Where the Landlords Are: A Network Approach to Landlord-Rental Locations*

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The US is home to more than 100 million renters, and approximately 11 million landlords, yet these two sides to the rental market are rarely studied in tandem. This study uses a multiscalar network-based approach to identify landlord market areas. Building on administrative data of rental properties' and landlords' locations, I define a landlord-property network as a spatial bipartite network, where landlords' addresses are connected to their properties' addresses, and vice versa. I first examine the location of landlords relative to their properties. I then compare the differences in socioeconomic characteristics in landlord and rental tracts. I simplify this network by extracting its backbone, defining a core component of a landlord market. I compare these networks to Metropolitan Statistical Areas and commuting networks, in order to evaluate the performance of the backbone extraction method. I find that most landlords are local, and, perhaps unsurprisingly, that landlord neighborhoods are richer, whiter, and more expensive than where their properties are located. Extracting the backbone of the commuting network results in a network that mirrors a regional definition, while the landlord market area is much more national in scope. These two networks differ geographically, and also with regards to their network statistics. While renters and homeowners search within a region for new housing, landlords and capital can search nationally for locations in which to invest. This paper provides a new, robust foundation to understand rental market investor dynamics and the relationship between owner, renter, and property.

Keywords: urban networks, rental markets, registries, landlords

Our understanding of rental housing ownership in the United States remains rudimentary. It is hard to pin down how many landlords there are in America — estimates range from 10 to 12 million (Richardson 2018). We have only recently begun to reexamine the relationship between landlords and their tenants, including the impact of professional management (Shiffer–Sebba 2020), the impact of corporate landlords (Travis 2019), absentee landlords (Rose and Harris 2021), and landlords who own in low-income neighborhoods (Desmond and Wilmers 2019; Shelton 2018). Yet these works only scratch the surface of illuminating the ownership and characteristics of America's 45 million rental units.

This paper aims to contribute to the burgeoning literature on landlords by considering where landlords are located relative to the properties that they own — the geography of landlords. It systematically collects rental registry data from eight large cities in the United States: Philadelphia, PA; Minneapolis, MN; Omaha, NE; Seattle, WA; Dallas, TX; Nashville, TN; Columbus, OH; and Washington, DC. Landlords and rentals are geocoded, and analyzed as a network, where *landlords* are connected to their *properties*, both of which exist in geographic space. I ask what fraction of rental properties have landlords with mailing addresses in the same city, metropolitan area, or state. What are the socioeconomic differences between rental neighborhoods and landlord neighborhoods? How is the geography of landlords distributed for a given city? I use network-science approaches to identify the core component of the landlord-property network, which is termed the landlord market

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area. I compare this network to the commuting network and Metropolitan Statistical Area (MSA) boundaries.

Why care about landlords' locations with respect to their properties? First, rich landlords investing in poor neighborhoods raises concerns about exploitation and inequality. Shelton (2018) argues that areas of racially and ethnically concentrated poverty are *directly linked* to areas of concentrated affluence via landlords in Louisville, KY. Hochstenbach (2023) finds in the Netherlands that landlords are more likely to live in less-dense, higher-income, and higher-value neighborhoods than the neighborhoods in which they own property. Harvey (2009) argues that we must investigate the sources of interregional income transfers. Insofar as most rental properties remain in the hands of private individuals (US Census Bureau 2021), and the median renter is cost burdened, the monthly payment of rent represents an income transfer from landlords to renters; this paper demonstrates the intra- and inter-regional flows of that rent.

Second, spatial and economic inequalities can compound, meaning that it may be preferable that rich landlords live in the neighborhoods where they own property. Research in the Netherlands paints a picture of landlords as high-income and high-wealth (Hochstenbach 2022). For the purposes of peer effects and socioeconomic integration, then, we might want landlords to live in similar neighborhoods as their tenants (Chetty et al. 2022). If landlords were to live in the same neighborhood as where they own property, we might expect less "landlord paternalism" (Rosen and Garboden 2022). From a property maintenance point of view, nearby landlords may take better care of their properties, whereas absentee landlords can be shielded from negative externalities (Rose and Harris 2021). Finally, technological changes mean that landlords may no longer need to be local to acquire and manage properties, but can instead find, acquire, and manage properties from afar (Fields 2022). Taken together, these concerns about spatial and economic inequality compel us to understand where landlords operate and where they own property.

The Relationship Between Regionalization, Housing Market Areas, and Landlords

This paper contributes to several conversations within the geography and housing literatures. First, I contribute to the literature on the differing types and scales of real estate investors. Özogul and Tasan-Kok (2020) find that researchers typically categorize real estate investors by: their spatial scale of operations; size and social composition; investment objective; or social behavior. Relating to spatial scale, Rose and Harris (2021) find that absentee landlords receive more code violations that owner-occupants; Immergluck and Law (2014) find that most investors in foreclosed properties in Atlanta operated in Georgia; and Crook, Ferrari, and Kemp (2012) find that most landlords in Scotland intentionally buy properties near to where they live. Relating to size, scholars have found that larger landlords may be more likely to evict tenants (Immergluck et al. 2020; Raymond et al. 2018), and that professional landlords have larger portfolios and different logics relating to rent raising and management (Shiffer–Sebba 2020). I intervene in these conversations by examining the spatial location of landlords, with a particular focus on landlords with residential mailing addresses.

Second, I call the geographical area bounded by landlord and rental locations a "landlord market area." The concept of a

landlord market area is derived from a long-established literature on housing market areas (Brown and Hincks 2008; Jones 2002; Royuela and Vargas 2009). Housing markets areas are designed to support regional housing development and are based on subnational migration or travel-to-work patterns. Housing market areas subset larger geographies into spatial regions where housing search is generally self-contained; that is, where most people looking for housing only look within the region, and not outside of it.

While labor — and therefore most home-searchers — is often bound by geography, capital is not (Sassen 1990). Where do landlords look when they wish to purchase property? One answer to this question is that they seek places with a rent-gap, such that they may capitalize on asset appreciation (Smith 1979). Recent scholarship has found that institutional-investor-owned suburban single-family rentals are often concentrated in middle-income white or low-income Black and Hispanic neighborhoods (Charles 2020). Yet the geographies of institutional investors may follow distinct logics from the geographies of mom-and-pop landlords. Researchers have found that mom-and-pop landlords prefer to live near the properties that they own as it provides them with more information and reduces risk (Crook, Ferrari, and Kemp 2012), and increases returns (D'Lima and Schultz 2021). Hochstenbach (2023) found that 70% of landlords who own rental properties in Amsterdam live within 20 kilometers of their property. Many non-professional landlords formerly lived in their rental properties (Shiffer–Sebba 2020). Landlord markets represent the intersection of multiple different actors, each with distinct logics.

I build off of these two strands of the literature to define a "landlord market area" as the area in which a substantial share of a city's landlords can be found. This definition mirrors the "housing market area" literature by identifying a reasonable subset of space where there is currently landlord activity. Absent capital controls, the true market area for a given parcel is global, while housing market areas are predominantly small regions. Technology has enabled real estate investors to identify, acquire, and manage properties from afar, at great scale (Fields 2022). Yet there must still be some logic to the location of landlords in a given city. For instance, Sakong (2021) examines the geography of Chinese investment in the US housing market, finding that US housing markets that have a shorter flight time to China have a higher proportion of Chinese owners.

What would we expect the landlord market area to look like? If being a landlord were a job that involved property maintenance, we might expect the landlord market area to resemble a commuting network. Given the work of Crook, Ferrari, and Kemp (2012), D'Lima and Schultz (2021), and Hochstenbach (2023), we might expect most of the landlords to be local. However, if being a landlord is a class position based on capital ownership (Hochstenbach 2022), enabled by property management companies and technology (Fields 2018; Fields 2022), then perhaps we would expect the landlord market area to reflect the global city network (Sassen 2005), as capital from superstar cities chases rent-gaps and returns in other locales.

Methods and Data

Data

I use rental registry data collected by eight cities and acquired via right-to-know requests and open data portals. After reviewing which of the 50 most populous US cities had rental registries, I selected these

eight cities based on data availability, data quality, and because these cities have very few exemptions for registration. While this is certainly a convenience sample, Columbus, Dallas, Minneapolis, Nashville, Omaha, Philadelphia, Seattle, and Washington, DC represent very different parts of the United States and have substantially different housing markets. Some are predominantly owner-occupied (Omaha, Philadelphia, and Nashville); some are sites of extensive institutional investor interest (Mills, Molloy, and Zarutskie 2019); some have high proportions of single-family rentals (Philadelphia, Columbus, Nashville), while others have a broader mix including large multifamily buildings. Their housing stock, industrial composition, and regulatory powers also differ.

These data include the location and number of rental units, and names and mailing addresses of landlords. Rental units are either represented as coordinates or parcels. Landlords are located using the mailing address provided by the rental registry. I use Dedupe, a machine learning software, to match landlord addresses to a complete list of parcels in the United States, provided by Regrid. Unmatched landlord addresses are geocoded using the Google Maps API. I estimate that I am able to geocode 98% of all addresses with 90% accuracy, far exceeding the commonly accepted threshold of an 85% geocode rate (Briz-Redón, Martinez-Ruiz, and Montes 2020). Rental registries also differ in their coverage and enforcement, with registered units representing the "formal" rental market. In Dallas, Minneapolis, Omaha, Philadelphia, Seattle, and Washington, upwards of 80% of rentals are registered. In Columbus, that number is 52%, in Nashville, 16%. These compliance rates thus bound this study by looking only at the formal housing market, which may not be representative of the whole rental market.

Landlord mailing addresses from rental registries present two challenges. First, some large-scale landlords who operate in many cities use local mailing addresses, while others provide mailing addresses for their national headquarters. Second, some landlords provide the mailing address of a management company, rather than their own mailing address. While I am unable to directly address these challenges, Regrid provides the Residential Delivery Indicator from the United States Postal Service. Because the majority of rental properties in the United States are owned by individual investors, the vast majority of whom manage their own properties (US Census Bureau 2021),[1] I expect that residential mailing addresses for landlords to be their actual residences, but I cannot conclude that with certainty. When I use all landlord mailing addresses, I caveat the findings that I am only able to identify the first-order flows of rent, recognizing that landlords that operate nationally may provide local mailing addresses.

Methods

First, I estimate what percentage of rental properties have landlords who live in the same municipality, metropolitan statistical area (MSA), or state. Here, I restrict the universe to landlords with a residential mailing address, capturing the majority of landlords. I group landlords with same or

[1] According to the 2021 Rental Housing Finance Survey, a full 78% of rental properties are managed by their owners; 84% of rental properties owned by individual investors are managed by their owners.

similar names to account for landlords with multiple properties, again using Dedupe. I also examine the distance between landlord mailing addresses and property mailing addresses, differentiating by whether the landlord has a residential mailing address.

Second, from all landlords in my sample, I construct a spatial bipartite network, where landlords are connected to their properties, both of which exist in geographic space. This landlord-property network is a weighted graph, where the weights are the number of units in a property. From this spatial bipartite network, I assign owners and renters to census tracts, connecting these geographies with weights based on the cumulative number of owners and units. The main network of interest is a weighted unipartite projection of a bipartite network, where census tracts are connected if there are landlords and properties that connect them, and the weights between nodes are the cumulative number of units or properties.

Among landlords with a residential mailing address, I compare the socioeconomic differences between the landlord's tract and the property's tract, averaging the dyad-level differences across the entire network. In order to generate a null distribution against which I compare the empirical results, the average differences in socioeconomic variables between tracts are compared to a simulated random network (Andris et al. 2021). I run 1,000 simulations for each city, where one end of an edge is randomly reconnected to any other node in the network, creating a random network with the same number of nodes and edges.

Third, I construct a reduced network, which I term the "landlord market area." Among the cities I consider, landlord-property networks are quite large and unequal: in Philadelphia, for instance, 49% of tract-to-tract edges have a weight of one. To include all edges in such a landlord market area would make this term meaningless. I therefore extract the network backbone of the landlord-property network (Neal 2022). Network backbones can be thought of as the "core" part of the network, and I use the "disparity" filter, from Serrano, Boguñá, and Vespignani (2009), to extract the backbone. For every edge in a network, the disparity filter compares the actual edge weight to a null distribution, where each node has equally weighted edges. Edges are retained if its weight is statistically significant, relative to this null model. I use the disparity filter, rather than an absolute measure (such as including all edges with a weight greater than 10) to account for city-by-city differences in the distribution of edge weights.

Because the geography of landlords is an as-of-yet unexamined question, there is no clear *a priori* expectation for its distribution in space. Thus, I compare the landlord market area to the to the commuting network in the same city. I do this both to ensure that the disparity filter produces reasonable results — I expect the commuting backbone to mirror MSA boundaries — and to compare the empirical results to the landlord market area. To create the commuting network, I use American Community Survey commuting data, created by a special tabulation via the Census Transportation Planning Products, provided by Dash Nelson and Rae (2016), and extract the backbone via the disparity filter. I map the resulting commuting and landlord market areas, and overlay the local MSA on these maps, showing the stark divergence between MSA definitions and landlord market areas. I compare the basic statistics associated with their network structure.

Table 1: Fraction of Landlords with a Residential Mailing Address, in Same City, MSA, or State

City	Number (Fraction of All Landlords)	Same City	Same MSA	Same State
Columbus	14,451 (72.1%)	48%	86%	89%
Dallas	2,811 (69.8%)	54%	85%	88%
Minneapolis	12,123 (89.4%)	50%	91%	92%
Nashville	4,053 (92%)	51%	80%	82%
Omaha	3,764 (80%)	68%	91%	90%
Philadelphia	36,686 (81.2%)	59%	88%	84%
Seattle	15,144 (85.3%)	61%	87%	90%
Washington, DC	19,457 (84.6%)	58%	84%	58%

Results

Comparing Landlord and Rental Locations

Table 1 shows the fraction of landlords with residential mailing addresses who have a mailing address in the same municipality, same MSA, or same state as their rental properties. Among landlords with a residential mailing address, this remains a local business. A slim majority of landlords with residential mailing addresses live in the same city in which they own property, and a substantial majority live in the same MSA. Given that I would expect landlords who have a residential mailing address to be mom-and-pop landlords, it is no surprise that they live close.

Table 2 shows the distances between property and landlord addresses, subset by whether or not the landlord's mailing address is residential. We again find that most landlords are local. Except for Omaha and Philadelphia, the median residential mailing address is closer than the median non-residential mailing address, furthering the belief that "mom-and-pop" landlords prefer to be closer to their properties (Shiffer–Sebba 2020). One number stands out in this table: the median landlord without a residential mailing address in Nashville is located 202 miles from their rental property. This number stems from the large number of properties owned by institutional investors in Nashville, with hundreds of homes in the registry. However, this may also reflect the likelihood of different types of landlords to register, given the relatively low compliance rate with Nashville's rental registry.

Table 2: Distance Between Landlord and Rental Properties, by Residential Mailing Address

City	Residential Mailing Address?	Mean (mi)	Median (mi)
Columbus	Overall	172.6	6.5
	Yes	119.4	5.3
	No	367.4	12.5
Dallas	Overall	197.3	8.6
	Yes	151.6	6.0
	No	123.3	9.0
Minneapolis	Overall	97.0	4.0
	Yes	85.6	3.9
	No	148.9	4.6
Nashville	Overall	309.5	9.3
	Yes	176.4	8.2
	No	817.0	202.1
Omaha	Overall	81.8	5.3
	Yes	73.4	5.4
	No	65.5	4.3
Philadelphia	Overall	47.0	4.2
	Yes	47.7	4.3
	No	40.1	3.7
Seattle	Overall	132.1	3.6
	Yes	131.6	3.5
	No	88.7	3.6
Washington DC	Overall	128.3	3.3
	Yes	146.2	3.2
	No	50.2	3.3

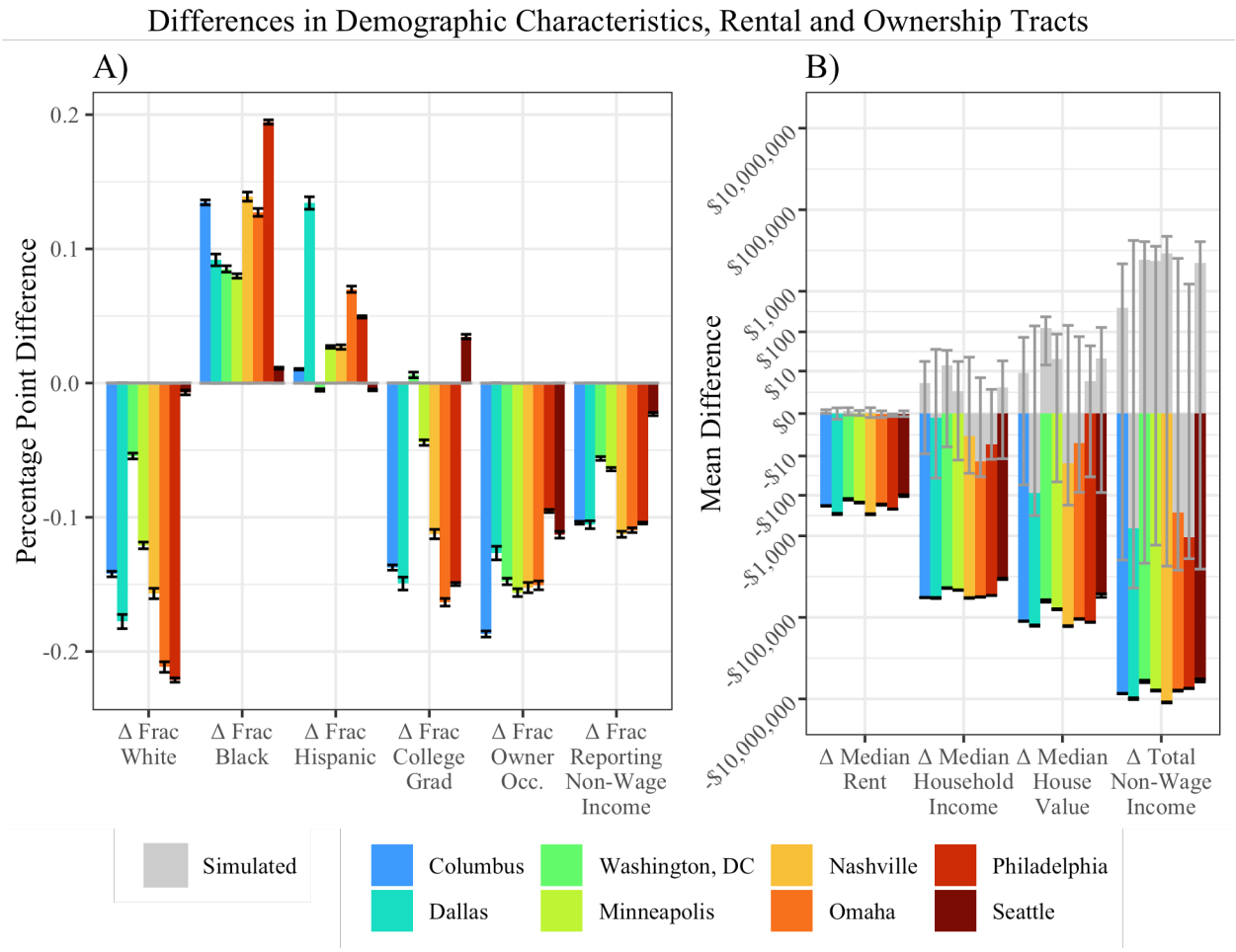

Figure 1.

Note: Restricted to rental properties where the owner had a residential mailing address. Population with a College Degree is limited to those ages 25+. Estimates are from the 2015-2019 ACS, from Manson et al. (2021). 83% Confidence Intervals plotted, but not visible in Panel A, due to their size.

Comparing Landlord and Rental Census Tracts

Figure 1 shows the differences in socioeconomic characteristics between landlords' mailing address tracts and their rental property's tracts, with Panel A showing the fractional differences, and Panel B showing the monetary differences, between these neighborhoods. To focus on the difference between likely residences, the figure presented here restricts the comparison to only those rental properties that have a landlord with a residential mailing address. Results from the network simulations, shown in gray, indicate that nearly all simulated differences are near zero, reflecting that, if landlords and properties were randomly distributed, landlord and rental neighborhoods would be similar. As the confidence intervals do not overlap, the actual differences observed in the data are statistically different from the simulations, results confirmed by t-tests.

Across the eight cities, rental tracts have significantly smaller proportions of white residents, and higher proportions of Black and Hispanic residents. As this is comparing differences across tracts, we can say that, on average, a Philadelphia landlord with a

residential mailing address owns property in a census tract that is 19 percentage points more Black than the tract in which the landlord has their mailing address. Among the cities, differences in magnitude are not solely explained by socioeconomic differences. For instance, both Omaha and Seattle are approximately 65% non-Hispanic white, yet in Omaha, rental tracts are 21 percentage points less white, compared to only a difference of 5 percentage points in Seattle. In general, Seattle has much smaller differences than the other seven cities, perhaps reflecting different rental or ownership patterns that warrant further investigation. Again perhaps reflecting city-specific demographic differences, Seattle and Washington, DC have slightly smaller Hispanic populations, and higher proportions of college-educated residents in their rental tracts, compared to landlord tracts.

Not surprisingly, rental tracts have significantly lower homeownership rates than the tracts where their landlords are found. Rental tracts have lower household incomes and lower house values than their respective landlords' tracts. Rental tracts also have fewer households reporting income from rentals, interest, dividends, royalties, estates, or trusts to the ACS. Across these cities, rental tracts, have, on average, 17 percent of households reporting rental or other non-wage income, compared to 26 percent of households in landlord tracts.

Comparing Commuting and Landlord Market Networks

Figure 2 brings visual clarity to the stark differences between the rental and commuting backbones. The landlord market areas, created from the sample of all landlords, are mapped in Panel A, while the commuting backbones are mapped in Panel B. The borders of the center city are highlighted in black, while the MSA border is in red. It is clear that, while commuting backbones mostly remain within the MSA boundary, the landlord market area extends far beyond the MSA border.

The disparity filter substantially reduces the size of the landlord-property network. For instance, the Washington, DC network originally contained 4,086 census tracts and 15,846 edges. The landlord market area has 90.6% fewer nodes and 92.5% fewer edges. The average weight of a retained edge is 4.84, compared to a mean edge-weight of 1.94 in the landlord-property network. Across all eight cities, the disparity filter reduces the number of nodes and edges by approximately 70-95%.

Using the disparity filter to create the commuting backbone provides us with a baseline result for the accuracy of this approach for commuting and landlord networks. As expected, the commuting backbone is mostly contained within the MSA boundary. The disparity filter is thus an appropriate method for this type of spatial network. In turn, we can believe that the landlord market area provides us with an accurate picture of where there are large concentrations of landlords, just as the commuting backbone provides us with a picture of where there are large concentrations of commuters.

The landlord market areas tell two stories. On the one hand, landlord market areas remain predominantly local. As we observed above, most landlords have mailing addresses in the same city or MSA as their rental properties. Yet the landlord market area is decidedly not *exclusively* local. In Minneapolis, there are 81 rental tracts in the landlord market area found outside the MSA — nearly 10 percent of the tracts found in the backbone itself. The Philadelphia landlord market has a number of nodes in cities of

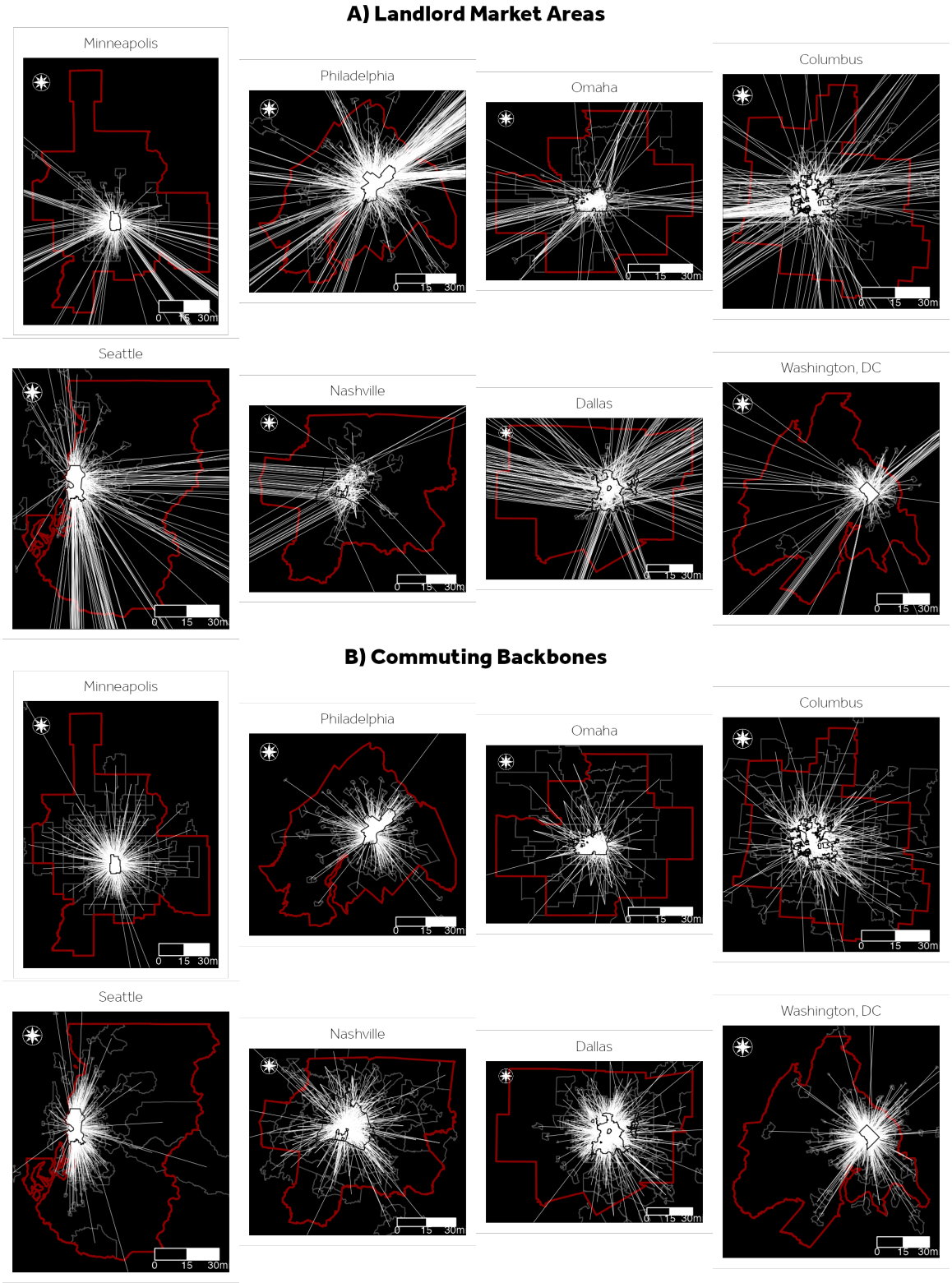

Figure 2: Landlord Market Areas and commuting backbones.

Note: Network edges are in white, central city borders are in black, MSA outlines are in red, network nodes (tracts) are outlined in grey.

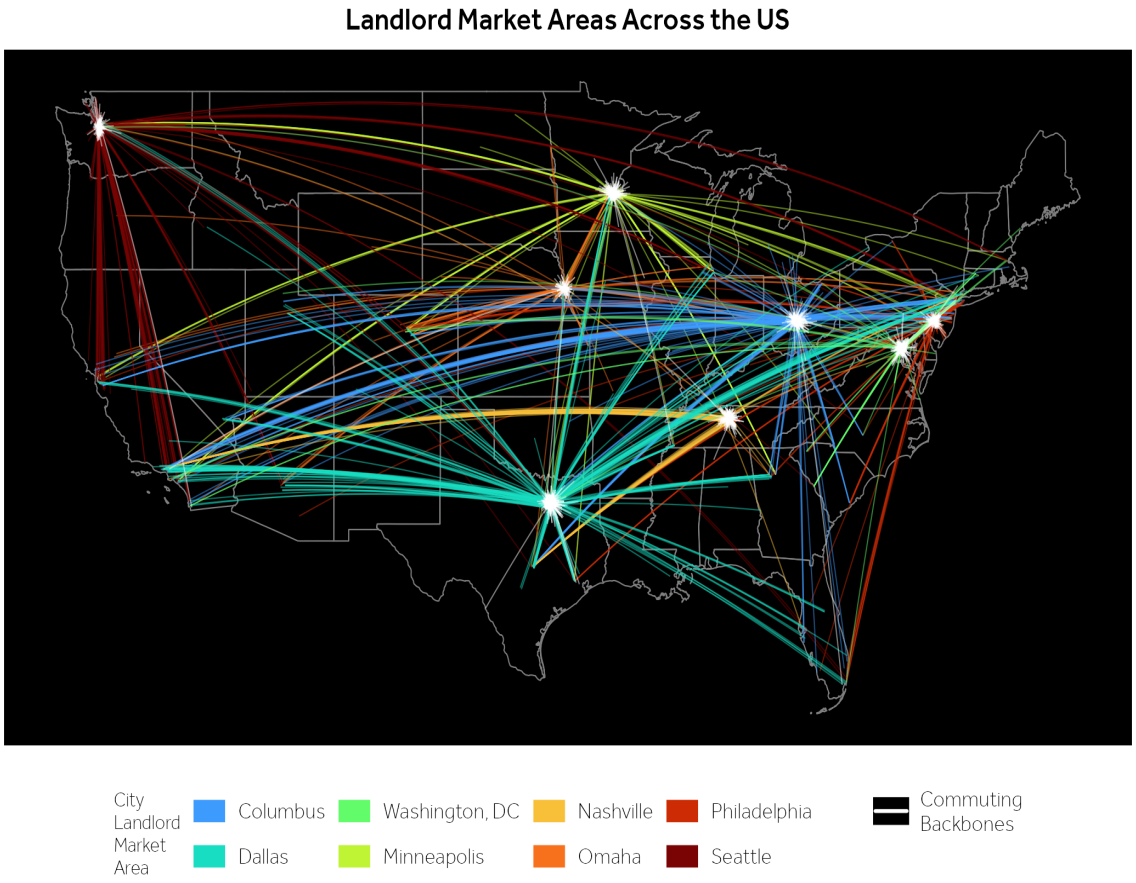

Figure 3.

global capital, as well as other important cities nearby: four out of five of New York City's boroughs are included; as are Rochester, Albany, Cleveland, Miami, Houston, Los Angeles, and many others. Rental ownership is much more national than commuting.

Figure 3 shows the landlord market areas and commuting backbones together at the national scale. This map shows that while the landlord market area is predominantly local, there are sites of national importance that appear across many of the cities. California, home to many superstar cities; Texas, headquarters of Invitation Homes, among the largest institutional investor for single-family rentals; and Georgia, a site of internal migration are represented across all eight networks. Thus, multiple different types of landlords are represented within the national landlord market areas. While a few of the nodes in the commuting networks are far from the center city, they appear to be fragments of the data process.

Comparing Network Statistics

Table 3 shows the network characteristics for the landlord market area and the commuting backbone. We see that the number of nodes and edges in the landlord and commuting backbones of a given city are often remarkably similar. As expected given the use

Table 3: Network Statistics Across Landlord and Commuting Backbones

City	Network	N Nodes	N Edges	Average Degree	Max Degree	Edge Density	Average Clustering Coefficient
Columbus	**Landlord**	421	931	4.42	42	0.011	0.070
	Commuting	408	1335	6.54	260	0.016	0.450
Dallas	**Landlord**	487	512	2.10	15	0.004	0.008
	Commuting	814	1705	4.19	444	0.005	0.254
Minneapolis	**Landlord**	411	879	4.28	37	0.010	0.103
	Commuting	541	927	3.43	323	0.006	0.534
Nashville	**Landlord**	187	254	2.72	25	0.015	0.028
	Commuting	322	875	5.43	243	0.017	0.478
Omaha	**Landlord**	239	471	3.94	41	0.017	0.083
	Commuting	252	778	6.17	151	0.025	0.426
Philadelphia	**Landlord**	942	3103	6.59	48	0.007	0.137
	Commuting	664	1435	4.32	286	0.007	0.184
Seattle	**Landlord**	400	1079	5.40	54	0.014	0.137
	Commuting	426	984	4.62	275	0.011	0.453
Washington, DC	**Landlord**	384	959	4.99	45	0.013	0.077
	Commuting	755	1382	3.66	340	0.005	0.474

of the disparity filter, both the commuting networks and the landlord networks are extremely sparse, with low edge density.[2]

Yet two clear patterns do stand out from these networks: first, commuting networks all have significantly larger maximum degree: for example, Minneapolis's most connected commuting node (tract) has 323 edges, while its most connected landlord node has only 37 edges. Second, clustering in the commuting networks is often higher than clustering in the landlord network. Both of these reflect real differences between commuting towards a downtown, as compared to a diffusion of rental properties throughout a city. These two patterns again reinforce that the backbone extraction produces networks that follow intuition. Additionally, in most of the cities, the number of nodes found in the commuting network is larger than the number of nodes found in the landlord network, reflecting that commuters may come from, or go to, more census tracts, than landlords and rentals. Backbone extraction produces reasonable core networks and we can therefore infer accuracy about the geographical extent of the landlord and commuting networks.

Discussion and Conclusion

Creating and analyzing the landlord-property networks in eight large US cities shows us the complicated contours of the rental property market today. The maps of the landlord-property backbones — the landlord market areas — show us that these networks are clearly national in scope. Many landlords exist beyond the region. Indeed, these maps likely understate the extent of this phenomenon, given that some landlords provide the addresses of property managers when complying with rental registration

[2] Edge density is a measure of the number of actual edges divided by the number of possible connections

ordinances. Similarly, many institutional investors provide local mailing addresses rather than their national headquarters. At the same time, even if the majority of landlords are local, a sizable proportion of landlords have residential mailing addresses outside of the MSA. Many landlords are local, but the flow of capital within the landlord market area is national.

Landlord market areas were created using the disparity filter to extract the network backbone from the overall landlord-property network. Given that we had no baseline for what the landlord backbone should be, we compared that backbone to a commuting backbone for the same eight cities. The disparity filter produced reasonable approximations for the metropolitan statistical area, based on commuting data, demonstrating its utility in producing a core network from a larger and messier data set.

Network methods are what provide us with this avenue for understanding. Only by recognizing that rental properties and landlords are but dyads within a larger landlord-property network structure can we begin to piece together the way that modern rental property ownership differs from other types of relational flows in our cities. Extracting the landlord-property backbone allows us to see more clearly the boundaries of the landlord market area, which would otherwise be obfuscated by the overwhelmingly large number of landlords and rentals. Network statistics reveal the differing structures between landlord-property networks and commuting networks.

Within the landlord markets themselves, areas where landlords live and areas where they own property are substantially different. Landlords have residential mailing addresses in areas with richer, whiter, and more educated neighbors than the areas where they own property. By comparing the socioeconomic differences between landlord nodes and renter nodes, this is not merely a tautology restating the fact that, in America, homeownership is correlated with many of these socioeconomic characteristics. Rather, it is clearly demonstrating that landlords own properties in neighborhoods that are different from their own. While not surprising, it's not immediately obvious why this need to be true. Owner-occupied rental properties, or landlords who own properties down the street, would have no differences in the socioeconomic variables calculated in this paper. Indeed, it is a peculiarity of the *distance* between modern-day landlords and their rental properties that produces this difference.

Future work ought to consider differences in landlord types, including corporate landlord status and size of landlords. Additionally, there is further work that is necessary to understand the flows of rent among the largest landlords, some of whom use local mailing addresses and others that use national headquarters. This research also excludes foreign mailing addresses, which may be of import in some local housing markets. Finally, there may also be differences in different housing submarkets, with different types of landlords invested in different types of neighborhoods or housing typologies.

Supplemental Material

This paper uses a unique data set of rental registries collected at the local level. Online supplementary material contains information on coverage and quality of these registries, including the number of units registered. Information about the mailing address matching process is also provided. Additionally, results from the network simulation are presented in tabular form.

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Supplementary Online Material

The supplementary online material provides greater detail of two aspects of the paper. First, it depicts the coverage of the rental registries in the eight cities analyzed. Second, it provides the exact magnitudes, differences, and t-values of the socioeconomic differences, as presented in Figure 1 in the text.

Rental Registry Coverage

The supplementary table depicts the coverage of the rental registries in the eight cities analyzed. There are significant differences in coverage among these cities, in terms of the number of rental units registered as compared to the number of rental units believed to be in the city per the ACS. Cities such as Philadelphia and Seattle have nearly 100% coverage, indicating that most of their rental properties are registered[3] with the city. Surprisingly, Minneapolis, has more registered properties than the ACS reports. This is possible either because of lagged Census data collection (wherein new rental construction isn't yet reflected in the Census) or because of error on the city side. Likely, it is a combination of both.

Rental registry coverage can suffer for two reasons. First, some properties may be exempted from the rental registry, such as owner-occupied properties, or rental properties with few units. Second, the city may not adequately enforce their rental registry. Those properties that are required to register and are actually registered thus represent the universe of the "formal" rental market, where landlords are in compliance with the law. Those units that are not registered are rental units in the "informal" market (Samuel, Schwartz, and Tan 2021).

All eight cities studied in this paper have very few exemptions. In Dallas and Philadelphia, "family occupied" rental units are exempted from registration. In the other six cities, there are no broad or explicit exemptions to rental properties that are meant to register. However, the cities clearly differ in their enforcement. Both Columbus and Nashville, which have the lowest apparent rates of compliance, are required to register rental properties as the result of state law, while the other six cities have registries as the result of local ordinances. Differences in compliance may be partially due to differences in rental building typology: it is harder to "hide" an unregistered multifamily apartment building than it is to hide an unregistered single family home. And indeed, while Nashville and Columbus have high rates of single family rentals, so too does Philadelphia.

There are likely real differences between landlords and rental properties that are and are not registered. In Philadelphia, landlords without a rental license cannot legally evict a tenant. In Detroit, Lynch (2022) found that large landlords were more likely to be registered than smaller landlords.

Nonetheless, rental registries represent the most accurate representation of the formal rental market. Alternative approaches, such as using property tax assessment databases, are underinclusive of those landlords who send their property tax bill to their rental properties, while overinclusive of second homes, homes under redevelopment, and homeowners who send their property tax bill

[3] Or have been registered recently. I retained "Inactive" or "Expired" licenses that expired in or after 2019, to account for frequent lapses and lack of timely renewals.

elsewhere. Unfortunately, no work to date has adequately studied the differences between tax assessment databases and rental registries.

The analyses in this paper rely on the rental licenses where I am able to geolocate the landlords' mailing address. These are thus reflected in the bottom half of the supplementary table. This represents the subset of rental units that 1) are licensed and 2) have a landlord with a US-based mailing address that I was able to geolocate. Column 3 in the bottom half of the table reflects the number of rental units I am able to analyze, as a fraction of the number of rental units estimated by the ACS. Thus, in Dallas, Omaha, Philadelphia, Seattle, Washington, DC, I can estimate the mailing address of upwards of 80% rental units and the landlords for those rental units. In Columbus, that number is approximately 46%, while in Nashville, that number is approximately 12%. The low coverage of rental units in Columbus and Nashville is concerning. This likely stems from differences in enforcement and in differences in the origin of rental licensing requirements, as mentioned above. Nonetheless, the findings in this paper rely on this sample of the rental market, representing the "formal" rental market of landlords who are in compliance with local and state law.

Supplementary Table 1: Descriptive Statistics

City	City Population, ACS 2017-2021	Number of Licenses	Number of Units	Number of Rental Units, ACS 2017-2021	Number of PO Box Mailing Addresses	Number of Exact License Match with Regrid	Number of Deduped License Matches with Regrid
Columbus	898,143	57,368	109,007	208,644	6,082	23,283	14,986
Dallas	1,300,239	10,891	251,560	301,691	807	4,339	3,494
Minneapolis	425,091	22,634	103,300	94,741	62	10,296	8,702
Nashville	682,646	13,839	20,560[4]	129,737	831	648	6,485
Omaha	488,059	16,925	80,495	81,394	2,745	6,511	5,000
Philadelphia	1,596,865	110,983	280,918	307,740	946	61,488	34,382
Seattle	726,054	25,992	149,497	184,866	2,092	13,451	6,845
Washington, DC	683,154	33,966	175,429	181,384	2,122	11,068	12,236
	Licenses Analyzed	**Units Analyzed**	**Number of Unmatched Licenses**	**Number of Unmatched Units**	**Number of Residential Mailing Addresses**	**Number of Non-Residential Mailing Addresses**	**Number of Unknown Type Mailing Addresses**
Columbus	50,444	95,629 (46%)	893 (1.6%)	1707 (1.6%)	29436 (51.3%)	12108 (21.1%)	8900 (15.5%)
Dallas	9,998	242,810 (80%)	2251 (20.7%)	57581 (22.9%)	5816 (53.4%)	1929 (17.7%)	2253 (20.7%)
Minneapolis	22,421	100,670 (106%)	152 (0.7%)	2398 (2.3%)	18000 (79.5%)	3215 (14.2%)	1206 (5.3%)
Nashville	11,647	16,111 (12%)[5]	678 (4.9%)	- (NA%)	8909 (64.4%)	2440 (17.6%)	298 (2.2%)
Omaha	14,103	71,478 (88%)	77 (0.5%)	557 (0.7%)	9615 (56.8%)	3547 (21%)	941 (5.6%)
Philadelphia	109,013	270,845 (88%)	1024 (0.9%)	6977 (2.5%)	82252 (74.1%)	21062 (19%)	5699 (5.1%)
Seattle	24,381	150,486 (81%)	207 (0.8%)	2423 (1.6%)	19545 (75.2%)	4262 (16.4%)	574 (2.2%)
Washington, DC	30,793	162,129 (89%)	486 (1.4%)	2789 (1.6%)	23331 (68.7%)	6835 (20.1%)	627 (1.8%)

Note: Percentages in parentheses refer to the fraction of licenses or units, as appropriate, from the first half of the table.

It is worth noting that PO Boxes are a major challenge in this work, as PO Boxes can only be geocoded to a post office or brick-and-mortar shipment business associated with the PO Box ZIP code. The use of PO Boxes ranges significantly among cities, with a low of 0.3% of mailing addresses

[4] Nashville only provided property counts, not unit counts. However, Regrid provides an estimated count of "mailing addresses," at a given property, which roughly corresponds to unit counts. I estimate that there are approximately 20,000 registered rental units in Nashville.

[5] Again, Nashville does not provide unit counts, so this number is an estimate based on Regrid data.

in Minneapolis, to a high of 16% in Omaha. This likely reflects differences in rental registration ordinances: the Minneapolis rental license application explicitly states that the owner address cannot be a PO Box. It also may indicate differences in landlord types and logics, as we might expect more professionalized landlords to use devices such as incorporation or PO Boxes to separate their personal and professional activities (Shiffer–Sebba 2020). Thus, the exclusion of PO Boxes from some of my analyses may bias the results towards focusing on smaller, mom-and-pop landlords, who are not so professionalized as to use PO Boxes.

Reflecting on the type of owner mailing addresses found in the data, we find that the majority of landlord mailing addresses are residential, as indicated by the USPS Residential Delivery Indicator collected by Regrid, yet that breakdown is not equal across cities. Indeed, in Columbus, only 52% of all owner mailing addresses were found to be residential. These numbers are not necessarily a count of sole proprietors, however, since many corporate landlords have residential mailing addresses. Again, these differences may account for differences in the professionalization of the landlord industry in these cities (Shiffer–Sebba 2020).

Socioeconomic Differences

Supplementary Table 2 provides the exact magnitudes, as well as t-tests and sample sizes from the visual information presented in Figure 1.

Supplementary Table 2: Differences in Demographic Characteristics, Rental and Ownership Tracts.

Variable	Statistic	Columbus	Dallas	Minneapolis	Nashville	Omaha	Philadelphia	Seattle	Washington, DC
Percentage Non-Hispanic White	t-value	-96.87	-46.70	-66.80	-55.99	-74.76	-192.31	-5.66	-34.77
	Actual Mean	-14PP	-18PP	-12PP	-16PP	-21PP	-22PP	-1PP	-5PP
	Simulated Mean	0PP	0PP	0PP	0PP	0PP	0PP	0PP	0PP
Percentage Black or African-American	t-value	100.68	28.85	66.59	56.72	59.83	169.37	20.19	49.90
	Actual Mean	13PP	9PP	8PP	14PP	13PP	19PP	1PP	9PP
	Simulated Mean	0PP	0PP	0PP	0PP	0PP	0PP	0PP	0PP
Percentage Hispanic or Latino	t-value	25.69	39.95	36.61	22.25	41.38	78.78	-10.32	-7.81
	Actual Mean	1PP	13PP	3PP	3PP	7PP	5PP	-1PP	-1PP
	Simulated Mean	0PP	0PP	0PP	0PP	0PP	0PP	0PP	0PP
Percentage College Graduate	t-value	-96.10	-43.04	-29.85	-44.35	-79.51	-180.08	27.78	3.97
	Actual Mean	-14PP	-15PP	-4PP	-11PP	-16PP	-15PP	3PP	1PP
	Simulated Mean	0PP	0PP	0PP	0PP	0PP	0PP	0PP	0PP
Percentage Owner-Occupied	t-value	-115.33	-34.79	-74.44	-55.45	-63.71	-114.81	-62.38	-84.20
	Actual Mean	-19PP	-13PP	-16PP	-15PP	-15PP	-10PP	-11PP	-15PP
	Simulated Mean	0PP	0PP	0PP	0PP	0PP	0PP	0PP	0PP
Median Income	t-value	-133.96	-50.27	-76.42	-69.09	-88.01	-207.08	-37.98	-54.28
	Actual Mean	-$32,622	-$33,482	-$21,406	-$33,452	-$31,632	-$28,949	-$11,395	-$19,087
	Simulated Mean	$5	$0	$3	-$3	-$14	-$5	$3	$15
Median House Value	t-value	-96.08	-37.78	-50.37	-51.58	-70.87	-180.69	-14.01	-20.68
	Actual Mean	-$124,168	-$159,336	-$63,260	-$163,901	-$109,564	-$131,542	-$29,334	-$39,648

	Simulated Mean	$9	-$88	$21	-$15	-$4	$5	$22	$125
Percentage of Households With Income from Rent, Dividends, Interest	t-value	-135.23	-49.78	-70.77	-68.95	-86.46	-213.76	-26.78	-55.69
	Actual Mean	-10PP	-11PP	-6PP	-11PP	-11PP	-10PP	-2PP	-6PP
	Simulated Mean	0PP	0PP	0PP	0PP	0PP	0PP	0PP	0PP
Total Income from Rent, Dividends, Interest	t-value	-85.62	-28.28	-44.08	-45.52	-45.38	-107.73	-16.39	-20.31
	Actual Mean	-$7,395,183	-$9,894,803	-$6,226,562	-$12,210,949	-$6,263,388	-$5,516,849	-$3,542,248	-$3,737,347
	Simulated Mean	$389	-$647	$5,506	$8,363	-$271	-$1,062	$4,959	$5,885

Note: Restricted to rental properties where the owner had a residential mailing address. PP is "percentage points." Population with a College Degree is limited to those ages 25+. Estimates are from the 2015-2019 ACS, from Manson et al. (2021)

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