

# The spatial distribution of businesses and neighborhoods: What industries match or mismatch what neighborhoods?

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## ARTICLE INFO

### Keywords:

Homeownership  
Business development  
Industrial organizations  
Spatial relationship  
Zoning regulations

## ABSTRACT

Using the Longitudinal Employer-Household Dynamic (LEHD) and American Community Survey (ACS), we evaluate the spatial relationship between businesses and neighborhoods through exploring the effects of homeownership rates on the job counts of businesses located at various distances to the neighborhoods. The effects of interest are evaluated for neighborhoods of different income levels and businesses of various types. To construct the spatial framework, we first cluster the businesses and then draw residential donut rings of different radii surrounding the business clusters. To control for any fixed locational and temporal features affecting the location choices of both households and businesses, we employ a fixed-effect (FE) identification strategy, where a positive (negative) coefficient suggests that the businesses match (mismatch) the neighborhoods with a higher concentration of homeowners. Our findings show that no industries mismatch the higher-income homeowners, whereas a mismatch exists between their lower-income counterparts and the industries of food and entertainment; the industries that match homeowners of both income groups include retail trade, whole trade, and education. In addition to these three sectors, health, professional services, and entertainment match the higher-income homeowners, whereas construction and transportation match the lower-income ones; for retail trade and whole trade, the matching occurs at a shorter distance between the lower income neighborhoods and businesses. Our results can assist the government in perfecting zoning regulations, developing subsidizing policies, and constructing affordable housing programs.

## 1. Introduction

When travelling across the U.S., Whole Foods, Starbucks, and some fine dining restaurants are often seen in prestigious neighborhoods. In less-affluent neighborhoods, on the contrary, stores including Walmart, 99 Cents, and plumbing repairs are prevalently observed. Likewise, when entering a peaceful neighborhood with single-family homes sitting on green grass, we might expect to find grocery stores and green open spaces such as parks or golf courses located within ten minutes' drive. We might, however, experience a change in business scenery—grocery stores and bars located right around the corner—in a vibrant neighborhood with higher densities. These contrasts inspire us to ponder on whether a pattern exists regarding the geographical closeness between neighborhoods and businesses of distinct attributes. To this end, through examining the effects of homeownership rates in neighborhoods of different incomes on the job counts of businesses located within varying distances, we explore the spatial relationship between neighborhoods

and businesses.

Acknowledging the spatial interactions of neighborhoods and businesses helps the government to determine which kinds of businesses should be introduced to which neighborhoods and at what distances the businesses should be placed from the residents so that positive interactions can be promoted and negative influences or frictions between the two can be avoided or managed. The related literature includes explorations on resident sorting (Tiebout, 1956; Ellickson, 1971; Rosen, 1974) and firm location choice (Hotelling, 1929; Guimaraes, Figueiredo, & Woodward, 2004; McFadden, 1974, pp. 105–142), where residents and businesses choose their locations to maximize their utilities or profits. The two processes ultimately determine the spatial distributions of businesses and residence.

One related line of literature studying the relative positions of businesses and residence examines the spatial job–residence imbalance on a county or city so that we know how many residents should be relocated to achieve a balance (Kain, 1968; Wilson, 1987; Aponte, 1996;

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<https://doi.org/10.1016/j.habitatint.2021.102440>

Received 9 January 2021; Received in revised form 15 August 2021; Accepted 21 September 2021

Available online 29 September 2021

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Pastor & Marcelli, 2000; Liu and Painter, 2012; Wang, Song and Xu, 2011; Fan, Allen and Sun, 2014; Hui, Zhong and Yu, 2015). Likewise, we also explore the relative positions of businesses and residents, but with a focus on the underexplored microlevel interactions of the two at varying distances. Another line of literature investigates how the amount of retail services varies with resident income to evaluate the accessibility of retail services (Alwitt & Donley, 1997; Schuetz, Kolko and Meltzer, 2012; Meltzer & Schuetz, 2012; Kang, 2019). Yet, these existing studies cover either a restricted scope of industries or a small span of geographies. These were also performed on an aggregated level without considering the distances between the businesses and residences. Lastly, these studies focus on the relationship between businesses and neighborhood income. However, given homeowners' profound influences on neighborhoods, localities with the same income levels with varying homeownership rates might generate differential spatial distributions of businesses and residents.

Our analyses then first contribute to extending the analyses to include both the mismatching<sup>1</sup> and matching conditions among the full 20 industries with two-digit NAICS codes and neighborhoods of different incomes. Second, we contribute by developing a spatial framework with machine learning methods that maps all the job clusters in the U.S. and incorporates the distances between the businesses and neighboring residents. Specifically, employing K-means clustering and K-nearest neighborhoods, we cluster the business block groups that are geographically adjacent and then draw residential donut rings of different radii to the cluster. The resulting data contain all the job clusters and their surrounding residential donut rings with the radii of within 0.3, 0.3–1, 1–2, 2–3, and 3–5 miles. These data have three advantages: they 1) allow the exploration of the relationship between businesses and residents for varying distances; 2) cover the job clusters in the whole country, allowing us to avoid the location bias that may result from analyses on a subset of the country; and 3) provide detailed microlevel geographical features across time, better tackling the identification issue arising from common factors that affect the location choices of both businesses and residents, such as the access to a highway entrance, the local weather, or the topography of the location. We are therefore able to employ a fixed-effect (FE) model to difference away any fixed locational and temporal effects for identification.

Third, adding to the current studies that only analyze the effect of residential income on job counts (Schuetz, Kolko and Meltzer, 2012; Meltzer & Schuetz, 2012; Kang, 2019), we examine the effect of homeownership rates on business job counts for different residential incomes, industry types, and distances between the businesses and neighborhoods to further the understanding of work–residence interactions. Homeowners, constituting 67.5%<sup>2</sup> of the country's population, exert profound influences on the outcome of residential sorting and firms' location choices through their more careful sorting and the deep and long-lasting involvement in local affairs, such as zoning regulations (Fischel, 2001, 2004; Blanchflower & Oswald, 2013), educational investment, property tax changes, and public infrastructure spending (DiPasquale & Glaeser, 1998; Dietz & Haurin, 2003; Rohe, McCarthy, & Zandt, 2002). Additionally, since homeowners are, on average, older, more likely to have children, and more likely to be married<sup>3</sup> than renters, they tend to display heterogenous preferences over the presence and distance to various types of businesses, such as retail, schools, youth facilities, and health services. This results in differential spatial

distributions of businesses and neighborhoods of varying homeownership rates.

For the interpretation of the results, we conclude that a match (mismatch) exists between the business types and the neighborhoods with a higher concentration of homeowners if we find a positive (negative) effect of homeownership rates on the job counts of a certain industry. Our results add new findings to the current literature regarding the mismatching and matching relationships between the neighborhoods and the industries, as well as the distances at which the mismatches and matches happen. First, we demonstrate that there are no industries that mismatch the higher-income neighborhoods with a higher concentration of homeowners. For the lower-income homeowners, their neighborhoods are found to be mismatched with two industries: accommodation and food, and art and entertainment. Thus, we confirm the findings that lower-income neighborhoods might be “food deserts” (Hilmers, Himers and Dave, 2012; Wrigley, Warm, Margetts, & Whelan, 2002), even with proportionally more homeowners in the community. In addition, we discover that entertainment near lower-income homeowners might also be deficient.

Second, homeowners in both income neighborhoods match retail, whole trade, and education. Former studies identify limited access to retail services in lower-income neighborhoods (Alwitt & Donley, 1997; Schuetz, Kolko and Meltzer, 2012; Meltzer & Schuetz, 2012). Our findings show that within lower-income neighborhoods, more homeowners are associated with more retail, whole trade, and educational services, which suggests a channel for us to attract more of these three through encouraging homeownership. Third, in addition to the three industries shared in common, lower-income homeowners match construction and transportation, whereas their higher-income counterparts match art and entertainment, health, and professional services. Lastly, although three industries (whole trade, retail trade, and education) are found to match homeowners of both income levels, the distance at which the positive effects happen is a little farther in the higher-income than in the lower-income neighborhood.

This article provides rich practical implications for government decisions on zoning regulations, subsidizing policies, and affordable housing. Specifically, for zoning purposes, the matching results provide a guiding map for the types of industries and neighborhoods that should be combined, as well as their geographical distances that are needed for more prosperous development. The mismatching results identified in the lower-income neighborhoods help the government to caution against possible high vacancy rates and make subsequent preparations if the neighborhood plans to introduce food and entertainment services. Specifically, to alleviate the lack of access to these two industries, which might lead to nutrition deficiencies and mental distress, in the lower-income neighborhoods, the government can provide subsidies to aid grocery stores and entertainment services to open. Or alternatively, they can offer shopping and transportation vouchers for the residents to make their purchases in existing stores in other neighborhoods. For affordable housing, the place-based housing program is likely to result in a concentration of lower-income residents who may suffer from the lack of access to food and entertainment, according to our study. It is therefore essential to provide an integrated housing program where housing and other services are co-provided and developed. In terms of demand-side housing subsidies, the longer distances between residents and retail as well as the lack of public transit in higher-income neighborhoods suggest the need to provide transition support, living expense assistance, and transportation subsidies, in addition to housing vouchers. Finally, policies encouraging homeownership might help to promote the development of retail, whole trade, and educational services in lower-income neighborhoods.

The remainder of the paper is organized as follows: Section 2 describes the theoretical motivation and literature review. Section 3 explores the methodology and the identification strategies to deal with the endogeneity. Section 4 presents the data and Section 5 provides the empirical results. Section 6 concludes the paper.

<sup>1</sup> The exact meaning of “mismatch” in this article differs from that in the “spatial mismatch hypothesis”. The mismatch in this article suggests a negative interaction between businesses and residents as opposed to the imbalance meaning in the “spatial mismatch hypothesis”. For this reason, we use imbalance for the former literature studying the relative amount of employment and residents.

<sup>2</sup> American Community Survey five-year estimates in 2019.

<sup>3</sup> American Community Survey five-year estimates in 2019.

## 2. Theoretical motivation and literature review

The spatial relationship between neighborhoods and businesses ultimately depends on the mutual selection of households and firms where households choose utility-maximizing home locations (Tiebout, 1956; Ellickson, 1971; Rosen, 1974) and firms locate where their profits are maximized (Hotelling, 1929; Guimaraes et al., 2004; McFadden, 1974, pp. 105–142). Specifically, in addition to the considerations of home prices, tax levels, and local environments, households weigh the benefits and costs of residing close to particular industry types, ranging from education and retail to food and entertainment. Likewise, when deciding on where to locate, firms also consider the distance to their targeted customers, labor supplies, and the neighborhood's features. As a corollary, both parties' location choices collectively determine the equilibrium spatial layout of neighborhoods and businesses. We then discuss the pertinent studies in residential sorting, firms' location choices, spatial work–residence imbalance, and how homeownership relates to location choices of firms and residents.

### 2.1. Residential sorting

Stemming from Tiebout sorting (1956), a large body of literature expands this seminal model, and the following effects on residential sorting have been studied: the quality and cost of local public goods (Ellickson, 1971; Epple & Sieg, 1999), education qualities (Bayer, Ferreira and McMillan, 2005), local wages (Albouy & Lue, 2015; Diamond, 2016), air pollution (Hamilton and Phaneuf, 2015; Liu, Hanley and Campbell, 2020), crime (Herzog, 2009), and racial composition (Bayer, Mcmillan, Murphy, & Timmins, 2016). Due to the complexity of resident sorting behaviors, another perspective for analyzing how residents sort into neighborhoods is to study the effects of amenities on house prices. These analyses reveal the preferences of residents over certain features, such as proximity to shopping centers, quality schools, etc. (Bayer, Ferreira and McMillan, 2007; Pope and Pope, 2015). There are, however, few studies, to the best of our knowledge, on how homeowners sort into locations with various distances to different kinds of businesses.

### 2.2. Firms' location choices

The exploration of firms' location choices starts with the Hotelling model (1929), where firms consider the effects of customer availability, locational features, and competition with other firms. A vast body of literature has built upon this model, with studies on the effects of neighborhoods on firms' location choices, such as the effect of income on retail services (Alwitt & Donley, 1997; Schuetz, Kolko and Meltzer, 2012; Meltzer & Schuetz, 2012), the gentrification effect on job counts (Meltzer & Ghorbani, 2017), the effect of public spending on the number of establishments (Gabe & Bell, 2004), and the effect of local tax policy on firms (Leonard, Yang, Zhang, & Reed, 2020). These studies mostly focus on general employment or limited types of industries covering small geographies. Plus, the homeownership effects on business location choice are under explored in the literature.

### 2.3. Spatial imbalance of businesses and residents<sup>4</sup>

The spatial imbalance literature considers the location choice of both residents and firms with an emphasis on the imbalance between them for disadvantaged populations, such as immigrants, minorities, and low-income groups. This analysis started when the employment in the U.S.

<sup>4</sup> We use “imbalance” in this article to refer to the “mismatch” in the literature related to the “spatial mismatch hypothesis” since the “mismatch” we use in this article refers to the negative relationship between homeownership rates and business job counts as opposed to the imbalance meaning in the spatial mismatch hypothesis

was suburbanizing while the minorities were still living in inner cities, leading to an imbalance between minorities with suitable job opportunities (Kain, 1968; Aponte, 1996; Wilson, 1987). Recent studies that explore the job–residence imbalance employ multiple methods and examine the imbalance for different industries of retail, food, and transportation. Some employ a spatial index on a metropolitan statistical area (MSA), county, or city to explore how many residents need to be relocated to achieve a balance between the job opportunities and the disadvantaged (Liu and Painter, 2011; Easley, 2018). Liu and Painter (2011) concentrate on the imbalance conditions of immigrants and find that their imbalance is more severe than those experienced by Caucasians. However, the condition is improving as immigrants locate toward employment opportunities. Easley (2018) also identifies a higher level of imbalance experienced by minorities.

The spatial imbalance analysis not only covers the U.S. but also expands to other parts of the world, with explorations on overall employment as well as on particular types of businesses, such as retail, health, and transportation. Wang et al. (2011) study the accessibility of jobs by exploring the amount of transit reachable jobs in Beijing, China. They find that the imbalance between employment and population is increasing over time in urban districts. Fan et al. (2014) also identify a job imbalance in Beijing, especially for the blue-collar workers. Hui et al. (2015) explore the work–residence imbalance and poverty concentration in Hong Kong. Their findings suggest that the public housing in the New Town does not lead to poverty concentration, but the public housing residents have a more severe spatial imbalance of jobs than residents in the inner city. Cheng et al. (2016) use travel time to analyze the access to hospitals in Shenzhen, China, and identify an imbalance in the health coverage within the city. Gómez et al. (2018) analyze the distribution of health equipment in Spain and locate the areas that need more health coverage. Liu et al. (2018) study the access to subways in Chongqing, China, and discover that the subways are more accessible in the inner-city area compared to rural areas.

Along this line of literature, we also explore the relative positions of businesses and residents, but with differing foci. We concentrate on a microlevel examination of the interactions between businesses and residents at varying distances between them. We also focus on both the mismatching and matching conditions for a full range of industries and neighborhoods with distinct features.

### 2.4. Homeowners in residential sorting and firms' location choices

Compared to renters with shorter stay and landlords who do not live in the neighborhood, homeowners exhibit distinct residential sorting behaviors and exert differential spillover effects on firms' location choices. We now discuss how homeowners sort into their home locations, which, in turn, affects firms' location choices.

#### 2.4.1. Homeowner sorting

In terms of their sorting behaviors, homeowners exhibit three distinct traits: First, homeowners have higher transaction costs and stay relatively longer in the community than renters. They stay in their neighborhood for an average of 13 years, whereas renters stay for only 3 years.<sup>5</sup> They further invest in the community with their home purchases. Homeowners consequently sort into neighborhoods with more careful considerations (Fischel, 2001, 2004; Bayer, Ferreira and McMillan, 2007) and exert a more enduring effect on the neighborhood. Second, differing from renters in age, the presence of children, marital status, and financial stake in the neighborhood, homeowners demonstrate varying preferences over access to schools, youth facilities, and health services, as well as the distance to those businesses, resulting in differential home location choices compared to renters. Third, homeowners need to consider the effect of proximity to certain businesses on their

<sup>5</sup> American Community Survey one-year estimates in 2018.

property values during their sorting process (Wen, Zhang and Zhang, 2014; Pope and Pope, 2015; Jang & Kang, 2015; Wu et al., 2017).

#### 2.4.2. Homeowning spillover effects on firms' location choices

The spillover effects of homeowning on firms' location choices occur through two channels. First, compared to renters and landlords, homeowners exert deeper influences on local amenities that influence a firm's location choice. The Homevoter Hypothesis from Fischel (2001 and 2004) specifies that homeowners have an essential financial stake in the community since the value of their major asset (their home) is closely dependent on the qualities of the neighborhood. Through zoning regulations, public hearings, and community activities, homeowners become watchful residents of every detail of community development, such as school-building, property tax changes, public infrastructure spending, new residential and commercial project development, and public safety (DiPasquale & Glaeser, 1998; Rohe et al., 2002; Dietz & Haurin, 2003; McCabe, 2013). Homeowning is also positively related to more social capital building (Manturuk, Lindblad, & Quercia, 2010) and higher levels of neighborhood satisfaction: renters feel that the neighborhoods with more homeowners tend to provide better living experiences (Lee, 2014). These amenities, including zoning stringencies, school qualities, tax levels, public infrastructure, and crime levels, are important factors affecting firms' location choices (Leonard et al., 2020; Gabe & Bell, 2004). Particularly, homeowners can employ stringent zonings to exclude the projects they deem harmful to the neighborhoods (Frieden, 1979; Fischel, 2001, 2004; Glaeser & Ward, 2009). For instance, they can include an open space requirement or stipulate that the change in zoning is subject to multiple rounds of committee approvals (Gyourko, Hartley, & Krimmel, 2019). Then, locating in such a community might incur a higher cost compared to alternative locations with less stringent zoning.

Second, homeowners engage in direct interactions with businesses through protesting and business invitations. They oppose projects deemed harmful to their neighborhood through protests and legal suits, which are found to influence business development (Teo & Loosemore, 2014). For instance, the homeowners in Sparing Valley, Las Vegas, united to boycott the construction of a second asphalt mixing plant close to their neighborhood due to the dust that the first plant created.<sup>6</sup> Another case involves the homeowners in the New York upper east side. They hired lawyers to bring a suit against a possible subway entrance near their building due to the aesthetic appearance and the potential nuisance the entrance might cause in their neighborhood.<sup>7</sup> Despite these oppositions to business development, homeowners also invite businesses to open in their neighborhood for community revitalization by leveraging tax cuts or credits. For example, Randallstown in Baltimore County expressed their hope to attract more retailers to the neighborhood to boost the economic activities in the local community.<sup>8</sup>

As discussed above, the sorting behaviors of homeowners as well as their spillover effects on the firms' location choices are likely to differ across homeowners with different incomes, businesses of various types, and varying distances between them. In this article, we therefore introduce a homeowning perspective and evaluate the spatial relationship by residential income, business types, and distances.

<sup>6</sup> <https://www.reviewjournal.com/local/local-las-vegas/spring-valley-are-a-residents-protest-against-plans-for-second-asphalt-mixing-plant/>.

<sup>7</sup> <https://www.nytimes.com/2012/02/26/nyregion/upper-east-side-residents-protest-proposed-subway-entrances.html>.

<sup>8</sup> <https://www.baltimorejournal.com/maryland/baltimore-county/bs-md-co-randallstown-walmart-20120917-story.html>.

### 3. Methodology

#### 3.1. The spatial distribution of businesses and neighborhoods

The spatial distribution between businesses and neighborhoods depends on both the household sorting behavior and the business location choice. Subject to their budget constraints, households and businesses choose the locations that maximize their utilities and profits, respectively. Following the models of residential sorting (Bayer et al., 2016) and firms' location choices (Hotelling, 1929), we describe the process with the two equations below:

$$U_{i,j,t}^{(h)} = U(D_{j,t}, X_{j,t}, g_i) \quad (1)$$

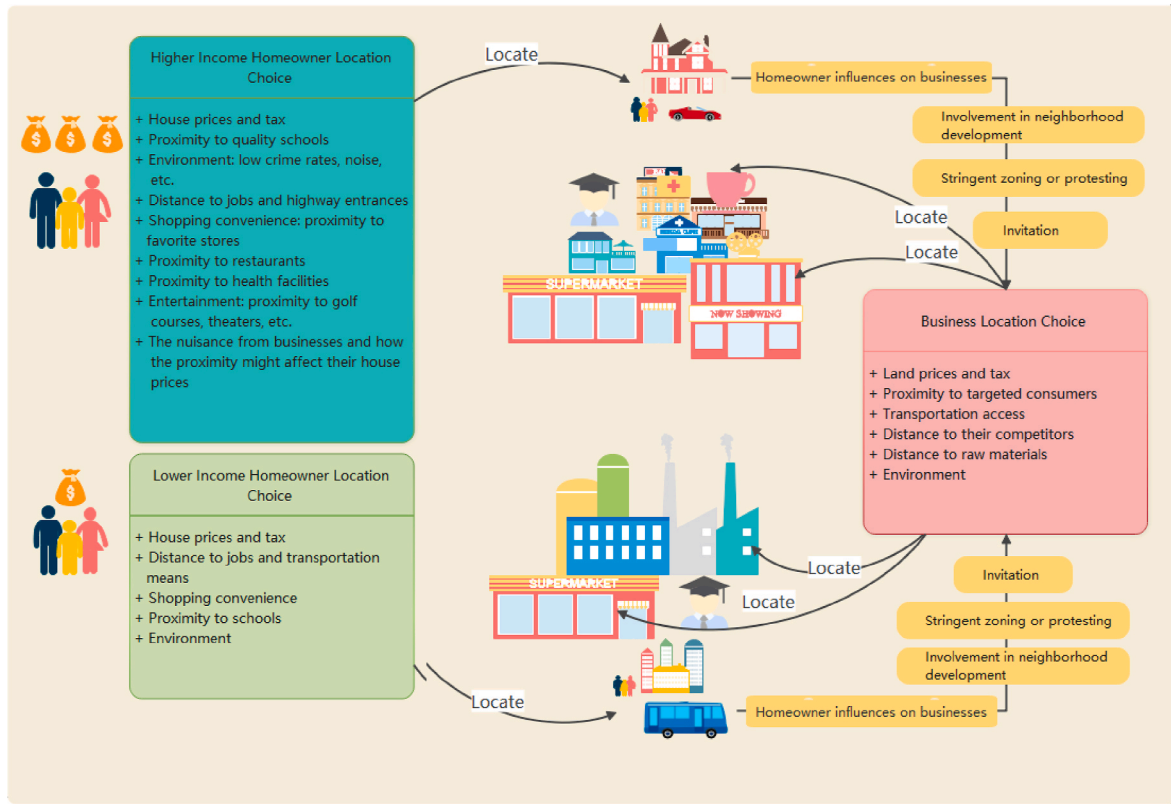
$$U_{b,l,t}^{(b)} = U(D_{l,j}, Y_{l,t}, k_b) \quad (2)$$

Equation (1) is the utility function for household  $i$ , neighborhood  $j$  in which the household chooses to locate, at time period  $t$ . It is a function of  $D_{j,t}$ ,  $X_{j,t}$  and  $g_i$ , where  $D_{j,t}$  represents the distance between neighborhood  $j$  and business cluster  $l$ . The utility of  $D_{j,t}$  represents the extent to which households value the proximity to various industries, such as retail, education, health, entertainment, etc.  $X_{j,t}$  denotes the characteristics for neighborhood  $j$  at time period  $t$ ;  $g_i$  denotes the unobservable variables affecting home location choices. By model assumption,  $X_{j,t}$  and  $g_i$  represent all the features—education, income, housing features, property tax levels, the natural and social environment, the weather, etc.—that affect the home location choice of households but are unrelated to the distance to businesses.

Equation (2) describes the business-profit-maximizing function for business type  $b$  in business cluster  $l$  at time period  $t$ . It depends on the distance between neighborhood  $j$  and job cluster  $l$ ,  $D_{l,j}$ ; the characteristics of the business cluster,  $Y_{l,t}$ ; and the unobservables,  $k_b$ .  $D_{j,t}$  and  $D_{l,j}$  are the same. As in Equation (1),  $Y_{l,t}$  and  $k_b$  include all the factors affecting firm location choice that are not related to the distance to households, such as rent, tax, the distance to their competitors, raw materials, and transportation access. The profits of  $D_{l,j}$  denote the net profits that firms gain from locating at certain distances to the neighborhood. The gross profits are related to the revenues that firms obtain from the proximity to targeted consumers, the amenities they enjoy from the neighborhood, and the credits or tax cuts they receive; the costs include the effort and money spent by firms in changing the zoning codes and dealing with opposition when necessary. These two equations then jointly determine the eventual spatial distribution of businesses and neighborhoods.

#### 3.2. Higher- and lower-income homeowners and businesses of various types

For homeowners with different incomes and businesses of various types, the utility functions in Equations (1) and (2) might differ, thus resulting in divergent spatial distributions. Fig. 1 demonstrates the simultaneous process of how 1) homeowners with higher and lower income sort into locations with different distances to businesses of particular types, and 2) different types of businesses choose their locations. On the left in Fig. 1, in deciding where to live, the higher- and lower-income homeowners consider factors including house prices, tax levels, proximity to various businesses, etc. However, the scope and the degree of importance of these factors differ between the two income groups. For instance, the lower-income homeowners tend to focus more on the distance to their jobs than the ambience. Yet, the higher-income homeowners probably prioritize access to good schools and the quality of the environment. In the end, one possible scenario is that the higher-income homeowners choose to live in a single-family house located within driving distance to schools, grocery stores, restaurants, movie theaters, urgent care, and coffee shops. The lower-income homeowners choose to live in multi-family buildings that are within walking distance to grocery stores, public transit, and are with only a few stops to their



**Fig. 1.** Location choices of homeowners and businesses. Note: This figure describes how the distribution of businesses and neighborhoods is jointly decided through the location choices of both parties.

workplaces.

On the right in Fig. 1, businesses consider the proximity to targeted customers, transportation access, etc. Different types of businesses vary in their considerations of these factors. For example, retail services place a heavy emphasis on public safety and the access to targeted customers. Warehousing, however, may heavily value transportation access. In the process of how businesses choose their locations, homeowners indirectly exert their influences through zoning, protesting, and invitations to businesses. Eventually, the location choices of homeowners and businesses portray the spatial distribution of neighborhoods and businesses with different attributes.

### 3.3. Empirical framework

To establish the spatial framework for analyzing the relationship, we follow the relative positions of businesses and neighborhoods appearing on maps. This position is depicted in Fig. 2, where the businesses cluster together and are surrounded by residents. Following this pattern and the methods used by former researchers for studying the effects of neighborhoods on jobs (Meltzer & Ghorbani, 2017), we select the job counts as the dependent variable and the homeownership rates as the independent variable to study their spatial relationship. The theoretical model then translates to an empirical model with fixed effects:

$$\ln (JobCount)_{l,t}^{(b)} = \alpha + \beta * Own_{l,t}^{(r,m)} + Controls_{l,t}^{(r,m)} + FE_l^{(r,m)} + FE_t + \epsilon_{l,t}^{(r,m)} \tag{3}$$

where  $\ln (JobCount)_{l,t}^{(b)}$  represents the log of job counts for job cluster  $l$  in year  $t$  for industry type  $b$ . We use the job counts of the 20 two-digit NAICS industries as the dependent variables. These are the classifications used by the U.S. Census for all business types. The specifics of these 20 industries are provided in Table 2.  $Own_{l,t}^{(r,m)}$  denotes the

homeownership rate of the donut ring  $r = \{1,2,3,4,5\}$  surrounding job cluster  $l$  in period  $t$  for income group  $m$ . The homeownership rate is calculated as the total number of homeowners divided by the total number of residents in the donut rings. In line with the literature (Meltzer & Ghorbani, 2017), the 5 donut rings are specified with the radii of  $\leq 0.3, 0.3-1, 1-2, 2-3,$  and  $3-5$  miles. For income levels, we use 19 categories.<sup>9</sup> The first 10 (namely, the lower-income groups) of the 19 include the observations whose average median household income of the residential donut rings stays below the 5%, 10%, 15%, 20%, 25%, 30%, 35%, 40%, 45%, and 50% quantile of the state median household income. The remaining 9 (namely, the higher-income groups) are composed of the observations for which the average median household income of the surrounding donut ring is above the 55%, 60%, to the >95% quantile of the state median household income. A negative (positive) coefficient for  $Own_{l,t}^{(r,m)}$  suggests that if homeownership rates increase, the job counts of the particular industry decrease (increase), indicating that a mismatch (match) exists between the businesses and the neighborhoods with a higher concentration of homeowners.

$Controls_{l,t}^{(r,m)}$  contains the donut rings' residential features affecting the job counts through consumption, including residential population, income, and education. The residential population is the total number of residents for each donut ring. Income is calculated as the average of median household income for the block groups included in each donut ring. These two appear in natural logarithms in Equation (3). The educational status is measured by the ratios of residents having bachelor and post-graduate degrees in the donut rings. We also add the job cluster characteristics, including employee education and job count density, to control for the agglomeration effects. The variables of education include

<sup>9</sup> The reason for using the 19 categories is to more accurately and dynamically capture the variation in the results with respect to the income levels.



**Fig. 2.** Relative positions of job clusters and donut rings. Note: This figure shows the relative position of a job cluster and the radii of within 0.3 miles and 0.3 to 1 mile. The study also includes the donut rings with radii of 1–2, 2–3, and 3–5 miles for the analyses.

the ratios of employees that have bachelor and post-graduate degrees in the job cluster. The job count density is calculated as the total number of job counts divided by the total land area of the job cluster. We finally include the distance to the CBD and the job counts of other job clusters to respectively control for the differences between downtown and suburbs, and for the competition from other job clusters.

To correct for the endogeneities due to the potential presence of unobservables or omitted variables affecting both the job counts and homeownership rates, including transportation access, local features (e. g., historical development, weather, and tax policies) and common macroeconomic factors (Krugman, 1991; Forkenbrock and Foster, 1996; Ellison & Glaeser, 1997; Rosenthal & Strange, 2001; Hanson and Rohlin, 2011), we employ a FE identification strategy to remove any fixed locational and temporal effects.  $FE_i^{(r,m)}$  is the individual job cluster fixed effects and  $FE_t$  is the time period fixed effects. The fixed locational effects remove the confounding factors that do not vary across time, and the time fixed effects serve to remove time-varying unobservables affecting the observations. The standard errors are clustered at the job cluster level. We next describe the data for the empirical research.

#### 4. Data

We assemble multiple data sources for the analysis. The dependent variable is the job counts for industries from Longitudinal Employer-Household Dynamic Workplace Area Characteristics (LEHD-WAC). The LEHD-WAC<sup>10</sup> provides job counts of people, categorized by their age, sex, education, income, and business industry types at the block level from 2002 to 2014. The independent variable of interest is the homeownership rate from the American Community Survey (ACS) at the block group level from 2009 to 2014.<sup>11</sup> The control variables of the residential population, education, and income are also obtained from the ACS. Other controls, such as employee population density and employee education, are drawn from the WAC. The geographic coordinates and land areas are collected from the 2010 Decennial Census.

<sup>10</sup> One limitation of the LEHD-WAC is that it lacks observations in Massachusetts in 2009 and 2010, DC in 2009, and Wyoming in 2014. We therefore drop all the data in the three states/areas from the analyses.

<sup>11</sup> The years 2009–2014 include the five-year estimate data of 2009, 2010, 2011, 2012, 2013 and 2014. For instance, 2009 includes the estimate of the data from 2005 to 2009 and 2010 from 2006 to 2010.

We match the three datasets: LEHD-WAC, ACS, and Decennial Census with the geocodes at the block group level.

Then, we construct our data in a spatial context to study the effects with distance. Fig. 2 shows the job clusters and the residents with the radii of within 0.3 miles and 0.3–1 mile. In accordance with the literature (Meltzer & Ghorbani, 2017), the length of the radius is calculated from the centroid of the job cluster to the centroid of the residential block groups. We bring together the business block groups that are geographically adjacent to form business clusters and then draw residential block groups surrounding the cluster to constitute donut rings of different radii to the center. A block group is categorized as business-oriented if the number of job counts is larger than that of housing units.<sup>12</sup> For the metropolitan and micropolitan areas in the U.S., there are 49,810 business-oriented block groups, which form 10,000 job clusters for the whole nation. The distribution of these job clusters is shown in Fig. 3. The average number of block groups for each cluster is five and the average radius is 2 miles. There are, altogether, 59,772 observations from 2009 to 2014.

Table 1 shows the descriptive statistics for the residential features of the five donut rings. The odd- and even-numbered columns describe the features of the higher- and lower-income groups, respectively. The higher-income (lower-income) group includes the donut rings whose average median household income is above (below) the 50th percentile of the state median household income. The first row of *Own* shows that the homeownership rates are noticeably higher in the higher-income groups than in the lower-income groups. As the distance increases from the job cluster, the homeownership rates in the lower-income groups steadily increase. For the higher-income groups, the homeownership rates are more evenly distributed with respect to distance to the business cluster. This indicates that the higher- and lower-income neighborhoods differ in the distribution of renters and homeowners with respect to distances to the businesses. For *Own Change* (second row), the homeownership rate decreases for all columns and the magnitude of such decrease is larger among the lower-income groups.

<sup>12</sup> Prior studies (Waddell & Shukld, 1993) adopted the standard that if the job density was higher than a certain threshold, it was then classified as a business cluster. Since the purpose of our research is exploring the spatial distribution between businesses and residents, we simply need to differentiate between these two as opposed to identifying localities with high concentrations of jobs. Additionally, our analyses include areas with low job densities.

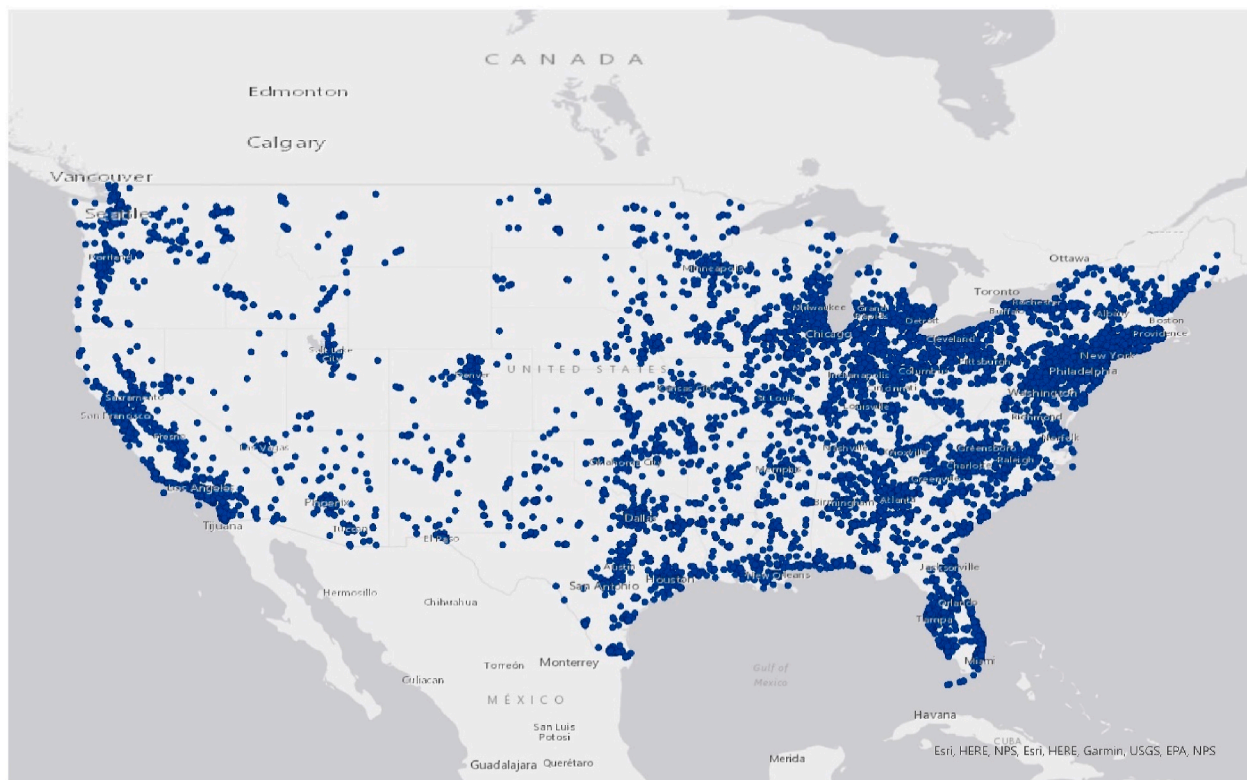


Fig. 3. The distribution of job clusters in the U.S.

Compared to their higher-income counterparts, the lower-income residents also live in areas with higher density.

Table 2 lists the summary statistics for the job counts of the various industries at the job cluster level from 2009 to 2014. The first column describes the names of the 20 NAICS industries. Column (2) provides the number of job clusters with positive job counts for each industry. Column (3) shows the observation ratios of each category. A higher ratio means that more job clusters contain jobs of this industry. Except for a few industries, such as agriculture, mining, and utilities, most of the categories appear on almost every cluster. Column (4) provides the average number of job counts of each industry per job cluster. Column (5) is the total number of job counts, and Column (6) is the job count ratio of each industry. Health care has the highest ratio of 14.6%, followed by retail at 10.8%, manufacturing at 9.5%, education at 8.9%, and accommodation and food at 8.8%. Column (7) shows the maximum number of job counts of each industry at the cluster level, with their corresponding locations shown in Column (8).

In Table 3, we list the job counts and the residential population coverage by income. Specifically, Columns (1) and (2) describe the job counts of the industries by income. The job counts for the higher-income (lower-income) groups for each industry are calculated from the sum of the job counts of the clusters surrounded by residents within 3 miles whose average median household income is above (below) the 50th percentile of the state median household income. Column (3) denotes the ratio of the job counts that fall into the higher-income part. As can be seen from Column (3), the industries of mining, construction, whole trade, retail trade, information, finance, real estate, professional services, management of companies, administration, arts, and accommodation and food services comprise more than 60% of the services located

in the higher-income groups. This suggests that there might be a disparity between the lower- and higher-income groups regarding the access to those industries. In terms of the observation numbers, about 56.7% of the job clusters locate in the higher-income groups. For Columns (4) and (5), we calculate the ratio of residential population to the number of job counts. A ratio of 44 in retail trade for the higher-income groups suggests that one staff working in the retail industry provides services to an average number of 44 residents in the higher-income neighborhoods. This ratio is as high as 75 in the lower-income groups, and such a gap exists in many other industries, implying that the lower-income groups might be relatively underserved compared to their higher income counterparts in retail trade, whole trade, information, finance and insurance, real estate, professional services, administrative support, arts and entertainment, accommodation and food, and other services.

## 5. Results

We perform FE estimations based on Equation (3) for each combination of the 19 income groups<sup>13</sup> and the 20 NAICS industries. Within each combination of the income groups and the industries, we estimate the coefficients for each of the five radii. The regression results with significant coefficients at 1%, 5%, or 10% significance levels are shown in the Appendix.<sup>14</sup> The standard errors are clustered at the job cluster level. The first 10 income groups are categorized as the lower-income

<sup>13</sup> Within the 19 income groups, the lower-income part is composed of the job clusters whose surrounding neighborhoods' median household income is less than the 5th, 10th, 15th, 20th, 25th, 30th, 35th, 45th, and 50th percentile of the state median household income. The higher-income part includes the job clusters whose surrounding neighborhoods' median household income is higher than the 55th, 60th, 65th, 70th, 75th, 80th, 85th, 90th, and 95th percentile of the state median household income.

<sup>14</sup> The statistically insignificant results can be provided upon request.

**Table 1**  
Summary statistics for residential characteristics.

Variable	Within 0.3 miles		0.3–1 mile		1–2 miles		2–3 miles		3–5 miles		US
	(1)Higher Income	(2)Lower Income	(3)Higher Income	(4)Lower Income	(5)Higher Income	(6)Lower Income	(7)Higher Income	(8)Lower Income	(9)Higher Income	(10)Lower Income	(11)
Own	0.7153 (.1674)	0.5414 (.1771)	0.7199 (.1634)	0.5557 (.1703)	0.7175 (.1533)	0.5821 (.1596)	0.7145 (.1502)	0.5975 (.1568)	0.7154 (.1312)	0.6177 (.1539)	0.659 -
Own Change	-0.0028 (.1400)	-0.0098 (.1240)	-0.0045 (.1779)	-0.0064 (.3549)	-0.0062 (.0697)	-0.0111 (.0782)	-0.0056 (.0811)	-0.0088 (.1092)	-0.0065 (.0476)	-0.0084 (.0647)	-0.006 -
Median Income	75975 (26304)	39823 (26304)	76347 (24931)	40829 (10072)	74022 (22737)	42288 (9647)	72574 (21260)	43254 (9482)	69365 (19398)	44957 (8808)	53889 -
High School	0.3630 (.1088)	0.4696 (.0878)	0.3647 (.1036)	0.4697 (.0833)	0.3742 (.0963)	0.4688 (.0768)	0.3804 (.0897)	0.4684 (.0739)	0.3940 (.0818)	0.4680 (.0700)	0.431 -
Bachelor	0.2154 (.0664)	0.1267 (.0561)	0.2141 (.0623)	0.1289 (.0527)	0.2070 (.0575)	0.1305 (.0471)	0.2026 (.0531)	0.1325 (.0442)	0.1933 (.0481)	0.1350 (.0410)	0.1775 -
Graduate	0.1045 (.0697)	0.0433 (.0350)	0.1034 (.0634)	0.0445 (.0332)	0.0981 (.0569)	0.0461 (.0309)	0.0938 (.0513)	0.0474 (.0293)	0.0854 (.0436)	0.0489 (.0267)	7.51% -
Age_25	0.3172 (.0633)	0.3604 (.0828)	0.3178 (.0602)	0.3569 (.0783)	0.3208 (.0548)	0.3546 (.0686)	0.3232 (.0510)	0.3517 (.0675)	0.3273 (.0439)	0.3481 (.0612)	0.334 -
Age2535	0.1321 (.0561)	0.1444 (.0448)	0.1301 (.0505)	0.1432 (.0428)	0.1297 (.0444)	0.1401 (.0369)	0.1297 (.0418)	0.1373 (.0357)	0.1282 (.0334)	0.1342 (.0323)	0.134 -
Age3545	0.1396 (.0318)	0.1258 (.0294)	0.1397 (.0300)	0.1272 (.0290)	0.1394 (.0263)	0.1280 (.0254)	0.1397 (.0254)	0.1283 (.0241)	0.1393 (.0208)	0.1291 (.0215)	0.13 -
Age4555	0.1518 (.0325)	0.1318 (.0312)	0.1536 (.0321)	0.1339 (.0316)	0.1528 (.0281)	0.1353 (.0272)	0.1531 (.0280)	0.1373 (.0276)	0.1528 (.0229)	0.1398 (.0250)	0.141 -
Age5565	0.1235 (.0349)	0.1078 (.0330)	0.1247 (.0334)	0.1092 (.0335)	0.1248 (.0307)	0.1124 (.0320)	0.1235 (.0295)	0.1138 (.0319)	0.1229 (.0252)	0.1159 (.0297)	0.123 -
Age65_	0.1359 (.0606)	0.1299 (.0625)	0.1341 (.0569)	0.1296 (.0621)	0.1324 (.0524)	0.1297 (.0531)	0.1307 (.0498)	0.1316 (.0541)	0.1295 (.0429)	0.1329 (.0469)	0.137 -
Residential Population	11528 (26304)	12450 (26304)	14502 (26304)	17469 (26304)	28878 (26304)	34043 (26304)	37925 (26304)	44728 (26304)	87246 (26304)	120518 (26304)	306058480 -
Res_pop_density	5523 (26304)	6168 (26304)	5166 (26304)	6037 (26304)	4466 (26304)	5249 (26304)	4051 (26304)	4883 (26304)	3098 (26304)	4596 (26304)	-
Obs	28,533	26,071	30,628	21,123	33,615	20,286	34,994	18,840	38,913	17,939	-

Note: the table describes the summary statistics for the donut rings that fall in the higher- and lower-income groups. The higher- and lower-income group include the donut rings whose average median household income is above and below the 50th percentile of the state median household income, respectively. Standard deviations of the means are provided in parentheses. The data are obtained from the ACS from 2009 to 2014. The national average in column (11) is from the 2014 Census. **Own** denotes the homeownership rates or the share of homeowners. **Own Change** represents the percentage change of homeownership rates from the prior year. **Median Income** represents the median household income. **High School**, **Bachelor**, **Graduate** denote the shares of people with these three educational levels. **Age 25** denotes the share of people with ages below 25. **Age2535** represents the share of people aged between 25 and 35. **Age65** denotes the share of people aged above 65. **Residential Population** means the number of the residents. **Res\_pop\_density** is the density of the residents in the respective donut rings in numbers per square miles.

groups and the last 9 as the higher-income groups. From the first table in the Appendix, we find a negative coefficient of -0.3465 for neighborhoods with income lower than the 20th percentile of the sample at the distance of 1–2 miles. The coefficient means that at the distance of 1–2 miles, a 1% increase in the homeownership rate (e.g., from 60% to 61%) for the neighborhood with income below the 20th percentile is associated with a 0.3465% decrease in the job counts within the construction industry. We also find positive coefficients for the distances of 2–3 and 3–5 miles. This indicates that construction does not match the homeowners in the lower-income group at a distance of 1–2 miles, but they match at a farther distance of 2–5 miles.

Since the results include multiple tables for the various income groups and industries, we present the findings in a graphical format, shown in Figs. 4 and 5, for visualization purposes. For these two figures, the horizontal axis illustrates the length of the five radii, including ≤0.3 miles, 0.3–1 mile, 1–2 miles, 2–3 miles, and 3–5 miles. The vertical axis represents the effects of homeownership rates on job counts of the various industries. The lines represent the FE estimation results and are drawn by connecting the points of the significant coefficients. For the shape of the curves, we assume an exponential distribution between the

effects and the distance. By assigning different values to the parameters, we can draw the lines that connect the coefficients.<sup>15</sup> We finally summarize the results in Table 4, which demonstrates the distances at which the positive or negative relationships between homeownership and business job counts are identified.

### 5.1. The lower-income groups

**Panel A.** both positive and negative effects for the lower-income groups

We first describe the results in Fig. 4, which shows the effects for the lower-income groups. This figure includes all the industries that have at least one significant coefficient for the five radii. The industries are grouped into three panels, where Panel A presents the industries for which both positive and negative effects of homeownership rates on the job counts exist, Panel B shows the industries with only positive effects, and Panel C demonstrates the industries with negative effects only. Panel A includes two industries: construction and transportation. The result displays that higher homeownership rates in the lower-income groups are associated with fewer construction services from 1 to 2

<sup>15</sup> The distribution is specified below, where  $\pi(D)^{(m,b)}$  stands for the homeowning impacts,  $D$  is the distance between the businesses and residents,  $m$  stands for residential income levels, and  $b$  is the varying business types. We graph the lines by assigning different values to the parameters  $\alpha$  and  $\beta$ :  $\pi(D)^{(m,b)} = \alpha_1 e^{-\beta_1 D} - \alpha_2 e^{-\beta_2 D}$ .



**Table 2**  
Descriptive statistics for industry job counts at the cluster level.

(1)NAICS	(2)Obs	(3)Obs Ratio	(4) Mean	(5)Total Job Counts	(6)Total Job Ratio	(7)Max	(8)Max Location
Total	58,193	1	8,866	86,632,883	1	467,929	-
NAICS sector 11 (Agriculture, Forestry, Fishing and Hunting)	29,683	0.5101	96	433,305	0.0055	11,322	North CA
NAICS sector 21 (Mining, Quarrying, and Oil and Gas Extraction)	21,249	0.3651	113	384,314	0.0049	17,320	Houston downtown
NAICS sector 22 (Utilities)	33,870	0.582	93	524,846	0.0058	11,712	LA downtown
NAICS sector 23 (Construction)	57,126	0.9817	336	3,275,593	0.0393	12,023	Vegas
NAICS sector 31–33 (Manufacturing)	55,091	0.9467	907	8,507,083	0.095	33,260	Seattle (Boeing)
NAICS sector 42 (Wholesale Trade)	56,825	0.9765	420	4,074,108	0.0459	26,227	NYC Manhattan
NAICS sector 44–45 (Retail Trade)	57,573	0.9893	969	9,451,916	0.108	18,221	New York
NAICS sector 48–49 (Transportation and Warehousing)	54,570	0.9377	323	3,273,232	0.0346	52,392	NYC (JFK airport)
NAICS sector 51 (Information)	52,465	0.9016	258	2,197,367	0.0258	47,206	Seattle (Microsoft headquarters)
NAICS sector 52 (Finance and Insurance)	55,854	0.9598	446	3,999,697	0.0476	75,889	NYC Manhattan
NAICS sector 53 (Real Estate and Rental and Leasing)	54,652	0.9392	135	1,210,697	0.0142	15,293	NYC Manhattan
NAICS sector 54 (Professional, Scientific, and Technical Services)	57,096	0.9811	594	5,607,413	0.0676	73,292	Chicago
NAICS sector 55 (Management of Companies and Enterprises)	45,423	0.7806	225	1,698,398	0.0212	13,630	Arkansas (Walmart home office)
NAICS sector 56 (Administrative and Support and Waste Management and Remediation Services)	57,129	0.9817	576	5,529,623	0.0673	26,435	Chicago
NAICS sector 61 (Educational Services)	54,794	0.9416	886	8,015,707	0.089	173,587	NYC Manhattan (NYU)
NAICS sector 62 (Health Care and Social Assistance)	57,056	0.9805	1314	12,411,715	0.1455	54,194	Houston (Texas Medical Center)
NAICS sector 71 (Arts, Entertainment, and Recreation)	50,039	0.8599	162	1,289,571	0.016	41,671	Orlando Disney
NAICS sector 72 (Accommodation and Food Services)	57,018	0.9798	763	7,765,260	0.0878	91,530	Vegas
NAICS sector 81 (Other Services [except Public Administration])	57,422	0.9868	257	2,443,596	0.0272	23,551	Seattle downtown
NAICS sector 92 (Public Administration)	54,042	0.9287	526	4,539,442	0.0516	90,563	NYC Lower Manhattan

Note: Column (1) is the NAICS codes for individual industries. Column (2) provides the number of job clusters with positive job counts for each industry. Column (3) is (2)/58,193, showing the shares of the job clusters that contain each of the industry types. A higher ratio indicates that more job clusters contain jobs of the respective industry. Except for a few industries, such as agriculture, mining, and utilities, most of the categories appear in almost every cluster. Column (4) provides the average number of job counts of each industry at the job cluster level. Column (5) is the total number of job counts, and Column (6) is the job count ratio of each industry. The industries of manufacturing, retail trade, educational services, health care, and accommodation and food services have relatively higher ratios. Column (7) shows the maximum job count number of each industry at the job cluster level. Column (8) shows the regions with the maximum job count for each industry.

miles and more construction services from 2 to 5 miles. Construction includes construction sites for residential, commercial, industrial, and transportation projects. It also includes plumbing, heating, and air-conditioning services. Since we can not pinpoint the specific services within the construction category, identifying the exact services that generate the differing effects for 1–2 and 2–5 miles becomes impossible. Yet, other studies and news reports<sup>16</sup> specify a lack of new construction or renovation in lower-income neighborhoods. Together with the finding that 61% of the construction services are located in the higher-income groups, as shown in Table 3, we conjecture that the negative effects found for 1–2 miles might have originated from the lack of revitalization in the lower-income localities. For the positive effects found for the farther distance of 2–5 miles, it might be that the lower-income homeowners work at the construction sites and/or in the plumbing and heating sectors with a commute distance of 2–5 miles.

We next consider transportation and warehousing, where we discover a positive effect of homeownership on job counts within the distance of 0.3 miles and a negative effect from 1 to 2 miles. Transportation and warehousing include air, railroads, urban transit, taxi services, etc. The result suggests that the lower-income homeowners match transportation services located nearby. This is in line with the literature findings that lower-income individuals rely more heavily on public transportation for their commute (Serulle & Cirillo, 2016). Additionally, lower-income neighborhoods are found to be more likely to locate near industrial areas and major roads,<sup>17</sup> which generates exposure to nuisances and hazards (Gochfeld & Burger, 2011).

<sup>16</sup> <https://www.urban.org/sites/default/files/publication/25346/412557-building-successful-neighborhoods.pdf>; [https://communityinnovation.berkeley.edu/sites/default/files/what\\_difference\\_can\\_a\\_few\\_stores\\_make\\_retail\\_and\\_neighborhood\\_revitalization.pdf?width=1200&height=800&iframe=true](https://communityinnovation.berkeley.edu/sites/default/files/what_difference_can_a_few_stores_make_retail_and_neighborhood_revitalization.pdf?width=1200&height=800&iframe=true).

<sup>17</sup> <https://www.smartcitiesdive.com/news/study-low-income-neighborhoods-disproportionately-feel-environmental-burden/543498/>.

**Panel B.** positive effects for the lower-income groups

We now describe Panel B, where only positive effects of homeownership on business job counts are found. The industries include whole trade, retail trade, and education, with the positive effects appearing at the distances of 1–2 miles, within 0.3 miles, and within 5 miles, respectively. Whole trade includes wholesalers for various kinds of merchandise, such as motor, furniture, construction materials, computer equipment, health, etc. Retail trade includes dealers for a variety of goods, such as automobiles, groceries, hardware, liquor, gasoline, clothing, jewelry, books, etc. Education consists of elementary and secondary schools, colleges, universities, and vocational schools.

As shown in Table 3, only 38% and 37% of the job counts in whole trade and retail trade are with the lower-income groups, who are still underserved compared to higher-income residents. For retail development, academic research and public media<sup>18</sup> have both specified that lower-income households suffer from an inadequate number and a smaller size of retail outlets (Alwitt & Donley, 1997; Schuetz, Kolko and Meltzer, 2012). They also have limited access to grocery stores offering healthy foods (Hilmers, Himers and Dave, 2012). Such limitations might pose serious health risks, such as obesity and other diseases<sup>19</sup>. A similar problem exists for educational services. Previous studies, for example, show that children from lower-income neighborhoods start behind and stay behind in education due to the limited guidance from their parents at an early stage, lack of school funding, and the inequitable distribution of teachers (Phillips, 2011; Ready, 2010). Our results suggest that these three industries match lower-income homeowners. Therefore, a promising picture is depicted that the accessibility to these three industries for the disadvantaged can be improved — if there are more homeowners in the lower-income groups, there will be more of these three services.

<sup>18</sup> <http://thefoodtrust.org/administrative/hffi-impacts/the-grocery-gap>.

<sup>19</sup> <https://www.knxx.org/post/real-reason-no-one-buys-produce-low-income-areas>

**Table 3**  
Job counts of industries by income.

	Job Counts			Residential Population to Job Counts	
	(1) Higher Income	(2) Lower Income	(3) Higher Income Ratio	(4) Higher Income	(5) Lower Income
NAICS sector 11 (Agriculture, Forestry, Fishing and Hunting)	158,862	274,443	0.3666	1658	960
NAICS sector 21 (Mining, Quarrying, and Oil and Gas Extraction)	252,598	131,716	0.6573	1043	1999
NAICS sector 22 (Utilities)	234,955	289,891	0.4477	1121	908
NAICS sector 23 (Construction)	1,994,356	1,281,237	0.6089	132	206
NAICS sector 31–33 (Manufacturing)	4,600,528	3,906,555	0.5408	57	67
NAICS sector 42 (Wholesale Trade)	2,506,571	1,567,537	0.6152	105	168
NAICS sector 44–45 (Retail Trade)	5,941,464	3,510,452	0.6286	44	75
NAICS sector 48–49 (Transportation and Warehousing)	1,704,281	1,568,951	0.5207	155	168
NAICS sector 51 (Information)	1,482,323	715,044	0.6746	178	368
NAICS sector 52 (Finance and Insurance)	2,635,358	1,364,339	0.6589	100	193
NAICS sector 53 (Real Estate and Rental and Leasing)	780,938	429,759	0.6450	337	613
NAICS sector 54 (Professional, Scientific, and Technical Services)	3,997,780	1,609,633	0.7129	66	164
NAICS sector 55 (Management of Companies and Enterprises)	1,081,741	616,657	0.6369	243	427
NAICS sector 56 (Administrative and Support and Waste Management and Remediation Services)	3,459,012	2,070,611	0.6255	76	127
NAICS sector 61 (Educational Services)	4,182,037	3,833,670	0.5217	63	69
NAICS sector 62 (Health Care and Social Assistance)	6,513,984	5,897,731	0.5248	40	45
NAICS sector 71 (Arts, Entertainment, and Recreation)	802,079	487,492	0.6220	328	540
NAICS sector 72 (Accommodation and Food Services)	4,878,277	2,886,983	0.6282	60	90
NAICS sector 81 (Other Services [except Public Administration])	1,462,363	981,233	0.5984	180	268
NAICS sector 92 (Public Administration)	1,916,758	2,622,684	0.4222	137	100
OBS	30,364	23,173	0.5672	-	-

Note: Income denotes the average median household income of the residents located within 3 miles of the job cluster. Higher (lower) income refers to the income that is above (below) the 50th percentile of the state level median household income. Columns (1) and (2) represent each industry’s total number of job counts that are within the higher- and lower-income groups, respectively. OBS represents the number of observations within the higher- and lower-income groups. Column (3) represents the ratio of the job counts of the higher-income group to the total number of job counts for each industry and is calculated from (1)/((1)+(2)). Columns (4) and (5) denote the ratio of the residential population within 3 miles of the job cluster to the job counts of each industry for the higher- and lower-income groups, respectively. It is calculated as the residential population divided by the total number of job counts. A number of 44 for retail trade of higher income suggests that in the higher-income neighborhoods, 1 retail staff provides services to 44 residents, on average.

**Panel C.** negative effects for the lower-income groups

Lastly, we identify a mismatch (i.e., negative effects of homeownership rates on business job counts) between the lower-income groups and two industries: accommodation and food, and art and entertainment. These two include hotels, casinos, recreational camps, restaurants, performing art companies, theaters, sports, museums, zoos, natural parks, golf courses, and bowling centers. The results then suggest that the lower-income homeowners and these two industries do not sort into the same areas. The possible reasons for this finding include: First, the costs of locating close to these two industries outweigh the associated benefits for lower-income homeowners. In fact, compared to retail, whole trade, and educational services, food and entertainment might be more optional than necessary. Second, these two industries may not choose to locate close to homeowners in lower-income neighborhoods due to the lack of targeted customers. This result indicates that lower-income neighborhoods with a higher concentration of homeowners might be deprived of close access to food and entertainment services. This discovery corresponds to the existing studies showing that lower-income neighborhoods might be “food deserts” (Schuetz, Kolko and Meltzer, 2012).

**5.2. The higher-income groups**

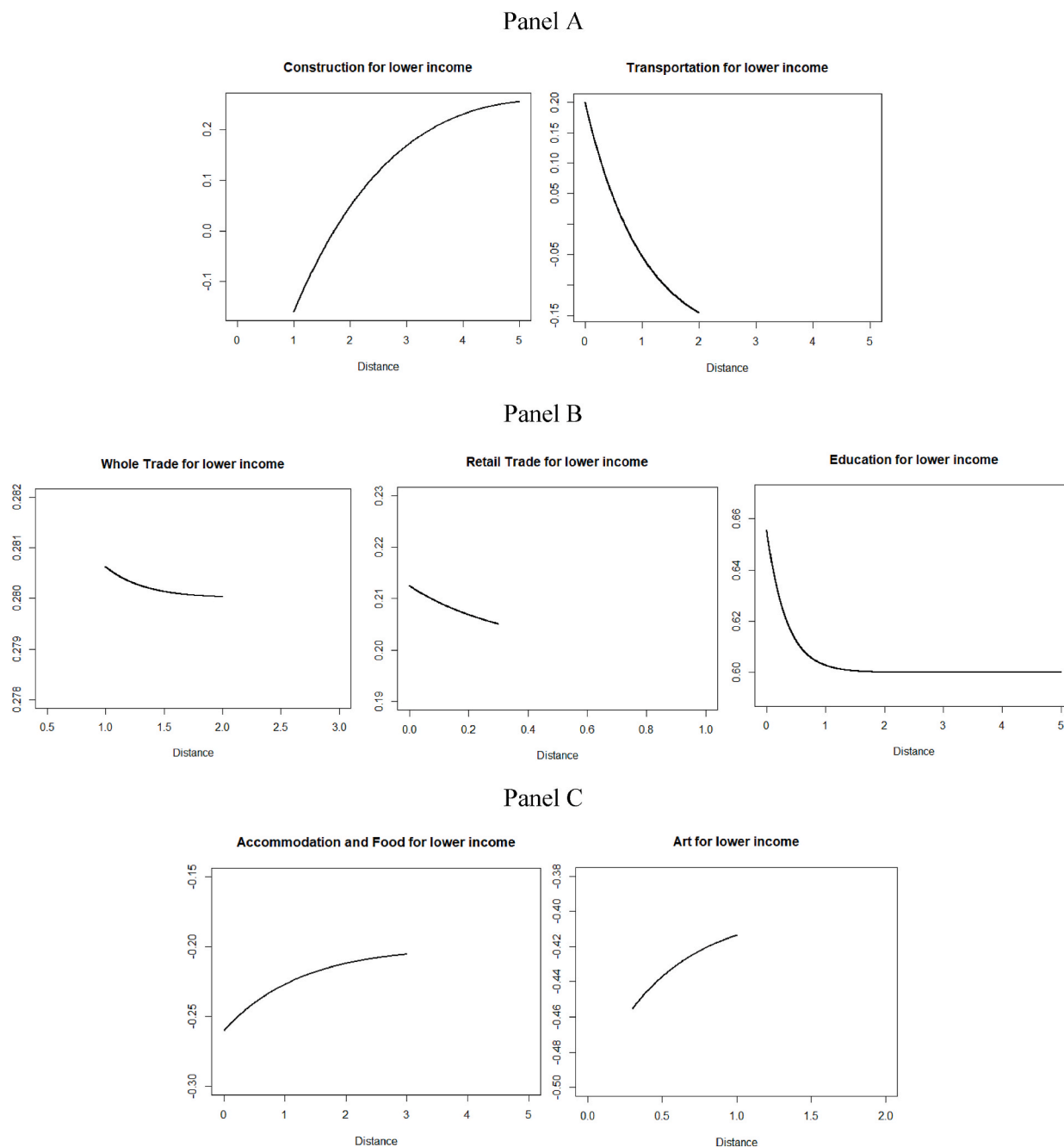
Fig. 5 demonstrates the results for the higher-income groups, where we mainly identify positive relationships between homeownership rates and business job counts. Specifically, we find that the industries of education, art and entertainment, health, retail trade, whole trade, and professional services match the higher-income homeowners. The health industry includes offices of physicians and dentists, medical centers, disability and mental health facilities, and daycare services. Professional services include the legal, notary, accounting, tax, payroll, architectural, engineering, design, research services, etc. For education, at the distance of within 0.3 miles, the effect is negative, suggesting that educational

services and higher-income homeowners might be avoiding each other at the adjacent distance. Possible explanations for this finding are as follows: the higher-income homeowners might not prefer to locate adjacent to educational services, such as Universities or Colleges, so that they can avoid the associated nuisances, like traffic, noise, and pollution; furthermore, since the educational services are generally indispensable for households, they do not necessarily need to locate adjacent to households to attract customers.

**5.3. Discussions of results and policy implications**

**5.3.1. Results summary**

Finally, Table 4 summarizes the results. From the table, we find no industries that mismatch the higher-income homeowners. For the lower-income groups, we find that the industries of accommodation and food, and art and entertainment are mismatched with the homeowners. The industries that match both income homeowners are whole trade, retail trade, and education, but the distances with positive effects for the three industries are shorter in the lower-income neighborhoods compared to those in the higher-income neighborhoods. The shorter distance could be due to that 1) the lower-income homeowners live in higher density areas and 2) the higher-income homeowners might implement stringent zonings to keep the businesses at a favorable distance to avoid nuisances. In addition to the common industries that match both income homeowners, the lower-income ones also match construction and transportation, and the higher-income homeowners match art, health, and professional services. Thus, typical neighborhood plazas in the lower-income neighborhoods might be composed of construction, education, whole trade, and retail trade, whereas the typical neighborhood plazas in the higher-income communities might consist of education, health, art and entertainment, whole trade, retail trade, and professional services.



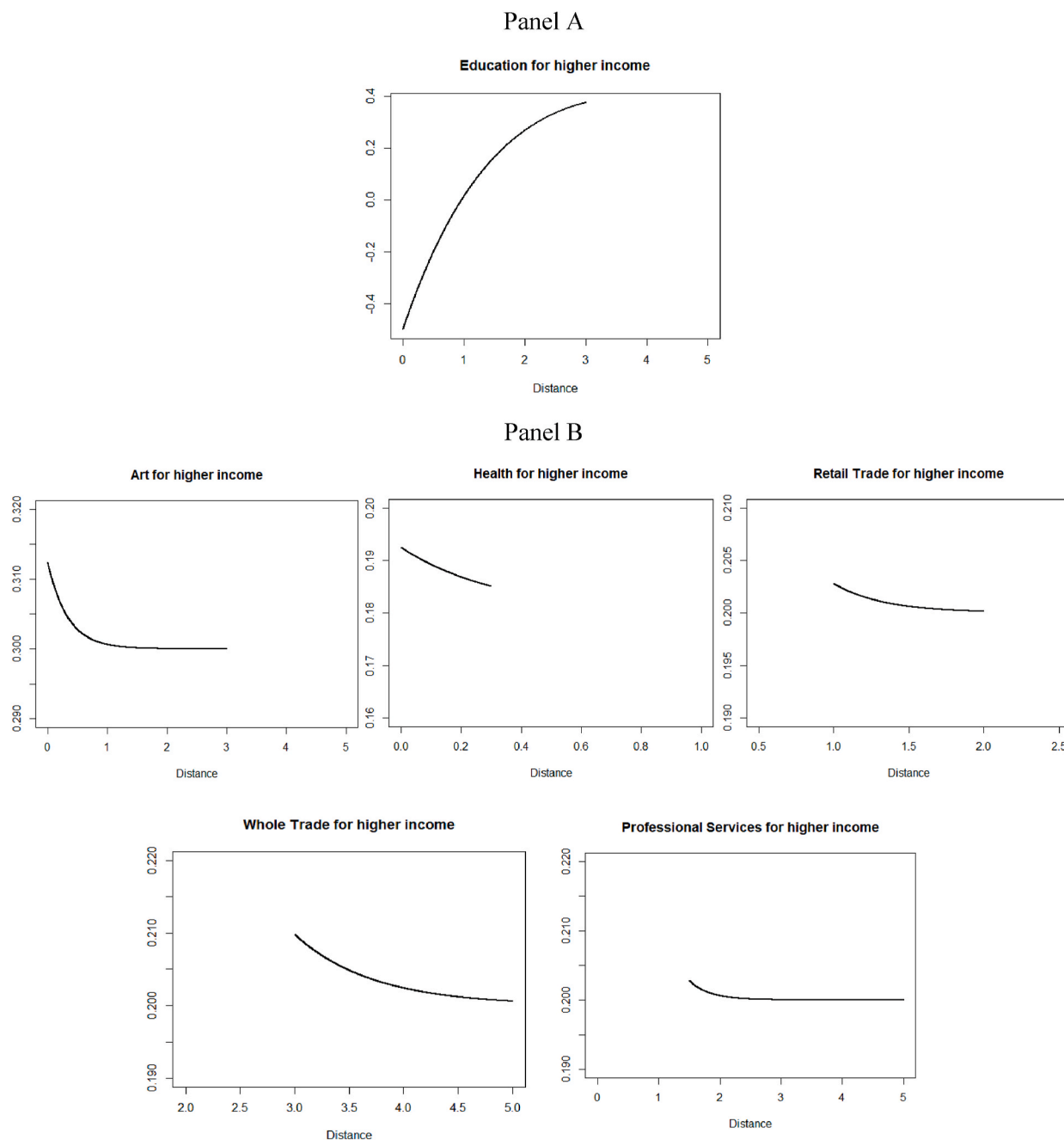
**Fig. 4.** Relationship between homeownership rates and jobs counts for different industries in the lower-income groups. Note: These figures display the effects of homeownership rates on the job counts of various industries for the lower-income groups. The horizontal axes illustrate the five radii of within 0.3 miles, 0.3–1 mile, 1–2 miles, 2–3 miles, and 3–5 miles. The vertical axes represent the magnitude of the effects from homeownership rates on the job counts of the various industries. The lines represent the FE estimation results and are drawn by connecting the points of the significant coefficients.

**5.3.2. Policy implications**

There are multiple policy implications of our findings. For zoning purposes, the mismatch between food and entertainment services with the lower-income homeowners suggests that the business plazas intended to attract food and entertainment services to the neighborhoods might not be able to successfully attract the targeted stores, resulting in high vacancy rates. Given the matching results, local businesses might profit from providing art and entertainment, health, retail, whole trade, and professional services to the higher-income neighborhoods with a high concentration of homeowners, whereas a combination of construction, retail, whole trade, and educational services might be a wiser market choice in lower-income neighborhoods with more homeowners.

For spatial positions, the government might consider the differences in distances where matching occurs between the residences and businesses in the higher- and lower-income neighborhoods. Additionally, the shorter distances identified between retail services and the homeowners in lower-income communities imply larger negative spillover effects from businesses, such as noise, pollution, and crime. This imposes increased pressure on policing and public environment protection.

For government subsidies intended to improve disadvantaged neighborhoods, the mismatch between the lower-income communities and the two industries of food and entertainment suggests a lack of access to fresh fruits, vegetables, and leisure opportunities, which are essential for physical and psychological health. One method of solving



**Fig. 5.** Relationship of homeownership rates and jobs counts for different industries in higher-income groups. Note: These figures display the effects of homeownership rates on the job counts of various industries for the higher-income groups. The horizontal axes illustrate the five radii of within 0.3 miles, 0.3–1 mile, 1–2 miles, 2–3 miles, and 3–5 miles. The vertical axes represent the magnitude of the effects from homeownership rates on the job counts of the various industries. The lines represent the FE estimation results and are drawn by connecting the points of the significant coefficients.

this predicament is to invite and subsidize food and entertainment stores to open in lower-income neighborhoods. This approach empowers neighborhoods through not only providing tangible food and entertainment services to the residents but also enhancing the local investment, employment, and tax base to realize sustainable local circulation and development. However, given the lengthy process of gentrification, the government might also need to provide vouchers to the lower-

income residents so that they can make purchases in existing stores. Consequently, subsidies for transportation might also be needed for them to travel to and from other stores.

Lastly, the concentration of lower-income homeowners can lead to food and entertainment deserts. This requires place-based housing programs to combine affordable housing with transportation, retail, educational services, food, health, and entertainment which might need

**Table 4**  
Summary of the results.

Panel A: results for lower-income groups					
Lower Income	(1) within 0.3	(2) 0.3–1	(3) 1-2	(4) 2-3	(5) 3-5
Accommodation and Food	negative	null	null	null	null
Art and Entertainment	null	negative	null	null	null
Construction	negative	null	null	positive	positive
Transportation	positive	null	negative	null	null
Whole Trade	null	null	positive	null	null
Retail Trade	positive	null	null	null	null
Education	positive	null	positive	positive	positive
Panel B: results for higher-income groups					
Higher Income	(1) within 0.3	(2) 0.3–1	(3) 1-2	(4) 2-3	(5) 3-5
Education	negative	null	null	positive	null
Art and Entertainment	positive	positive	null	positive	null
Whole Trade	null	null	null	null	positive
Retail Trade	null	null	positive	null	null
Health	positive	null	null	null	null
Professional Services	null	null	positive	positive	positive

Note: These two tables provide a summary of the match (positive) and mismatch (negative) results by distance and industries for the lower- and higher-income groups.

government subsidies to survive and develop. Regarding demand-side housing policies, one program intended to fight poverty and enhance upward mobility is the Moving-to-Opportunity (MTO) program administered by the U.S. Department of Housing and Urban Development (HUD). This program offers residents in high-poverty neighborhoods the option to move to low-poverty neighborhoods. Our findings on the distance difference suggest that residents in higher-income neighborhoods need to rely on vehicles to access the retail and educational services that are within a shorter or walkable distance to homeowners in lower-income neighborhoods. Additionally, public transit is not within reachable distance for higher-income neighborhoods. Thus, lower-income households might face transportation difficulties when given the opportunity to move from high-to low-poverty areas. Given the difference in the matched industries found for the two different income neighborhoods, some lower-income residents might also encounter skill mismatch when relocating to higher-income areas. Therefore, a more sustainable subsidy program that considers growing transportation and living expenses is probably needed to aid those lower-income households to adapt to the new environment.

Although our analyses are based on empirical results in the U.S. context, the major conclusions might also apply to other parts of the world. For instance, the phenomenon of a concentration of lower-income residents leading to a lack of access to jobs and services can be observed in most places. It might also be universal that the distances where the match and mismatch between businesses and residence happen can differ across neighborhoods. Yet, the differences in population densities, preferences, cultural traditions, and development histories can lead to variations in the exact industries and distances constituting the mismatching and matching results.

## 6. Conclusions

In this study, we explore whether a pattern exists for the spatial

distribution of neighborhoods and businesses by investigating the effects of homeownership rates in neighborhoods with different incomes on the job counts of 20 two-digit NAICS code businesses located within various distances to the neighborhoods. Specifically, we construct a rich dataset that maps the job clusters surrounded by residential donut rings of different radii. To account for the endogeneity that might arise from common factors affecting the location choices of both homeowners and businesses, we employ a FE identification strategy to remove any fixed locational and temporal effects. The results describe the two-way interactions between homeownership rates and business job counts, where a positive (negative) effect suggests a match (mismatch) between the homeowners and businesses.

The results show that the homeowners in both income groups match the industries of whole trade, retail trade, and education. This matching occurs at a farther distance in the higher-income group than in the lower-income one. In addition to these three industries, the higher-income homeowners also match art and entertainment, health, and professional services, whereas the lower-income homeowners match the industries of construction and transportation. These findings agree with our observation regarding the heterogeneity in the spatial relationship of neighborhoods and businesses with distinct features. That is, in a higher-income neighborhood, a larger concentration of homeowners is associated with more grocery stores, entertainment facilities, urgent care, day care facilities, and fine dining restaurants located within a short driving distance. For the lower-income neighborhoods with more homeowners, we are likely to expect affordable grocery stores, repair shops, and public transit located nearby. These results can assist the government in constructing zoning policies regarding the decision of introducing what industries and at which distances the industries should be positioned to the lower- and higher-income homeowners for a better fit.

The mismatch is only identified in the lower-income neighborhood, where we find that the homeowners mismatch accommodation and food, and art and entertainment. This mismatch signals an alarm for the plazas intended to accommodate these two industries in the lower-income neighborhoods, as the plaza might fail to attract or retain these two industries. From a social efficiency perspective, these two industries can immensely benefit the neighborhoods through the provision of a wider variety of healthy foods and entertainment, helping to prevent obesity and other diseases in the long term. Thus, to endow lower-income homeowners with easy access to these two industries, the government can provide monetary incentives to attract them or offer vouchers. For affordable housing policies that involve relocating lower-income residents to higher-income communities, we might consider providing transportation subsidies to households facing longer travel distances between residence and retail or educational services in wealthier neighborhoods.

## Author statement

Bingbing Wang: Conceptualization, Methodology, Software, Validation, Formal analysis, Data curation, Writing- Original draft preparation, Writing - Review & Editing, Visualization, Investigation, Funding acquisition. Bo Wen: Revising the manuscript, Writing- Reviewing and Editing.

**Appendix 1. Homeowning impacts for different income neighborhoods and industries**

Construction for lower income groups:

	(1) <5%	(2) <10%	(3) <15%	(3) <20%	(4) <25%	(5) <30%	(6) <35%	(7) <40%	(8) <45%	(9) <50%
0.3OWN	<b>1.1876**</b>	.3057	.2396	-.0845	-.1579	-.1331	-.0822	-.0031	.0353	.0527
Std	(.5765)	(.2735)	(.1992)	(.1644)	(.1387)	(.1212)	(.1130)	(.1027)	(.0975)	(.0886)
N	1204	3003	4856	7013	9125	10896	13183	15283	16994	20179
.3-1 OWN	.6807	.1644	.0946	.0122	-.0400	-.0802	-.0831	-.0929	-.0642	-.0580
Std	(.7341)	(.3122)	(.2630)	(.1970)	(.1403)	(.1303)	(.1136)	(.1047)	(.1033)	(.0913)
N	1184	2954	4719	6835	8808	10556	12702	14696	16388	19275
1-2 OWN	<b>-1.4867***</b>	<b>-.8177**</b>	<b>-.4661*</b>	<b>-.3465*</b>	-.2399	-.2010	-.1043	-.0901	-.0262	-.0748
Std	(.5746)	(.3560)	(.2679)	(.2154)	(.1802)	(.1598)	(.1383)	(.1239)	(.1098)	(.1005)
N	1209	2987	4792	6925	8961	10706	12930	14963	16695	19763
2-3 OWN	1.1310	<b>.8338*</b>	.2458	.3612	.2525	.0730	.0712	.0733	.0756	.0431
Std	(.8719)	(.4649)	(.2744)	(.2290)	(.1887)	(.1691)	(.1539)	(.1332)	(.1234)	(.1148)
N	1171	2885	4667	6734	8758	10455	12677	14689	16417	19266
3-5 OWN	.5956	.3976	.4625	<b>.4779*</b>	.2864	.2803	.2379	.2734	.1906	.2155
Std	(.5806)	(.3693)	(.3144)	(.2704)	(.2165)	(.1996)	(.1779)	(.1739)	(.1640)	(.1470)
N	1117	2809	4555	6580	8575	10292	12486	14476	16197	19213

Education for higher income groups:

	(1)>55%	(2)>60%	(3)>65%	(4)>70%	(5)>75%	(6)>80%	(7)>85%	(8)>90%	(9)>95%
0.3 OWN	.0094	-.0230	-.1515	-.1585	-.1616	-.1264	-.2959	<b>-.6996**</b>	<b>-1.6189***</b>
Std	(.1640)	(.1761)	(.1913)	(.2176)	(.2555)	(.3163)	(.2992)	(.3421)	(.5727)
N	16393	14734	12692	10495	8748	6733	4663	2914	1178
.3-1 OWN	-.0630	-.1004	-.0609	.0182	.0752	.2710	.1775	-.1152	-.0306
Std	(.1212)	(.1315)	(.1484)	(.1606)	(.1764)	(.1961)	(.2735)	(.3794)	(.3823)
N	15874	14225	12269	10201	8500	6608	4595	2906	1207
1-2 OWN	-.0877	-.0819	-.0871	-.0516	-.1948	-.1776	.0398	-.0033	-.4528
Std	(.1410)	(.1470)	(.1621)	(.1760)	(.1980)	(.2165)	(.2512)	(.2714)	(.6308)
N	16366	14682	12702	10554	8830	6804	4720	2965	1231
2-3 OWN	.2691	<b>.4053**</b>	<b>.4039**</b>	<b>.4215*</b>	.3191	<b>.4783*</b>	<b>.9024***</b>	<b>.6183*</b>	.2363
Std	(.1759)	(.1882)	(.2027)	(.2227)	(.2238)	(.2503)	(.2683)	(.3249)	(.5156)
N	16175	14467	12485	10345	8665	6665	4646	2890	1196
3-5 OWN	-.2292	-.2593	-.3585	-.2230	-.1498	-.2625	-.3482	-.0740	.6184
Std	(.2407)	(.2457)	(.2617)	(.2870)	(.3076)	(.3266)	(.3292)	(.4605)	(.7609)
N	15946	14258	12350	10229	8537	6583	4636	2869	1187

Note: These are FE with the dependent variable as the natural log of the job counts of different industries and the independent variable of interest as the home-ownership rates of the donut ring under study. Analyses are performed for different residential income percentiles in the respective columns. Col. (1) represents the group with a residential income less than the 5th percentile of the sample income. Col. (2) represents the group with residential income less than the 10th percentile of the sample income (0%–10%). The rows indicate the different distances. Controls include residential population, employee education, employee population density, residential median income, residential education, home-ownership rates of other rings, distance to CBD, job counts for job clusters adjacent to the one under study, and year fixed effects. Standard errors are clustered at the job cluster level and are presented in parentheses. \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

Transportation for lower income groups:

	(1) <5%	(2) <10%	(3) <15%	(3) <20%	(4) <25%	(5) <30%	(6) <35%	(7) <40%	(8) <45%	(9) <50%
0.3 OWN	.5189	.0529	.0874	.1468	.1296	.2505	<b>.2772*</b>	<b>.2716*</b>	.1420	.1259
Std	(.4955)	(.2559)	(.2224)	(.1903)	(.1828)	(.1651)	(.1521)	(.1429)	(.1454)	(.1299)
N	1185	2934	4739	6835	8882	10595	12827	14871	16543	19620
.3-1 OWN	.0927	.4788	-.3154	-.1063	.0410	-.0705	-.0329	.0253	.0442	-.0117
Std	(.7558)	(.3999)	(.3007)	(.2324)	(.2314)	(.1953)	(.1853)	(.1703)	(.1596)	(.1462)
N	1183	2910	4633	6659	8584	10286	12368	14277	15920	18700
1-2 OWN	<b>-2.6764***</b>	<b>-1.0240*</b>	-.5860	-.5021	-.1838	-.2945	<b>-.3345*</b>	-.2651	-.1980	-.0427
Std	(.9452)	(.5436)	(.4075)	(.3186)	(.2397)	(.2127)	(.1921)	(.1771)	(.1625)	(.1518)
N	1185	2904	4658	6708	8698	10406	12549	14522	16202	19152
2-3 OWN	.9402	-.1547	-.2970	-.2787	-.2474	-.1735	-.1586	-.0317	-.0733	-.0640
Std	(1.4727)	(.5944)	(.3723)	(.3346)	(.2776)	(.2556)	(.2188)	(.2073)	(.1948)	(.1790)
N	1139	2801	4534	6536	8500	10145	12285	14259	15945	18705
3-5 OWN	.7335	.1839	.3417	.3746	.4953	.2930	.3092	.2774	.3002	<b>.4445**</b>
Std	(.8915)	(.5294)	(.4081)	(.3986)	(.3639)	(.3232)	(.2778)	(.2598)	(.2432)	(.2141)
N	1072	2703	4395	6349	8268	9926	12020	13953	15616	18522

Art for lower income groups:

	(1) <5%	(2) <10%	(3) <15%	(3) <20%	(4) <25%	(5) <30%	(6) <35%	(7) <40%	(8) <45%	(9) <50%
0.3 OWN	-.5788	-.1276	.1782	-.0151	-.1678	-.0645	-.1698	-.1767	-.1582	-.1625
Std	(.5768)	(.3525)	(.3976)	(.2938)	(.2459)	(.2100)	(.1924)	(.1740)	(.1654)	(.1493)
N	1032	2597	4230	6156	8037	9638	11645	13518	15062	17856
.3-1 OWN	-.3836	-.3442	<b>-.7120**</b>	<b>-.7781***</b>	<b>-.5654***</b>	<b>-.3789*</b>	<b>-.4056**</b>	<b>-.4419***</b>	<b>-.4170***</b>	<b>-.2698*</b>
Std	(.9925)	(.4686)	<b>(.3432)</b>	<b>(.2729)</b>	<b>(.2140)</b>	<b>(.1976)</b>	<b>(.1764)</b>	<b>(.1618)</b>	<b>(.1558)</b>	<b>(.1405)</b>
N	996	2517	4077	5962	7736	9299	11205	13010	14534	17066
1-2 OWN	1.7534	-.2962	-.1989	-.2350	-.2999	-.3569	-.3102	-.2409	-.2477	-.2577
Std	(1.4048)	(.8716)	(.5383)	(.4202)	(.3213)	(.3190)	(.2754)	(.2438)	(.2208)	(.1917)
N	1029	2582	4110	5919	7688	9275	11207	13039	14621	17340
2-3 OWN	1.6843	.6744	.2597	.1659	-.0871	-.0482	-.1214	-.0994	-.0676	-.1741
Std	(2.0484)	(.7093)	(.5028)	(.3940)	(.3228)	(.2966)	(.2682)	(.2434)	(.2167)	(.2013)
N	1040	2460	4017	5796	7565	9083	11013	12817	14398	16925
3-5 OWN	2.7125	.0346	.1014	.1184	.2616	.0785	.1559	.1919	.3056	.1458
Std	(1.8261)	(.6366)	(.4795)	(.4051)	(.3269)	(.3071)	(.2725)	(.2653)	(.2432)	(.2255)
N	961	2415	3943	5682	7391	8914	10840	12621	14195	16814

Note: These are FE with the dependent variable as the natural log of the job counts of different industries and the independent variable of interest as the home-ownership rates of the donut ring under study. Analyses are performed for different residential income percentiles in the respective columns. Col. (1) represents the group with a residential income less than the 5th percentile of the sample income. Col. (2) represents the group with residential income less than the 10th percentile of the sample income (0%–10%). The rows indicate the different distances. Controls include residential population, employee education, employee population density, residential median income, residential education, home-ownership rates of other rings, distance to CBD, job counts for job clusters adjacent to the one under study, and any fixed effects. Standard errors are clustered at the job cluster level and are presented in parentheses. \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

Accommodation and Food for lower income groups:

	(1) <5%	(2) <10%	(3) <15%	(3) <20%	(4) <25%	(5) <30%	(6) <35%	(7) <40%	(8) <45%	(9) <50%
0.3 OWN	-.5728	-.2974	-.1568	-.1404	-.1582	<b>-.2236**</b>	<b>-.2062**</b>	<b>-.1813**</b>	<b>-.1549**</b>	-.1090
Std	(.4337)	(.2184)	(.1643)	(.1313)	(.1076)	<b>(.1027)</b>	<b>(.0977)</b>	<b>(.0833)</b>	<b>(.0774)</b>	(.0743)
N	1247	3077	4932	7095	9228	11013	13297	15398	17110	20285
.3-1 OWN	.5539	-.2427	-.1692	-.0994	-.1311	-.1223	-.1064	-.0523	-.0589	-.0395
Std	(.5458)	(.3093)	(.1941)	(.1654)	(.1391)	(.1181)	(.1031)	(.0897)	(.0844)	(.0757)
N	1233	3023	4801	6929	8902	10667	12814	14823	16520	19401
1-2 OWN	.8624	.3170	-.0724	.0299	.0071	.0189	.0504	.0012	.0213	-.0109
Std	(.4769)	(.2926)	(.2672)	(.1903)	(.1454)	(.1374)	(.1236)	(.1096)	(.1003)	(.0897)
N	1258	3049	4867	7024	9075	10827	13045	15088	16818	19864
2-3 OWN	-.1797	-.2190	-.2565	-.3001	-.2266	-.1605	<b>-.2298*</b>	-.1610	-.1634	-.1746
Std	(.5012)	(.3584)	(.2512)	(.2111)	(.1723)	(.1496)	<b>(.1389)</b>	(.1272)	(.1201)	(.1091)
N	1223	2946	4752	6827	8867	10583	12795	14814	16554	19387
3-5 OWN	-.1384	-.0506	.1348	.1970	.0803	.2402	.2156	.2247	.1909	.1237
Std	(.3114)	(.2437)	(.2953)	(.2421)	(.1987)	(.1961)	(.1805)	(.1603)	(.1473)	(.1368)
N	1196	2913	4685	6697	8692	10419	12600	14580	16306	19303

Art for higher income groups:

	(1) >55%	(2) >60%	(3) >65%	(4) >70%	(5) >75%	(6) >80%	(7) >85%	(8) >90%	(9) >95%
0.3 OWN	.0159	.0309	.0950	.1252	.0453	.0225	.3231	<b>.5061*</b>	.6499
Std	(.1346)	(.1397)	(.1440)	(.1573)	(.1777)	(.2089)	(.2656)	<b>(.2905)</b>	(.4617)
N	15610	14041	12119	10048	8386	6501	4544	2851	1170
.3-1 OWN	.0601	.1245	.1381	.2400	.1796	.0800	.3879	<b>.7508*</b>	.1605
Std	(.1304)	(.1421)	(.1558)	(.1753)	(.1909)	(.2175)	(.3209)	<b>(.4542)</b>	(.6050)
N	15108	13554	11714	9768	8153	6376	4441	2834	1190
1-2 OWN	-.1143	-.0861	-.0484	-.0736	.0210	.0129	.1078	.2885	-.0525
Std	(.1387)	(.1440)	(.1594)	(.1766)	(.1968)	(.2430)	(.3096)	(.3786)	(.5408)
N	15511	13928	12070	10068	8407	6487	4520	2850	1193
2-3 OWN	.0450	.1077	<b>.2757*</b>	<b>.3755**</b>	.2925	.2485	<b>.5274*</b>	.5055	.9874
Std	(.1671)	(.1789)	<b>(.1663)</b>	<b>(.1861)</b>	(.1921)	(.2231)	<b>(.2772)</b>	(.3965)	(.8766)
N	15329	13729	11862	9839	8243	6358	4483	2782	1165
3-5 OWN	.1257	.2027	.1154	-.0628	-.1078	-.0004	-.2246	.2903	1.1327
Std	(.2462)	(.2580)	(.2740)	(.2874)	(.3138)	(.3618)	(.4196)	(.4224)	(.7601)
N	15058	13470	11683	9666	8059	6222	4395	2724	1154

Note: These are FE with the dependent variable as the natural log of the job counts of different industries and the independent variable of interest as the home-ownership rates of the donut ring under study. Analyses are performed for different residential income percentiles in the respective columns. Col. (1) represents the group with a residential income less than the 5th percentile of the sample income. Col. (2) represents the group with residential income less than the 10th percentile of the sample income (0%–10%). The rows indicate the different distances. Controls include residential population, employee education, employee population density, residential median income, residential education, home-ownership rates of other rings, distance to CBD, job counts for job clusters adjacent to the one under study, and year fixed effects. Standard errors are clustered at the job cluster level and are presented in parentheses. \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

Health for higher income groups:

	(1)>55%	(2)>60%	(3)>65%	(4)>70%	(5)>75%	(6)>80%	(7)>85%	(8)>90%	(9)>95%
0.3 OWN	.0959	<b>.1298*</b>	<b>.1795**</b>	.1013	.0899	.0391	.1155	.0455	.0414
Std	(.0766)	<b>(.0800)</b>	<b>(.0821)</b>	(.0882)	(.0975)	(.1086)	(.1282)	(.1595)	(.2267)
N	16857	15152	13047	10777	9004	6934	4798	2987	1213
.3-1 OWN	-.0398	-.0834	-.0713	-.0332	-.0924	-.1274	-.0348	-.0006	-.2952
Std	(.0743)	(.0779)	(.0877)	(.1000)	(.1111)	(.1269)	(.1845)	(.2231)	(.4066)
N	16227	14535	12539	10432	8699	6768	4711	2981	1231
1-2 OWN	-.0841	-.0655	-.0448	-.0569	-.0715	-.1156	-.1004	.0808	.4526
Std	(.0913)	(.0944)	(.1039)	(.1164)	(.1296)	(.1568)	(.1935)	(.2432)	(.5031)
N	16735	15017	12997	10789	9017	6950	4821	3021	1247
2-3 OWN	-.0176	.0132	.0568	.0732	.1222	.0007	.1784	.1799	.1455
Std	(.0927)	(.0980)	(.1069)	(.1174)	(.1290)	(.1439)	(.1380)	(.1496)	(.1978)
N	16570	14825	12786	10584	8860	6817	4751	2949	1216
3-5 OWN	-.0105	.0091	.0778	.0864	.1757	.3598	.3184	.4733	.2179
Std	(.1340)	(.1374)	(.1441)	(.1581)	(.1706)	(.1713)	(.1867)	(.2368)	(.3845)
N	16372	14649	12664	10453	8718	6707	4706	2910	1206

Education for lower income groups:

	(1) <5%	(2) <10%	(3) <15%	(3) <20%	(4) <25%	(5) <30%	(6) <35%	(7) <40%	(8) <45%	(9) <50%
0.3 OWN	-.0892	.6460	<b>.7804**</b>	.4237	.2034	.1214	.1493	.1712	.1617	.1323
Std	(.7571)	(.4269)	<b>(.3500)</b>	(.2804)	(.2405)	(.2079)	(.1938)	(.1785)	(.1662)	(.1505)
N	1190	2952	4750	6866	8937	10645	12861	14882	16549	19615
.3-1 OWN	1.1997	.4898	.2911	.3490	.2904	.2737	.2566	.1558	.1145	.0643
Std	(.9138)	(.6430)	(.4541)	(.3158)	(.2255)	(.1963)	(.1794)	(.1621)	(.1649)	(.1464)
N	1177	2884	4605	6644	8567	10266	12306	14247	15896	18685
1-2 OWN	1.3477	<b>1.0833*</b>	.5567	.6173	.0378	.1058	.0712	-.0215	-.0103	.0954
Std	(1.0811)	<b>(.6628)</b>	(.4909)	(.3865)	(.2903)	(.2545)	(.2333)	(.2120)	(.1877)	(.1796)
N	1166	2884	4635	6695	8673	10368	12505	14491	16181	19114
2-3 OWN	.0297	<b>1.2081*</b>	<b>.9797**</b>	<b>.6781*</b>	.3777	.3262	.2796	.2727	.1810	.1072
Std	(1.0383)	<b>(.6330)</b>	<b>(.4708)</b>	<b>(.3788)</b>	(.3220)	(.2894)	(.2408)	(.2147)	(.2002)	(.1849)
N	1168	2818	4570	6571	8535	10189	12319	14257	15932	18661
3-5 OWN	.7844	<b>.8056*</b>	<b>.7802*</b>	<b>.8016**</b>	<b>.6868**</b>	<b>.4904*</b>	<b>.6896**</b>	<b>.5718**</b>	.3773	.1991
Std	(.8916)	<b>(.4546)</b>	<b>(.4629)</b>	<b>(.3963)</b>	<b>(.3365)</b>	<b>(.3019)</b>	<b>(.2824)</b>	<b>(.2586)</b>	(.2397)	(.2092)
N	1109	2772	4479	6416	8325	9978	12095	14022	15699	18567

Note: These are FE with the dependent variable as the natural log of the job counts of different industries and the independent variable of interest as the home-ownership rates of the donut ring under study. Analyses are performed for different residential income percentiles in the respective columns. Col. (1) represents the group with a residential income less than the 5th percentile of the sample income. Col. (2) represents the group with residential income less than the 10th percentile of the sample income (0%–10%). The rows indicate the different distances. Controls include residential population, employee education, employee population density, residential median income, residential education, home-ownership rates of other rings, distance to CBD, job counts for job clusters adjacent to the one under study, and year fixed effects. Standard errors are clustered at the job cluster level and are presented in parentheses. \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

Whole Trade for lower income groups:

	(1) <5%	(2) <10%	(3) <15%	(3) <20%	(4) <25%	(5) <30%	(6) <35%	(7) <40%	(8) <45%	(9) <50%
0.3 OWN	-.6349	-.0244	-.0099	.0362	.0276	-.0058	.0140	.0823	.0760	.0600
Std	(.4355)	(.2604)	(.1998)	(.1541)	(.1343)	(.1147)	(.1033)	(.0918)	(.0913)	(.0813)
N	1233	3054	4909	7074	9182	10954	13229	15327	17024	20190
.3-1 OWN	.0316	-.2518	-.1932	-.0338	-.0372	-.0438	-.0672	-.0420	-.0156	.0079
Std	(.5274)	(.3720)	(.2219)	(.1727)	(.1319)	(.1214)	(.1079)	(.0972)	(.0909)	(.0838)
N	1230	3005	4777	6894	8872	10624	12766	14761	16457	19325
1-2 OWN	.0049	-.1796	.2839	.1766	.2540	<b>.2608*</b>	<b>.3034**</b>	<b>.2052*</b>	.1532	.1418
Std	(.6663)	(.3507)	(.2807)	(.2294)	(.1726)	<b>(.1524)</b>	<b>(.1379)</b>	<b>(.1245)</b>	(.1112)	(.0987)
N	1243	3025	4838	6970	9009	10758	12966	15002	16731	19777
2-3 OWN	-.0533	.1673	.2999	.0867	.0231	.1045	-.0330	.0830	.0365	.0294

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	(1) <5%	(2) <10%	(3) <15%	(3) <20%	(4) <25%	(5) <30%	(6) <35%	(7) <40%	(8) <45%	(9) <50%
Std	(.6652)	(.3993)	(.2422)	(.2038)	(.1888)	(.1737)	(.1478)	(.1410)	(.1290)	(.1153)
N	1204	2926	4726	6786	8811	10518	12734	14745	16485	19329
3-5 OWN	-.7610	-.0338	-.0966	.1080	.0450	-.0325	.0032	.0861	.0494	.0344
Std	(.9968)	(.3949)	(.3046)	(.2536)	(.2176)	(.2037)	(.1871)	(.1703)	(.1564)	(.1394)
N	1153	2851	4613	6636	8623	10340	12534	14516	16236	19238

Retail Trade for lower income groups:

	(1) <5%	(2) <10%	(3) <15%	(3) <20%	(4) <25%	(5) <30%	(6) <35%	(7) <40%	(8) <45%	(9) <50%
0.3 OWN	-.3470	.0829	.1418	<b>.2520**</b>	<b>.2052**</b>	<b>.2013**</b>	<b>.1528*</b>	.1046	.0920	.0638
Std	(.3167)	(.2009)	(.1367)	<b>(.1090)</b>	<b>(.0958)</b>	<b>(.0904)</b>	<b>(.0813)</b>	(.0733)	(.0788)	(.0690)
N	1251	3090	4961	7139	9277	11069	13370	15480	17190	20382
.3-1 OWN	.7805	.1558	.0432	.1940	.0876	.1336	.0694	.0604	.0144	.0390
Std	(.5714)	(.2202)	(.1423)	(.1313)	(.0993)	(.0874)	(.0809)	(.0722)	(.0676)	(.0616)
N	1249	3040	4815	6951	8936	10703	12862	14874	16586	19491
1-2 OWN	.0047	-.0961	.0125	-.0055	-.0134	-.0274	-.0068	-.0294	-.0190	.0140
Std	(.3499)	(.2498)	(.1812)	(.1541)	(.1195)	(.1058)	(.0972)	(.0873)	(.0806)	(.0756)
N	1274	3071	4897	7056	9129	10895	13121	15164	16901	19987
2-3 OWN	-.5427	-.3193	.0320	.1071	.0915	.0578	-.1337	-.0927	-.0933	-.1110
Std	(.9251)	(.3470)	(.2353)	(.1993)	(.1484)	(.1323)	(.1360)	(.1165)	(.1087)	(.0974)
N	1225	2961	4776	6858	8907	10624	12854	14893	16637	19507
3-5 OWN	-.5344	-.1180	-.1160	.0702	-.0071	-.0273	-.0213	.0504	.0581	.0507
Std	(.4447)	(.3133)	(.2166)	(.1836)	(.1527)	(.1413)	(.1262)	(.1151)	(.1055)	(.0979)
N	1189	2915	4700	6746	8760	10493	12709	14709	16433	19463

Note: These are FE with the dependent variable as the natural log of the job counts of different industries and the independent variable of interest as the home-ownership rates of the donut ring under study. Analyses are performed for different residential income percentiles in the respective columns. Col. (1) represents the group with a residential income less than the 5th percentile of the sample income. Col. (2) represents the group with residential income less than the 10th percentile of the sample income (0%–10%). The rows indicate the different distances. Controls include residential population, employee education, employee population density, residential median income, residential education, home-ownership rates of other rings, distance to CBD, job counts for job clusters adjacent to the one under study, and year fixed effects. Standard errors are clustered at the job cluster level and are presented in parentheses. \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

Whole Trade for higher income groups:

	(1) >55%	(2) >60%	(3) >65%	(4) >70%	(5) >75%	(6) >80%	(7) >85%	(8) >90%	(9) >95%
0.3 OWN	-.0222	-.0704	-.0622	-.0807	-.0444	-.0738	-.2362	-.2949	.0186
Std	(.0761)	(.0780)	(.0861)	(.0973)	(.1090)	(.1215)	(.1505)	(.1879)	(.3847)
N	16830	15134	13041	10762	8990	6920	4786	2979	1203
.3-1 OWN	-.0073	-.0281	-.0410	-.1140	-.1095	-.1553	-.2695	-.3364	-.4743
Std	(.0823)	(.0899)	(.1051)	(.1118)	(.1218)	(.1357)	(.1811)	(.2267)	(.4019)
N	16208	14523	12528	10416	8680	6755	4688	2968	1220
1-2 OWN	.0264	.0192	.0173	.0693	.0184	-.1550	-.0565	.0027	<b>-.7962*</b>
Std	(.1100)	(.1169)	(.1284)	(.1444)	(.1574)	(.1851)	(.2360)	(.2667)	<b>(.4744)</b>
N	16732	15010	12983	10774	9013	6951	4809	3002	1239
2-3 OWN	-.0196	-.0213	-.0446	.0130	.0225	.0444	.1208	.0883	.1318
Std	(.0843)	(.0884)	(.0972)	(.1019)	(.1051)	(.1200)	(.1363)	(.1623)	(.2386)
N	16526	14781	12754	10563	8849	6814	4744	2937	1210
3-5 OWN	.1649	<b>.2246*</b>	<b>.2464*</b>	<b>.2988**</b>	<b>.2883*</b>	.2897	.1676	.0540	.1407
Std	(.1215)	<b>(.1298)</b>	<b>(.1427)</b>	<b>(.1552)</b>	<b>(.1717)</b>	(.1892)	(.2087)	(.2771)	(.4266)
N	16311	14592	12611	10404	8683	6686	4682	2895	1202

Retail Trade for higher income groups:

	(1) >55%	(2) >60%	(3) >65%	(4) >70%	(5) >75%	(6) >80%	(7) >85%	(8) >90%	(9) >95%
0.3 OWN	-.0743	-.0830	-.0237	-.0487	-.0798	-.0496	.0500	-.1346	-.1413
Std	(.0644)	(.0690)	(.0681)	(.0723)	(.0821)	(.0959)	(.1072)	(.1361)	(.2133)
N	16885	15181	13074	10794	9012	6935	4788	2974	1206
.3-1 OWN	-.0121	-.0019	-.0309	-.0365	-.0173	.0382	.0031	-.1482	-.2633
Std	(.0621)	(.0669)	(.0750)	(.0826)	(.0947)	(.1060)	(.1320)	(.1534)	(.2984)
N	16284	14591	12592	10467	8721	6774	4704	2975	1224
1-2 OWN	<b>.1630**</b>	<b>.1736**</b>	<b>.2099**</b>	<b>.2288**</b>	<b>.2749***</b>	.1477	.2855	.3233	-.0816

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	(1)>55%	(2)>60%	(3)>65%	(4)>70%	(5)>75%	(6)>80%	(7)>85%	(8)>90%	(9)>95%
Std	(.0742)	(.0782)	(.0867)	(.0966)	(.1057)	(.1331)	(.1783)	(.2416)	(.3269)
N	16797	15061	13030	10814	9042	6973	4821	3008	1245
2-3 OWN	-.0229	-.0133	-.0311	-.0083	.0034	.0112	.1908	.1219	-.0217
Std	(.0913)	(.0980)	(.1103)	(.1270)	(.1386)	(.1379)	(.1493)	(.1384)	(.1592)
N	16631	14875	12822	10610	8882	6832	4758	2943	1212
3-5 OWN	.0500	.1114	.0897	-.0055	.0034	.0708	-.0022	.2205	.2886
Std	(.1326)	(.1327)	(.1426)	(.1415)	(.1606)	(.1772)	(.2171)	(.3022)	(.5003)
N	16410	14682	12688	10466	8729	6718	4701	2906	1203

Note: These are FE with the dependent variable as the natural log of the job counts of different industries and the independent variable of interest as the home-ownership rates of the donut ring under study. Analyses are performed for different residential income percentiles in the respective columns. Col. (1) represents the group with a residential income less than the 5th percentile of the sample income. Col. (2) represents the group with residential income less than the 10th percentile of the sample income (0%–10%). The rows indicate the different distances. Controls include residential population, employee education, employee population density, residential median income, residential education, home-ownership rates of other rings, distance to CBD, job counts for job clusters adjacent to the one under study, and year fixed effects. Standard errors are clustered at the job cluster level and are presented in parentheses. \*\*\*p < 0.01, \*\*p < 0.05, \*p < 0.1.

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