Using Linked Administrative Data to Profile a City's Rental Stock and Landlords and Guide a Lead-Safe Housing Initiative

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Abstract

By the time they enter kindergarten, an estimated 25 percent of Cleveland, Ohio, children have at least one test showing an elevated blood lead level, and to address this high rate of lead exposure at its source, the city committed to a lead-safe housing strategy. Most families with young children rent homes in the private rental market, making these properties and their owners key elements in moving forward on a lead-safe agenda. This article describes how parcel data, property tax rolls, deed and foreclosure records, housing code violations, rental registry information, building permits, evictions, and Housing Choice Voucher program records were used to evaluate lead risk in the rental housing stock and develop a typology of landlords. Deterministic and probabilistic methods were used to link the property data sources, resulting in the identification of 103,386 rental units, 54,786 rental properties, and 36,659 landlords for the analysis. More than one-third of the rental properties were found to be at high risk of failing to meet lead safety standards. A latent class analysis uncovered three classes of landlords, characterized as having different capabilities to comply with the lead safety ordinance. Small, under-resourced landlords who would likely require the highest level of support from the lead safety coalition owned approximately 25 percent of the rental properties. This study guided the lead-safe Cleveland strategy and is being updated to evaluate progress toward reducing lead hazards in rental housing.

Introduction

Prevention of lead exposure in young children requires action at the intersection of the health, housing, and regulatory systems. In older cities, much of the affordable housing stock carries a significant risk of lead exposure due to its age, deferred maintenance, and low market value (Shaw, 2004). Moreover, less than one-fourth of low-income families nationally live in public or subsidized housing units (Kingsley, 2017), but families with young children seeking housing in the low-cost private rental market face limited choices and leverage when it comes to their selection of housing units, and many families have difficulty finding affordable rental housing. African-American children are disproportionately exposed to lead in their homes, in large part due to historical patterns of redlining and discriminatory housing policy (Rothstein, 2017; Sampson and Winter, 2016). Prolonged disinvestment and lack of maintenance in the affordable housing stock are key factors contributing to persistent racial and socioeconomic disparities in lead exposure among young children.

The challenges of bringing privately owned rental housing up to health and safety standards are considerable. In older industrial cities, small buildings owned by individual rather than corporate landlords tend to dominate the affordable rental market. Families with children often seek out this individually owned segment of the rental market due to the preponderance of single- and two-family structures. Although little is known about the rental inventory and business practices of small landlords, several studies attest to the significant size of this sector and to its continued growth (Messamore, 2023). Other research suggests that personal perceptions and social networks often uniquely influence small landlords in the choices they make with respect to their properties and tenants (Garboden and Newman, 2012; Gomory, 2022; Greif, 2018; Shiffer-Sebba, 2020).

Bringing rental housing up to lead-safe standards was an important objective when leaders in Cleveland, Ohio, established a comprehensive approach to protecting children from lead exposure in their homes (City of Cleveland, 2019; Lead Safe Cleveland Coalition, 2023). Longitudinal research demonstrated the costly long-term effects of lead exposure on Cleveland children in the form of substantially higher involvement in public systems and lower educational attainment later in life compared with their peers (Coulton et al., 2023). Studies elsewhere confirmed that lead dust in the residential environment was the primary source of elevated blood lead levels in children, and the risk of exposure was greatest in low-quality rental housing (Lanphear, Hornung, and Ho, 2005). Lead exposure rates among children in Cleveland have been high for many years, and those rates were highest in neighborhoods where housing has been vacant or subject to disinvestment (Fischer, Steh, and Chan, 2018). However, little systematic information existed about the inventory and segmentation of the local rental market or the business models of the landlords in this space. Because these properties and their owners were key elements for achieving the goal of lead-safe housing in Cleveland, information on this sector was essential to guide the strategies for bringing rental housing up to lead-safe standards and ultimately eliminating the risk of lead exposure in children.

This article describes how multiple administrative data sources were organized, cleaned, and linked to characterize two units of analysis: Cleveland rental properties built before 1978 and their landlords. It reports on the resulting inventory and segmentation of the local rental market and the

business models of the landlords in this space and demonstrates that, when such local data sources are combined, they have the potential to inform cross-sector initiatives, such as the one undertaken in Cleveland, to achieve lead safety for children. Drawing on these findings, this article discusses the value of such information and the strengths and limitations of such data and methods.

Methods

Prior to implementing the lead-safe housing initiative in Cleveland, it was important to gain a comprehensive understanding of rental housing and the ownership patterns of rental units. Such information was essential to establishing realistic plans for implementation, including estimating the resources needed for inspections and repairs and establishing processes for engaging landlords and community partners in the program. However, the data that were needed to profile rental properties and landlords along the many dimensions relevant to lead safety were not available from any one source. Instead, the data were spread across several agencies, each with its own record systems supporting its own administrative responsibilities.

Study Area

This article focuses on rental housing in the city of Cleveland, the principal city within Cuyahoga County, Ohio. Cleveland has a strong cultural and industrial history, and like similar metropolitan areas, deindustrialization and population loss have taken a toll. Embedded within a large metropolitan area on Lake Erie, it occupies 77 square miles of land area. The population estimate for Cleveland in 2021 was 368,006, down from a peak population in 1950 of 914,808. The relative age of Cleveland's housing stock and the limited income of residents are contributors to the prevalence of lead risk in the rental housing stock. In 2021, the poverty rate in Cleveland was estimated at 29.3 percent, and the median household income was $35,562 (U.S. Census Bureau, 2021a). Much of the housing stock predates the 1978 laws prohibiting lead-based paint, with 59.1 percent of units built before 1950 and 88.8 percent built before 1980, according to the 2021 American Community Survey (U.S. Census Bureau, 2021b). Rental housing predominates in the city, with 60.9 percent of occupied units being rentals.

Data Sources and Preparation

This study focuses on privately owned rental housing in Cleveland that, by being built before 1978 when lead paint was outlawed, presents a potential risk for lead exposure. It also looks at the owners of rental properties in Cleveland to determine the locations and characteristics of their holdings. This article presents two units of analysis. First, it focuses on the universe of properties known or suspected to be active in the Cleveland rental market in 2018. The process for identifying rental properties relied on clues found in administrative records and is discussed in the following sections. After identifying these rental properties in Cleveland, this article turns to their owners as a second unit of analysis.

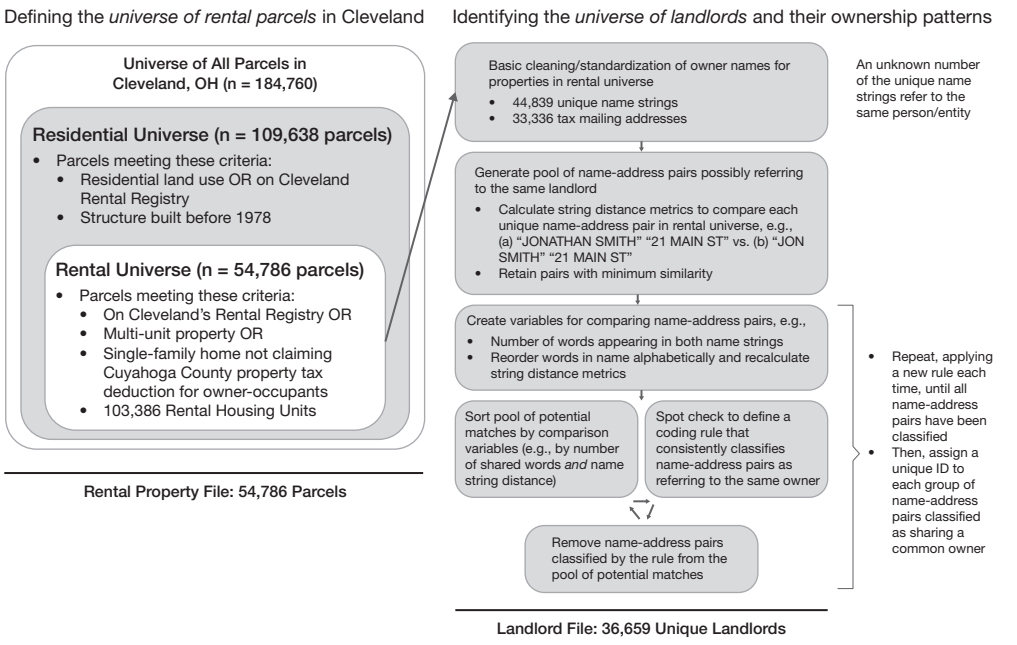
This research uses a variety of public records to identify the Cleveland rental properties and describe their physical and market conditions. To optimize the coverage and accuracy of this research, the research team undertook an elaborate process of acquiring public records, learning

about their content, linking them together by property and owner identifiers, and evaluating data quality. Some records came from Cleveland municipal agencies, and others came from the county government or specialized district agencies. For example, the team relied on rental registration records from the City of Cleveland and property characteristics data from the Cuyahoga County Fiscal Office to identify the full universe of rental properties in Cleveland.

The main data source was the Cuyahoga County Fiscal Office Master Annual Property File, which includes detailed information about every parcel in Cleveland, including property characteristics, conditions, values, ownership, foreclosures, and tax delinquency. In addition, the Cleveland Department of Building and Housing supplied rental registration and code violation information, the Cuyahoga Metropolitan Housing Authority supplied Housing Choice Voucher (HCV) program data, the U.S. Postal Service supplied Postal Vacancy records, the Cuyahoga County Land Bank supplied records on demolition used to refine the rental universe, and the Cleveland Housing Court supplied eviction filings data. The following sections discuss the integration of these varied pieces of information to create two files that contain the variables needed for the analysis. Exhibit 1 provides a visual representation of the processes for reshaping this integrated dataset into two analysis datasets: one organized at the property level for investigating the rental market and the other organized at the landlord level to analyze ownership patterns.

Exhibit 1

Steps in Building Rental Property and Linked Landlord Data Sets



Sources: Cuyahoga County Fiscal Office; City of Cleveland Department of Building and Housing

Rental Property File

The research team began by building a file that included every residential parcel in the city of Cleveland during the 3-year period from 2016 to 2018. The team standardized the addresses associated with the parcels so they could be linked to other data sources based on the address and geocoded for mapping or other geographic linkages. For each parcel, the team imported owner names, tax mailing addresses, owner occupancy tax credit status, property characteristics, assessed market values, recent sales prices, foreclosure and tax histories, housing code violations, building permits, building condition ratings, rental registry dates (if any), postal vacancy spells, eviction filings, and whether HCVs had been used. Because most of this information was time-dependent, the team specified whether the record referred to a particular time point or reflected an event occurring within a given period (for example, a code violation in the previous 3 years).

To identify properties that were likely to be rentals, the team used multiple criteria. A residential property was considered for inclusion in the rental universe if (1) it was in the City of Cleveland's rental registry in 2018,[1] (2) the property owner did not claim the owner occupancy tax credit in 2018, or (3) property records indicated that the parcel contained more than one housing unit. The exception to this rule was that if the owner of a two- or three-unit property claimed an owner occupancy tax credit, it was assumed that the property owner occupied one of the units. From this pool of potential rentals, the team then excluded properties for the following disqualifying reasons: a demolition in 2018, Cuyahoga Land Bank ownership, state forfeiture, or long-term vacancy reported in postal records. The team further restricted the file to properties built before 1978 (the year lead paint was outlawed) and excluded public housing authority-owned properties, arriving at a final rental universe of 54,786 properties corresponding to 103,386 rental units.

Landlord File

The focus here was on creating a database with information on the private owners of rental properties. Creating such a database is not a straightforward process, given that local administrative data sources with relevant information about landlords are typically organized around parcels or addresses rather than landlords. Creating a database of landlords necessitated reshaping the parcel-level property file into a landlord-level file consisting of a single record for every unique landlord in Cleveland, with information about the numbers, locations, and characteristics of their properties. The two pieces of information available for constructing the landlord-level database were the names and tax mailing addresses for the owners of all likely rental properties recorded in the Cuyahoga County Fiscal Office tax billing file. Before carrying out this process, it was necessary to clean and standardize the names and addresses.[2]

Once cleaned, the research team undertook a multistep process to uncover the patterns of property ownership, even if the owner names varied somewhat. The first step in the process was to compare

[1] Although Cleveland had a rental registry in 2018, many landlords did not register. Thus, this analysis used additional indicators to identify rental properties.

[2] Examples of the cleaning and standardization procedures include making all text uppercase, removing inconsistently used words (for example, street suffixes, which may be spelled out as "STREET," abbreviated as "ST," or absent) and punctuations (for example, removing the period in "JR."), and applying consistent naming conventions (for example, changing "WEST 25TH" to "W 25" or "TRS" to "TRUSTEES").

the owner's name and tax mailing address of every parcel in the rental universe with the names and addresses of every other rental parcel. The team used string distance metrics from the *R* package *stringdist* to flag cases with at least a superficial similarity between the comparison of owner names or addresses of the two parcels, generating an initial pool of potentially matching parcel pairs to investigate more closely to determine common ownership (van der Loo, 2014).

The team then created many additional helper variables to better assess the degree and nature of the similarities between each pair of owners. Some examples of these helper variables include the number of words appearing in both owner names, the uniqueness of any shared words, the number of initials in common, the string distance between each name after removing any small one- to two-character words from the name strings, and the string distance after first sorting the words in each name string alphabetically (for example, "SMITH, JOHN JR" would be alphabetized as "JOHN JR SMITH").

An iterative process to classify each pair of parcels as a match (that is, owned by the same person or entity) or a nonmatch followed this step. First, the team sorted the pool of potential matches by one or more helper variables and then examined the names and addresses at the top and bottom of the sorted data. If the researchers found the pairs of owner names at either end of the sorted data to be consistently matching or nonmatching, they continued to scan up or down until arriving at a point where the pattern broke down, and matches, nonmatches, and unclear cases began intermixing. At this breakpoint, the team used the values of the helper variables on which the data were sorted to define a new condition in the code for classifying pairs of owners as matches or nonmatches. The researchers completed each iteration by filtering the pool of potential matches by the new condition, leaving behind only the still-unclassified pairs of parcels. They then began a new iteration on the remaining cases, sorting on a new combination of helper variables and repeating the process until all pairs of parcels were classified. After classifying the entire pool of potential matches, the researchers retained the pairs of parcels determined to share a common owner and attached an owner identification to all their properties.

This process allowed the research team to compute variables reflecting landlord characteristics by grouping all an individual's properties and using the information available in the property file described previously. Owners were classified as "persons" if their property deeds contained names of individuals or as "corporate" if their deeds had company or organizational names. They were also classified as being in the local area (defined as Cuyahoga County) or out of town. Similarly, for each landlord, the team computed the number and types of properties and units owned, the average condition ratings and market values of their properties, markers of financial vulnerability (for example, tax delinquencies and foreclosure sales), and participation in the rental registry or HCV program.

These steps resulted in a landlord data file comprising a deduplicated list of 36,659 owners along with summary measures reflecting their rental properties in 2018. However, it is important to note that the research team probably missed some duplicates. If an individual owned properties under the names of several limited liability companies (LLCs) or used various unrelated owner names and addresses, the team's deduplication algorithms may have missed these matches. However, investigating interlocking ownership of businesses or personal relationships not evident in the titling of the property was beyond the scope of this study.

Data Analysis

Data analysis proceeded in two phases. First, the research team explored the characteristics of rental properties and landlords through descriptive statistics, focusing on characteristics that had implications for designing the lead-safe strategy for Cleveland. These characteristics included markers of distressed housing conditions, low property values, limited landlord capacity and connectedness to systems, and business structure. Counts and percentages were reported for the city as a whole and broken down by neighborhood to facilitate planning.

Second, the team employed latent class analysis (LCA) using the data science software Stata to identify classes of landlords based on the characteristics of their rental properties and the size of their portfolios (Stata Press, 2023). LCA is a statistical technique that classifies cases into a specified number of groups or types such that the similarities within types and differences between types are maximized. It should be noted that not all landlords within a classification group will be identical, nor will all the groups differ on every condition. LCA instead finds the distinctions that best account for the patterns in the descriptive information, which are then used to interpret the meaning of the typology.

Results

The analyses presented in this section focus on three domains: the rental property file of privately owned properties built before 1978 (n = 54,786), the rental units within these properties (n = 103,386), and the unique individuals or companies that owned these rental properties (n = 36,659).

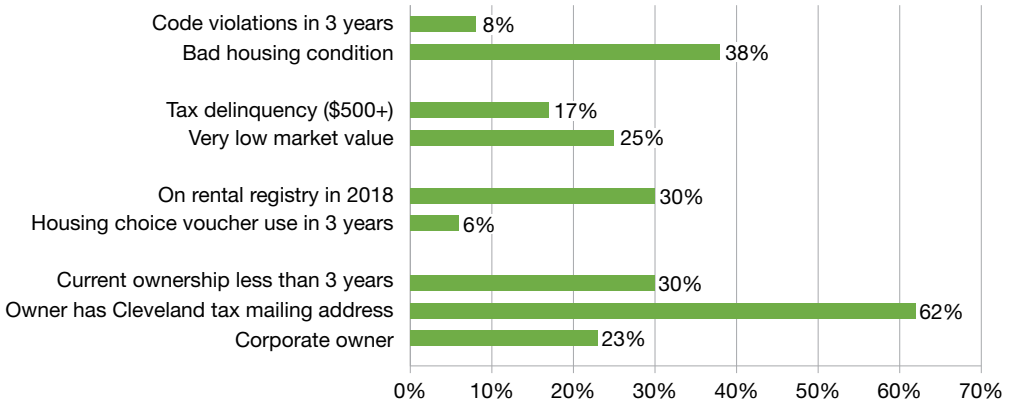
Description of the Rental Universe

This descriptive analysis reports on selected characteristics of rental properties expected to inform the implementation of lead-safe strategies in Cleveland. The analysis first focuses on building type, because detached units would require a different remediation strategy than large apartment buildings. During the study period (2018), single-family structures were prevalent in the rental universe, accounting for 42 percent of all rental units. Another 24 percent of rental units were two-family homes, 21 percent were small buildings (3–20 units), and 12 percent were large buildings (more than 20 units).

Second, many of the Cleveland rental properties showed signs of being distressed due to physical and market conditions. Such properties would likely require costly repairs but have little equity to support financing. As exhibit 2 shows, properties rated as being in bad condition made up 38 percent of the rental property universe, and approximately 8 percent of properties had an open housing code violation. Also, market conditions were unfavorable for many rental properties—roughly one-fourth had a very low assessed market value, defined as less than $25,000 for single and double homes and less than $10,000 per unit for three- or more unit buildings. Furthermore, 17 percent of rental properties were tax-delinquent by at least $500 in 2018, a possible indication of disinvestment.

Exhibit 2

Selected Characteristics of Pre-1978 Rental Properties in Cleveland, 2018 (n = 54,786)



Source: Property file built from multiple administrative data sources as described in exhibit 1

Third, during the study period, relatively few rental properties in Cleveland were connected to government housing programs. As exhibit 2 shows, only 30 percent were included in the rental registry, and 6 percent were taking HCVs. The owners and tenants of the disconnected properties, which make up most of Cleveland rental properties, may have little familiarity with local agencies and regulations, which may make it more challenging to engage them in complying with lead safety inspections and other requirements.

Finally, the location and stability of rental property ownership suggested the need for more than one engagement strategy. As exhibit 2 shows, rental properties turned over with some degree of frequency, with 30 percent having changed ownership within 3 years. However, most properties had the same owner for a longer period. Moreover, entities with addresses in Cleveland or Cuyahoga County suburbs owned 62 percent of rental properties, making personal contact related to lead-safe interventions possible. Most of the remaining owners had addresses outside Cuyahoga County but within Ohio, requiring other forms of contact. Corporate entities (that is, LLCs, limited partnerships, and other organizations or businesses) owned 23 percent of Cleveland rental properties, and 77 percent were titled in the name of individuals, suggesting the need for differentiated approaches to communicate with these individual owners not incorporated as businesses.

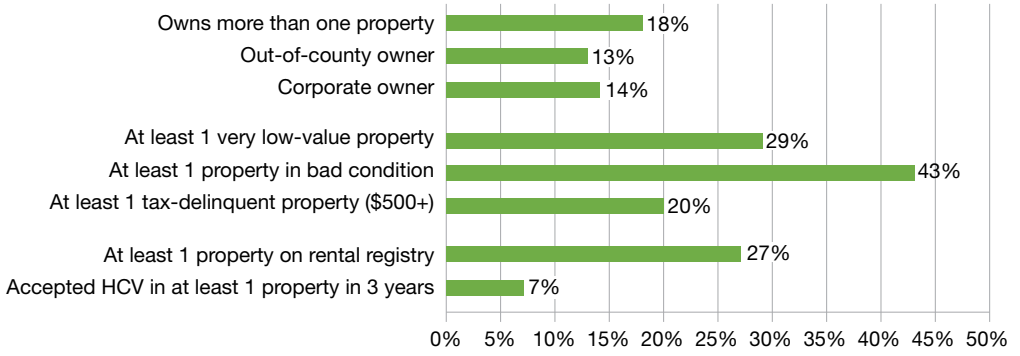
Selected Characteristics of Landlords

This section presents another way of looking at the Cleveland rental landscape by focusing on the property owners (exhibit 3). Most landlords owned only a single property in Cleveland, with only 18 percent owning two or more. It should be noted that, because the research team focused specifically on rental properties in Cleveland, landlord ownership of any rental properties outside the city is unknown and beyond the scope of this study. Most owners of Cleveland rental properties had a presence in the city or the surrounding Cuyahoga County area based on the location of their tax mailing address. Corporate entities accounted for 14 percent of these owners, and the other 86 percent of owners were classified as persons. A notable portion of landlords owned properties that

had markers of distress or disinvestment, including having at least one property that was in bad condition (43 percent), had very low assessed market value (29 percent), or was tax-delinquent (20 percent). Only a minority of owners had properties in the rental registry (27 percent) or rented to households with HCVs (7 percent).

Exhibit 3

Selected Characteristics of Study Landlords in 2018 (n = 36,659)



HCV = housing choice voucher.

Source: Landlord file built from multiple administrative data sources as described in exhibit 1

To segment the landlord population in a way that could inform local strategy, the research team undertook an LCA of landlord characteristics using Stata's *gsem* command, latent class function, specifying three possible classes based on landlord characteristics (Stata Press, 2023). The number of landlord-held properties entered the model as an ordinal variable with an ordered logit specification. Other variables related to corporate status, share of properties in bad condition, of low value, and with violations and tax delinquency entered the model with a logit specification. Model fit indices—Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) — favored the three-class model (AIC: 263,752; BIC: 263,999) over two-class (AIC: 267,588; BIC: 267,750) or one-class models (AIC: 283,142; BIC: 283,219). Estimates for a four-class model did not converge.

The results of the LCA suggest that landlords can be divided into three classes (exhibits 4 and 5). *Class 1* comprised 60 percent of landlords. However, these landlords accounted for only 44 percent of the properties and 45 percent of the rental units. Nearly all *Class 1* landlords (92 percent) owned only a single property in Cleveland, and slightly more than one-half of their properties were single-family homes. Their properties were generally rated as being in above-average or good condition, with few code violations or instances of tax delinquency. Their properties were seldom classified as being of very low value. Only 24 percent of these landlords were in the rental registry, and very few had tenants with HCVs.

Exhibit 4

Landlord Latent Classes: Prevalence and Counts of Properties and Units

	Class 1		Class 2		Class 3		Total	
	n	%	n	%	n	%	n	%
Landlords	21,788	60	11,083	30	3,788	10	36,659	100
Properties	24,328	44	12,197	22	18,261	33	54,786	100
Units	46,902	45	25,705	25	30,779	30	103,386	100

Note: Unique landlords used for latent class analysis, and they might have multiple properties and units.
Source: Landlord file built from multiple administrative data sources as described in exhibit 1

Exhibit 5

Descriptive Characteristics of Landlords by Latent Classes (%)

	Class 1 (n = 21,788)	Class 2 (n = 11,083)	Class 3 (n = 3,788)
At least one property:	%	%	%
in bad condition	7	96	93
with very low market value	8	58	66
with code violations in 3 years	5	13	34
with delinquent tax balance > $500	9	37	34
on rental registry	24	19	70
that accepted HCVs in 3 years	5	4	26
Number of properties owned	%	%	%
1	92	91	0
2	6	7	34
3 or 4	2	1	35
5 or more	0	0	30
All properties owned 3 years or less	27	23	22
Owns only single-family homes	54	26	25
Owner based outside Cuyahoga County	13	11	20
Corporate owner	12	11	36

HCVs = housing choice vouchers.
Source: Landlord file built from multiple administrative data sources as described in exhibit 1

Class 2 accounted for 30 percent of landlords, controlling 22 percent of the rental properties and 25 percent of the rental units. Nearly all (92 percent) had only one property in Cleveland. They tended to own fewer single-family homes than *Class 1* landlords and, instead, owned mostly two-family homes or buildings with three to four units. Nearly all the properties of *Class 2* landlords were in bad condition, more than one-half had very low market values, and more than one-third were tax-delinquent. Few corporate owners were in this class, and owner participation in the rental registry or HCV program was low.

Class 3 landlords comprised 10 percent of rental property owners but represented 33 percent of the rental properties and 30 percent of the rental units in Cleveland. These landlords were more likely to be corporate owners compared with the other classes and tended to own numerous properties

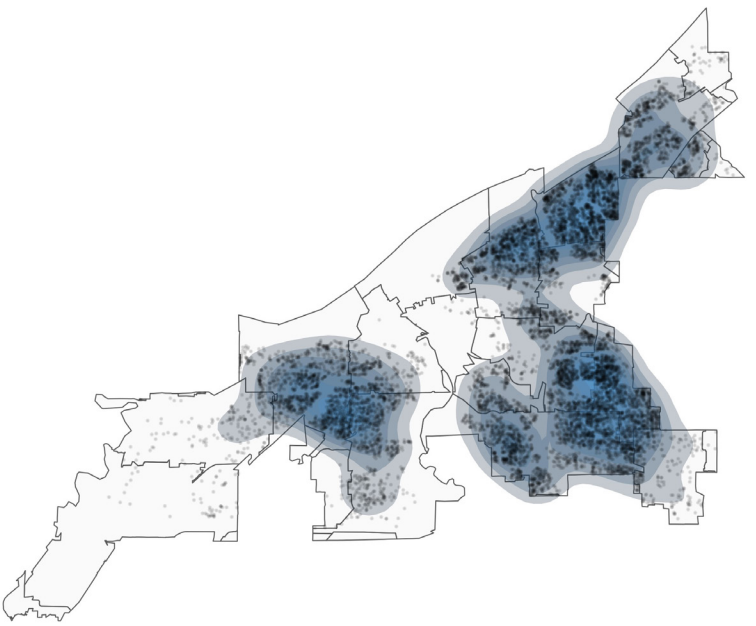
and included larger buildings in their portfolios. Most of these landlords (93 percent) had at least one property rated as being in bad condition, and 34 percent had at least one property with code violations or tax delinquency. The owners in this class were the most likely to include corporate entities and be based outside the county. Compared with the other classes, they had high levels of participation in the rental registry (70 percent) and HCV program (26 percent).

A Neighborhood Perspective

Thus far, the focus of this analysis has been on properties and landlords in the entire Cleveland rental market. However, as the lead-safe initiative is being rolled out geographically, it was strategically important to anticipate how the rental property conditions and mix of landlords differed by neighborhood. To illustrate this neighborhood variation, the exhibit 6 map shows the concentration of *Class 2* landlords (black dots) as revealed through LCA compared with the concentration of distressed rental properties (density curves) and other properties. These types of properties and landlords are likely to require more attention and assistance to achieve compliance with the lead-safe ordinance. Thus, the areas with the highest concentrations of points and at the center of the density curves are areas that will require additional resources and effort to bring the rental housing up to lead-safe standards. The concentration of high need overlaps considerably with areas that were historically redlined and hard hit by subprime lending and foreclosure during the previous decade (Perzynski et al., 2022). This pattern points to the ongoing effect of systemic racism in the housing market and its pernicious ongoing effects on the health of African-American children.

Exhibit 6

Spatial Concentration of Selected Property and Landlords Characteristics



Notes: Density curves are rental properties in bad condition or less than $25,000 assessed market value, or both. Points are Class 2 landlord-owned properties.
Source: Landlord file and property file built from multiple administrative data sources as described in exhibit 1

Discussion

The three classes of landlords identified in this study are likely to respond differently to the requirements of Cleveland's lead-safe ordinance or need customized resources to assist them in coming into compliance. Access to capital, likely return on investment in repairs, scale of operation, and managerial capacity are relevant variations among the landlord types that can inform the planning for lead-safe implementation. For example, *Class 2* landlords face particular challenges because most of their properties are in poor condition and need repair, but low market values limit access to conventional home improvement loans. Also, as small owners, they are unlikely to be tapped into networks of suppliers and contractors or be able to achieve economies of scale for their property renovations. They will need access to various types of subsidized capital, such as grants and low-interest loans. Moreover, because *Class 2* landlords typically own only one property in Cleveland and have low participation in the rental registry, outreach will be required to engage them in the process and provide access to information and resources.

Class 3 landlords have the scale and size to overcome some of the limitations facing *Class 2* landlords. They also have more connections to regulatory processes and government programs, as evidenced by their higher participation in the rental registry and HCV program. Although they often have at least one property in poor condition or at low market value, having multiple properties suggests greater capitalization and likely connections to construction services and financing.

Class 1 landlords, the most prevalent type in Cleveland, generally hold single-family properties in good condition and with solid market value. This fact suggests that many of these properties will meet lead-safe standards or that the ratio of repair costs to property values will be favorable for conventional financing. However, because their current level of participation in the rental registry is low and their scale of operation is small, *Class 1* landlords will likely benefit from receiving information about the lead-safe ordinance, the rental registration process, and access to qualified contractors or other resources if repairs are required.

An important implication for lead safety is that a significant portion of the landlords holding distressed properties are individuals with small-scale operations rather than real estate companies or professional entities. Most of their properties are not yet in the rental registry, nor are these owners participating in public programs, such as HCV. The low property values and deteriorated conditions of many of their properties suggest these landlords will find it difficult to get conventional financing in the amount required to upgrade their properties. These small operators may require outreach, information, technical assistance, and other support to bring their properties into the rental registry, complete lead inspections, and upgrade them to lead safety standards. Moreover, they may need to avail themselves of subsidized capital, including grants and low-interest loans, to bring their properties up to lead safety standards.

The research team notes that this article has several limitations. Cleveland properties and landlords probably differ along several other dimensions that could not be ascertained from the administrative records used for this typology. Also, because compliance with the rental registry was low, the team relied on other indicators of the property being a rental, such as the owner-occupancy tax credit, number of units, and so forth. Some properties may have been misclassified.

In addition, the reliance on public records and owner names to link landlords to their properties probably overestimates the unique number of individual entities involved. As demonstrated in several studies, deduplication is especially problematic when owners of record operate under more than one company name (An et al., 2022; Hangen and O'Brien, 2022). Moreover, the classification of landlords is based on a limited set of characteristics derived from administrative records. For example, it was impossible to investigate other important aspects of their businesses, such as the size of their portfolios or professionalization. As the lead-safe initiative unfolds, it will be important to gather landlords' perceptions to gain a deeper understanding of the classification and its implications for lead-safe strategies across all areas of the city.

Conclusion

This analysis demonstrates how multiple administrative data sources—along with record linkage, spatial analysis, and statistical methods—can inform community planning and action on important concerns, such as lead safety in housing. It also illustrates that such data sources can be organized for two different units of analysis—rental properties and property owners—to yield insight into both. Furthermore, it shows how such an analysis can inform policy direction and be used to evaluate strategies for specific problems, constituencies, or locations.

The study identified the total of pre-1978 rental properties in Cleveland's housing market, approximately 100,000 units in 55,000 properties (owned by 36,000 landlords). Importantly, this total includes both registered rentals (those on the city's rental registry) and rentals operating outside the registry. From a policy perspective, lead risk must be reduced in both groups of properties to have an eventual effect on child lead exposures, especially given that non-registered rentals account for approximately 70 percent of the pre-1978 rental housing stock. This finding informed the scope of the Cleveland Lead Safe Initiative and its deployment by city area and has guided an understanding of compliance rates by neighborhood.

In addition, the study assessed both the conditions and owner characteristics of these rental properties. These data were essential in understanding the relative anticipated cost of bringing different types of properties up to lead-safe standards. The analysis identified the likely capacities of property owners to undertake property improvements based on the number and quality of their property holdings. This information was instructive in fashioning outreach strategies to owners and developing financial and other supports to facilitate the achievement of lead safety in their properties. Identifying a population of owners with limited holdings of higher risk properties ensured the strategy offered deeper supports for these owners. As the initiative has implemented its loan and grant offerings, adjustments have been made to the application process and maximum award amounts based on learning from direct experience with properties.

Beyond the trends and patterns this analysis illuminated, the rental property and landlord data continue to inform ongoing program decisions and monitoring related to lead safety. The data sources are updated quarterly and used to populate a public-facing dashboard that allows community partners to monitor the initiative and surface challenges as they emerge. The monitoring data show that compliance rates are much higher among known rental properties compared with probable rentals, suggesting the challenges in outreach to owners who have not

previously complied with the city's rental registration requirement. Greater compliance is also evident among properties with larger numbers of units. Low compliance among properties that are singles and doubles has been highlighted as a specific challenge because these properties account for most units in Cleveland's pre-1978 rental housing stock.

Single- and two-family homes owned by individuals based in the region—whether within the city or in the surrounding Cuyahoga County suburbs—dominate the rental housing stock in Cleveland. This preponderance of detached and individually owned rental housing units suggests that the lead-safe initiative will require the ability to customize inspections and repairs to this mix of properties. Although most of Cleveland's rental properties are maintained in above-average or good condition and have solid market value, many properties are unlikely to meet lead safety standards. Monitoring the repair of single- and two-family homes scattered on a case-by-case basis takes a different kind of capacity in city government than tackling code compliance in larger rental properties.

Because the lead-safe initiative is still in its early phase, the focus continues to be on monitoring compliance with rental registry and lead-safe certification requirements, especially in the neighborhoods with a concentration of properties and landlords that present the greatest risk due to poor housing conditions and limited capacity to invest in repairs. The continued use of administrative data—such as housing values, conditions, ownership patterns, and so forth—is key to tracking changes in the rental housing stock and illuminating unanticipated consequences or patterns that have strategic implications for Cleveland's lead-safe initiative. Such analysis will allow not only an examination of compliance with lead safety requirements but also an assessment of how the rental landscape may change over time.

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