLogic Tax/Deeds/Involuntary Liens, Zillow ZTRAX
- **Tax sale records**: FOIA requested and scraped from local tax authorities when possible
- Merge tax sale addresses to CoreLogic whenever possible to retrieve lat/lon, otherwise use Google Maps API → determine ring positions

### Business entry/exit and amenities
- ArcGIS Business Analyst (Shoag & Veuger 2018) + DnB/NETS database
- Yelp public-use dataset for high frequency nowcasting

### Census data
- IPUMS-NHGIS extracts from decennial Census and ACS on neighborhood demographics
- State and local govt. finance data (ASSLGF + STC)
## Tabulations: D.C. tax lien sales by buyer and area type

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<td>574</td>
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<td>Institutional + non-gentrifying</td>
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<td><strong>Total</strong></td>
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<td><strong>5,936</strong></td>
<td><strong>4,655</strong></td>
<td><strong>17,640</strong></td>
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**Source:** D.C. Office of Tax & Revenue Buyer's Books (2005-2019). Tabulations exclude sales to non-profit buyers, or 4.2% of the sample (779 liens).
Method #1: “Naive” differences in ring means

- Around each tax sale event, draw three rings and compute avg. price for properties within radius $r$ miles: $R^{in}(r \leq 0.1)$, $R^{mid}(0.1 < r \leq 0.5)$, $R^{out}(0.5 < r \leq 1)$

- Then two sets of treatment effects by year:

  \[
  \text{Inner treatment}(T) = (R^{in}_{\ell,T} - R^{out}_{\ell,T}) - (R^{in}_{\ell,-1} - R^{out}_{\ell,-1}) \quad (3)
  \]

  \[
  \text{Middle treatment}(T) = (R^{mid}_{\ell,T} - R^{out}_{\ell,T}) - (R^{mid}_{\ell,-1} - R^{out}_{\ell,-1}) \quad (4)
  \]

  - Differences between rings in $T$ are relative to one year before the tax sale event in $T = 0$
  - Bin estimates at $t = -5$ and $t = +10$ to separate dynamic effects from secular time trends

- Importantly, this method only takes out the year FE$s$, but not local time trends
- Prices pre-trend up (down) in (non-)gentrifying areas

- True for both middle and inner ring estimates

- Similar result if split rings by initial assessed value

- In gentrifying areas, inner ring estimates (+) drop off after around 0.5 mi.
  - No gradient w.r.t. distance in non-gentrifying areas (−)
- Split middle rings by quartile of tax assessed value as of year prior to sample

- Tax assessed value from Zillow ZTRAX (CoreLogic doesn’t go back that far)

- Similar trends to ring estimates split by gentrifying vs. non-gentrifying

- Additional evidence that tract type model based on flows picks up prices (revealed preference)
Notes: Each estimate compares average prices of homes sold in the inner ring within 0.1 miles of a tax sale property relative to an outer ring of properties 0.5 to 1 miles away, and pre vs. post-tax sale event. Unit prices winsorized at the 1st and 99th percentiles. 95% confidence intervals obtained via 1,000 block bootstrap iterations at the tax sale ring level.
Starting with $N = 18,419$ D.C. tax lien sales, merge to CoreLogic and track subsequent title transfers beyond the 6 month redemption period:

- 8,693 of which have title changes after the redemption date
- 5,448 exchanged in arms-length transactions
- 2,146 transferred to institutional owner (event definition)
- Overall, only 14 exchanges to the mortgage lender

Similar proportions if exclude repeat delinquencies, or use auction date as event cutoff:

- 868 transfers to institutional owners out of 4,368 title changes
- Repeat delinquencies are a way for LLCs to retain the corporate veil

Foreclosure rate conditional on tax lien sale is $868/8,693 \approx 10\%$
**Heterogeneity by neighborhood type (individual buyers)**

- **A.** Sales in previously gentrifying tracts
- **B.** Sales in previously non-gentrifying tracts
- **C.** Sales in recently gentrifying tracts
- **D.** Sales in recently non-gentrifying tracts

- **Similar effects in gentrifying areas for individual buyers**

- **Placebo:** re-estimate pop. flows model to identify *ex ante* vs. *ex post* gentrification
  - *ex ante:* 1990 – 2005
  - *ex post:* 2005 – 2019

- **Insignificant, non-monotonic responses in Panels A/B**
  - investors not just amplifying pre-existing trends

- **Non-monotonic responses in non-gentrifying areas, but no statistical significance**
### Pricing Effects of Tax Sales on Nearby Properties in Recently Gentrifying Tracts

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<th>Distance (mi.)</th>
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### Pricing Effects of Tax Sales on Nearby Properties in Recently Non-gentrifying Tracts

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Pricing Effects of Tax Sales on Nearby Properties in Previously Gentrifying Tracts

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Method #3: Implementation of the ED method

- House prices around tax sale property $S$ follow:

$$\log(p_{i,t}) = m_S(d_i, \tau_i) + \phi_S(d_i, \theta_i) + \gamma_S(\theta_i, t_i) + \varepsilon_{i,t} \quad (5)$$

- $i$ relates to $S$ in polar coordinate plane $(d, \theta)$
- $\tau_i$ number of years since the tax sale transfer
- $\phi_S(\cdot)$ and $\gamma_S(\cdot)$ allow house prices to vary across locations and trend differently across time in multiple directions
- $m_S(\cdot)$ is the two-dimensional empirical derivative of interest

- Find partial derivative of $p_{i,t}$ w.r.t. $d$, holding $\theta_i$ and $t_i$ fixed, by computing:

$$\frac{\log(p_{d-\delta,\theta,t}) - \log p_{d+\delta,\theta,t}}{2\delta}, \text{ for } \delta > 0$$

- Iteratively compare properties $d - \delta$ and $d + \delta$ from $S$ to difference out the local effects (take a bunch of diff-in-diff pairs)
The empirical derivatives estimator is semi-parametric in that researchers must still choose six tuning parameters:

- \( h_{r,n} \): smoothing in distance (miles)
- \( h_{t,n} \): smoothing in time (years)
- \( g_t^n \): bowtie search area width in time
- \( g_\theta^n \): bowtie search area width in polar distance
- \( k_n \): max # of house price pairs included in bowtie
- \( r \): ring radius within which to trace out the derivative

Compared to two other papers using this method, I use smaller \( r \) and \( h_{r,n} \):

- Tax sales more numerous and geographically clustered
- Results largely robust to choices of tuning parameters
## Alternative Tuning Parameters for Empirical Derivatives Estimator

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<td>3 years</td>
<td>3 years</td>
<td>1.5 years</td>
</tr>
<tr>
<td><strong>Bowtie dimensions</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$g_{n}^{f}$ (width in years)</td>
<td>1.6 years</td>
<td>1.6 years</td>
<td>1.6 years</td>
<td>1.6 years</td>
<td>1.6 years</td>
<td>1.6 years</td>
</tr>
<tr>
<td>$g_{n}^{\theta}$ (width in polar distance)</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Sample selection</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\kappa_{n}$ (# price pairs)</td>
<td>5 pairs</td>
<td>5 pairs</td>
<td>5 pairs</td>
<td>8 pairs</td>
<td>5 pairs</td>
<td>5 pairs</td>
</tr>
<tr>
<td>$\ell_{n}$ (excluded zone)</td>
<td>0.01 mi.</td>
<td>0.01 mi.</td>
<td>0.01 mi.</td>
<td>0.01 mi.</td>
<td>0.01 mi.</td>
<td>0.01 mi.</td>
</tr>
<tr>
<td>$r$ (ring radius)</td>
<td>1.5 mi.</td>
<td>1 mi.</td>
<td>0.5 mi.</td>
<td>0.5 mi.</td>
<td>0.5 mi.</td>
<td>0.33 mi.</td>
</tr>
</tbody>
</table>

**Notes:** Column (I) corresponds to the set of parameters used in Diamond & McQuade (2019). Column (VI) corresponds to the parameters used in Ganduri & Maturana (2022). I use the set of parameters in column (III) in establishing my main results.
Price surface w.r.t. tuning parameter sets (non-gentrifying)
Imputing homeowners’ racial identities

- Use \texttt{wru} R package developed by Imai & Khanna [IK] (2016)
  - Infer racial category $R$ using location $\ell$ and surname $S$ in Census surname list

- Then estimate $\tilde{p} \equiv \Pr(R_i = R | L_i = \ell, S_i = S)$ via Bayes’s rule
  - Assumes location and surname statistically independent conditional on race, or $L_i \perp \perp S_i | R_i$

- Try three definitions of racial category probability
  1. Set $URM = 1$ if $\tilde{p} > 0.5$ for Black or Hispanic
  2. Set $URM = 1$ if highest probability race is Black or Hispanic (exactly follows IK)
  3. Continuous Bayesian probability that race is either Black or Hispanic

High correlation with L2 voter registration data at block group level
Robustness of racial classification to probability cutoff

Race of CoreLogic tax homeowners by wru package

Race of DC tax lien homeowners by wru package

- "Other" includes surnames with majority Native American, multi-racial respondents, and any rare surnames not in the Census surname list
Similar story for continuous URM buyer prob. measure...

-3 Years Since Sale

-2 Years Since Sale

-1 Years Since Sale

1 Years Since Sale

2 Years Since Sale

3 Years Since Sale

4 Years Since Sale

5 Years Since Sale

Prob. URM Buyer

Miles to Property

estimated $\beta_d$

95% confidence interval

Miles to Property
No (-) effect on URM buyer dummy for ind. tax liens

Miles to Property

- estimated $\beta_d$
- 95% confidence interval
Weaker effect on URM buyer prob. for ind. tax liens

Prob. URM Buyer

Miles to Property

-3 Years Since Sale
-2 Years Since Sale
-1 Years Since Sale
1 Years Since Sale
2 Years Since Sale
3 Years Since Sale
4 Years Since Sale
5 Years Since Sale

Miles to Property

○ estimated $\beta_d$  
--- 95% confidence interval
Big drop in URM seller prob. as well, but some pre-trend
No (−) effect on URM seller dummy for ind. tax liens

Miles to Property

• estimated $\beta_d$  
→ 95% confidence interval
Also not much effect on URM seller prob. for ind. tax liens

Miles to Property

- estimated $\beta_d$
- 95% confidence interval
Two-Stage Gentrification Model
What is gentrification?

- Deep question debated in sociology since the 1980s

- Two main strands of sociological models taken to data:
  1. **“Stage” models** (Marcuse 1985, 1986): layered sort of geographic areas into four categories
     - Abandonment, gentrification, growth, low income concentration
  2. Risk aversion models (Gale 1979; Kerstein 1990): persistence of gentrification depends on migrants’ risk attitudes towards amenity preservation
What is gentrification?

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- Contrast to the urban economics literature which tries to model within-metro sorting through utility maximization problems
  - Brueckner & Rosenthal (2009); Guerrieri, Hartley, Hurst (2013); Lee & Lin (2018); Couture & Handbury (2019); Murphy (2021); Su (2022)
  - Econ state variables often used as factor sorts in the sociological stage models
Generalization of stage model adopted by UMN Institute on Metropolitan Opportunity
- I generalize and apply the model to all U.S. Census tracts over 1990–2005 and 2005-2019

Intuition for each sorting stage:
1. **1st stage**: sort areas based on strength of local economy (i.e. in-migration)
2. **2nd stage**: further sort based on ability to accommodate low-income pop. growth

High/low income population shares form a **sufficient statistic** for local economic performance as in standard $V = Z \cdot W/P^\beta$ sorting condition
- Few assumptions, but results consistent with more complicated sorts (e.g. housing prices)

Use of thresholds reminiscent of Schelling’s (1971, 1978) **tipping point** theory
Model completely governed by three threshold parameters

- Model characterized by a vector $\mathbf{x} := \{x_1, x_2, x_3\}$
  - $x_1$ [1st stage]: % change in non-low-income residents
  - $x_2$ [1st stage]: p.p. change in low-income population share
  - $x_3$ [2nd stage]: % change in low-income residents

- Robustness: check how maps change as I iterate over values in $\mathbf{x}$
  - Baseline: select $x_1, x_2$ to match avg. tipping points observed within metro area
  - Exercise complements race-based RD-style tests in Bayer, Fang, & McMillan (2014)

- Examine neighborhood “persistence” under two definitions:
  - Type persistence: prob. tract type is exactly the same in subperiod $t$ and $t + 1$
  - Gentrification persistence: correlation of dummy for weak/strong gentrifying (under $\mathbf{x}$ vs. $\overline{\mathbf{x}}$) between $t$ and $t + 1 \rightarrow \text{corr} \approx 0 \implies$ long-run steady state
### Transition Matrix: Gentrification Rarely Followed by Reversals

<table>
<thead>
<tr>
<th></th>
<th>Abandonment</th>
<th>Gentrification</th>
<th>Growth</th>
<th>LI Concentration</th>
<th>Unclassified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abandonment</td>
<td>0.47%</td>
<td>0.58%</td>
<td>0.15%</td>
<td>0.13%</td>
<td>2.02%</td>
</tr>
<tr>
<td>Gentrification</td>
<td>0.37%</td>
<td>2.33%</td>
<td>0.75%</td>
<td>1.46%</td>
<td>4.48%</td>
</tr>
<tr>
<td>Growth</td>
<td>0.17%</td>
<td>0.79%</td>
<td>0.64%</td>
<td>0.54%</td>
<td>2.51%</td>
</tr>
<tr>
<td>LI Concentration</td>
<td>0.53%</td>
<td>1.52%</td>
<td>0.033%</td>
<td>6.95%</td>
<td>6.45%</td>
</tr>
<tr>
<td>Unclassified</td>
<td>1.59%</td>
<td>9.69%</td>
<td>3.43%</td>
<td>14.18%</td>
<td>36.76%</td>
</tr>
</tbody>
</table>

**Notes:** Rows indicate the initial tract type in 1990-2005, while columns indicate the more recent tract type in 2005-2019.

- 1/4 of initially *gentrifying* continue to gentrify, while 48% reach the steady state represented by *unclassified*.
- Only 19% of *gentrifying* tracts reverse course to become *abandoned* or *LIC*. 

Convert variable $X_{j,t}$ between 2000 tract $j$ and 2010 tract $k$ via:

$$X_{k,t} = \sum_{j \subseteq k} \omega_j \cdot X_{j,t}$$

$$\omega_j = \frac{\text{2010 population of overlap}}{\text{2010 population of the 2000 tract}}$$

Map 1990 tracts to 2010 using similar procedure: first reweight from 1990 to 2000 geography, then reweight to go from 2000 to 2010

Can also aggregate from block group level but more missing values
At state level, gentrification persistent over 30-year period

Gentrifying tract fraction (2005−2019)

Gentrifying tract fraction (1990−2005)

$\rho = 0.78$

Cameron LaPoint (Yale SOM)
Using "strong" cutoff parameters \( \{x_1, x_2, x_3\} = \{10\%, 5\text{p.p.}, 0\%\} \), where unclassified means demographic change is sufficiently minimal.
Using “weak” cutoff parameters \( \{x_1, x_2, x_3\} = \{5\%, 2.5\text{p.p., }0\%\} \) and lumping weak and strong types together.
• Tract type probabilities all decreasing with respect to $x_1$ and $x_2$ first stage thresholds
  ▶ More stringent definition of neighborhood change $\Rightarrow$ more tracts unclassified

• Abandonment/gentrification move in opposite direction of LIC/growth w.r.t. $x_3$ since former are about low-income population population decline

• In practice, pick parameters to match tipping points observed for each metro area
Long-run Gentrification Persistence by State

Gentrification persistence between 1990−2005 and 2005−2019