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How urban mechanisms perpetuate housing insecurity

Housing Insecurity, Transit Networks, Commuting, Human Mobility, Social Mobility

Extended Abstract

The rapidly increasing density of urban areas threatens to exacerbate the ever present housing crises around the world [1]. In many cases, the proposed solution by government officials and urban planners, alike, is to build more housing, particularly more affordable housing [2]. These solutions can influence the state of housing in a direct and indirect manner. Direct policies range from zoning laws to rental-assistance voucher programs. On the other hand, indirect policies include the strategic planning of employment opportunities and the robustness of transport systems, which can affect the level of investment that goes into developing infrastructure for different regions. Our work focuses on the effect of these indirect policies on housing insecurity. Specifically, we analyse how transport, employment, and urban layouts may contribute to the hardships endured by those facing housing insecurity. We begin by defining housing insecurity levels in US cities. We leverage transit networks and employment data to investigate the extent to which transit hinders social mobility for individuals facing poor housing conditions.

Social scientists have carefully studied the sources and consequences of unstable housing using different granularities. However, developing a consistent metric for housing insecurity has been a long-standing obstacle [3]. In an effort to encompass the multiple facets of housing insecurity, we define housing insecurity with respect to affordability, quality, and stability. By applying spectral clustering on housing features that capture these dimensions of insecurity, we adopt an unsupervised learning approach to define three different housing categories: **most** vulnerable, **mildly** vulnerable, and **less** vulnerable. With data provided by the Eviction Lab, we define eviction rates for cenus tracts within 20 US cities. The rest of our housing data, which measures affordability, access to facilities, and overcrowding, comes from the 2019 American Community Survey (ACS). The housing metrics we use are listed in Panel B of Figure 1. Panels A and B in Figure 1 depict the clustering results for Bridgeport, one of the 20 cities in our analysis. Panel A visualises the housing landscape from a geospatial perspective, illustrating how census tracts from similar housing demographics tend to be in close proximity to one another. Each column in Panel B displays a housing demographic's insecurity level for all the features that we use to cluster census tracts. This heatmap conveys that housing vulnerability is multi-dimensional. Areas that may be classified as less vulnerable still can have high levels of insecurity in some dimensions, indicated by darker hues of red.

Using the housing demographics we have defined, we investigate whether transport infrastructure and employment landscapes serve as obstacles to individuals that are trying to access better housing options. To analyse the public transportation network within the 20 cities, we gather General Transit Feed Specification data from The Mobility Database.Given these transit networks, we can extract the transit routes and the travel time of a journey from any two tracts in a city. By defining driving times between two points using OpenRouteService, we can calculate ***travel impedance***, defined as the ratio of transit to driving time for a given journey. A travel impedance value, t, larger than 1 indicates that a trip takes t times as long using public transportation. We define the overall transit efficiency of a city by averaging the travel impedances for all pairs of census tracts. Thus, we can compare transit systems across cities.

To account for differences in the spatial size of cities, we compare each city's transit efficiency to its area, finding no significant correlation. Furthermore, we analyse travel impedance as a function of trip distance, for each city. In this manner, we identify three transit signatures that correspond to the overall efficiency of a city's transport infrastructure. Panel C in Figure 1 uses Cleveland, Albuquerque, and Bridgeport as an example of each signature. The cities with the most efficient transport systems, such as Cleveland, exhibit decreasing impedance as transit journeys becomes longer. Conversely, the least efficient cities, such as Bridgeport, express an increasing trend. Cities with moderate efficiency reveal decreasing impedance until a distance threshold, at which point the impedance-distance relationship shifts to an increasing behaviour. These results highlight how less efficient cities encumber individuals dependent on public transit from accessing employment opportunities that are located further.

We incorporate commuting behaviour by using US Census data from the Longitudinal Employer-Household Dynamics program (LEHD). The LEHD Origin-Destination Employment Statistics (LODES) dataset informs the volume of commutes between any two pairs of census tracts in a city. Thus, we can define census tracts from a residential perspective, based on the degree of housing vulnerability they face, as well as from an employment perspective, based on the housing demographic composition of individuals that commute there. We apply local spatial autocorrelation (LSA) to define *employment hotspots*, which represent census tracts with an unusually high concentration of employment rates for a particular housing demographic. Panel D in Figure 1 visualises how commuting costs would change for the most vulnerable housing demographics if they were to start commuting to employment hotspots of individuals with better housing conditions. In doing so, we encode the concept of social mobility into a stochastic process, run over 100 iterations, by defining new workplaces of individuals commuting from the most vulnerable tract. We uniformly sample these workplaces from the employment hotspots of individuals that live in tracts with lower levels of housing insecurity. The red rectangle indicates the average travel time of these hypothetical commutes.We observe that San Francisco, Philadelphia, and Milwaukee are the only cities in which transit times would remain under 30 minutes, indicated by the dashed line. Cities in the lower half of the panel would have transit trips longer than one hour, reflected by the dotted line. We note that the most vulnerable housing groups in Fort Worth, Houston, Dallas, and Greenville would already spend an average of 60 minutes commuting via transit.

Our findings motivate a nuanced approach to defining levels of housing insecurity that consider multiple facets of the residential landscape. Furthermore, this work emphasises how individuals already facing housing insecurity are burdened further by transit infrastructure, which limits the opportunities to which they have access. Ultimately, this research aims to shine light on how housing issues can be approached from an urban planning perspective, in addition to the conventional policies that directly impact the state of housing.

References

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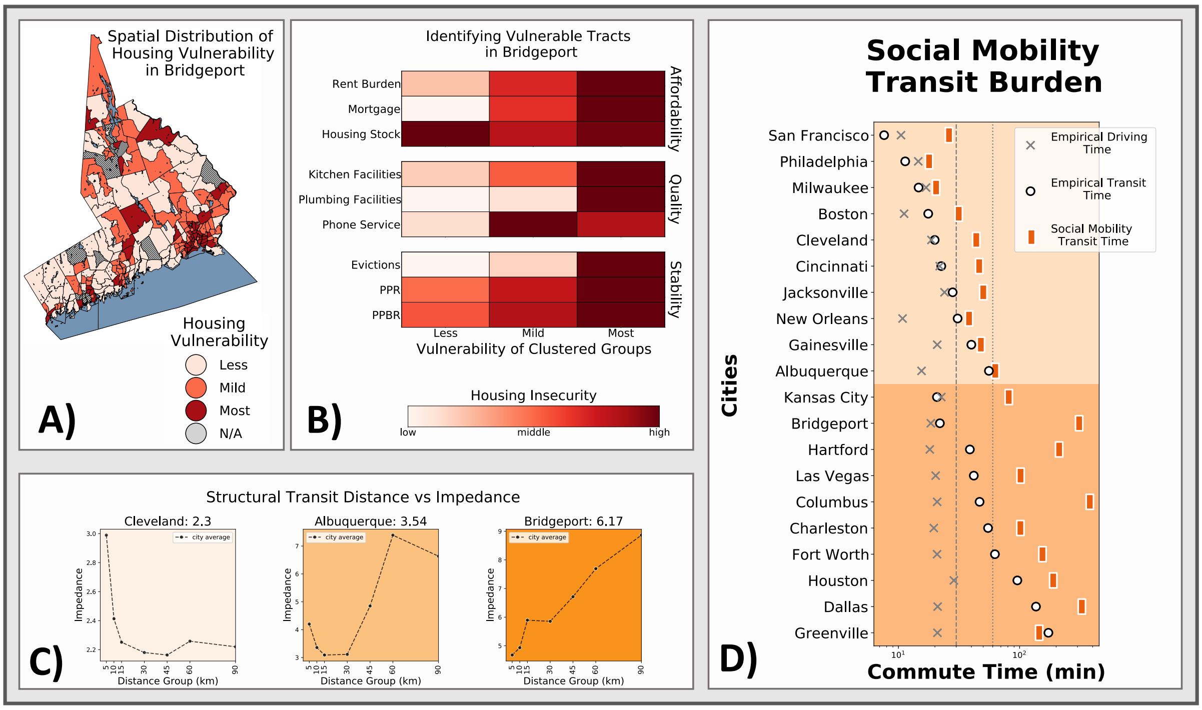

Figure 1: Panel A and B depict results for Bridgeport, Connecticut, one of the 20 cities in our analysis. Panel A presents a geovisualisation of the spatial distribution of the identified housing demographics, with the darker shades of hue reflecting census tracts that are more vulnerable to housing insecurity. Panel B illustrates our approach to applying meaning to clusters identified by our spectral clustering approach. The red hues depict the average value of all census tracts in a housing cluster, in regard to each of the 9 housing features, with darker hues representing higher levels of housing insecurity. Panel C highlights three transit signatures we identify by plotting travel impedance as a function of trip distance, where trips between all pairs of tracts in a city are characterised by their distance. Panel D illustrates the transit burden as a measure of travel time, capturing how public transit commuting times would change if residents from vulnerable housing tracts were to start commuting to employment locations, in which individuals with better housing conditions work.