

Abstract

Fast food restaurants and liquor stores—vice stores—have been shown to be more prevalent in predominantly Black and low income U.S. neighborhoods, and are associated with a number of health risks and social ills. The purpose of this study was to investigate the association between vice store density and spatial distribution as a function of racial, socioeconomic, and other population characteristics; to examine spatial clustering among these outlets; and to study how store turnover follows population change over a 13-year period in Chicago. We found heterogeneous associations between stores and population characteristics, with the most consistent finding being a positive association between percent Black and liquor store exposure. A high degree of spatial clustering was evident, and liquor stores were more likely to stay in business over time than fast food restaurants. However, when liquor stores closed, they were more likely to be replaced by non-vice businesses. Results suggest that vice stores are associated with lower positions in racial and socioeconomic hierarchies, and this patterning is often durable over time.

KEYWORDS: Fast food, liquor stores, neighborhood, gentrification, Chicago, African American/Black

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Fast food and liquor store density, co-tenancy, and turnover:

Vice store operations in Chicago, 1995-2008

Chicago's Grand Boulevard neighborhood traverses an area encompassed by Pershing (E. 39th St.), Cottage Grove, Calumet, and 43rd St. In 2000, a tour of the community (St. Jean, 2007) identifies a number of businesses. Liquor stores are mentioned six times, take-out restaurants thrice, along with several small grocers, dollar stores, barber and beauty shops, laundromats and check cashing stores. In short, the archetypal retail corridor in poor Black neighborhoods. More than 10 years later, a virtual tour of the neighborhood and vicinity via Google Maps Street View suggests that liquor stores and fast food continue to dominate retail. Those that are visible include Jamaica Liquor, J & J Fish & Chicken, SuperJet Food & Liquor (apparently defunct), McDonald's, Cut Rate Liquor (2), Harold's Fried Chicken, White Castle, Vegas Food & Liquor, Atlanta Food & Liquors, Quick Bite Fish & Chicken, and Chicago Rib House. Elsewhere in Chicago, Englewood is reportedly the site of 63 fast food restaurants and 23 food and liquor stores in 6 square miles, encouraging residents "to buy the cheeseburger for a dollar...Eating like that you can feed a whole family" (Chicago Policy Research Team, 2010) p. 16).

Public health literature suggests that these neighborhoods are not anomalies. A review of 40 studies on fast food and population, generally found that fast food restaurants are prevalent in low-income and racial and ethnic minority areas in the U.S. and Canada (Fleischhacker, Evenson, Rodriguez, & Ammerman, 2010). Subsequent research (Richardson, Boone-Heinonen, Popkin, & Gordon-Larsen, 2012) used national data to examine inequalities in proximity to food resources (fast food as well as groceries, supermarkets and convenience stores) by population characteristics in urban and suburban areas. Fast food was most available in high poverty neighborhoods, and areas with greater minority populations incurred additional penalties. The

authors argued that the observed density of convenience stores in only those high poverty areas where the population is predominantly White, suggests complex social and economic drivers in store siting (Richardson et al., 2012).

The alcoholic beverage outlet prevalence in Grand Boulevard also echoes data from other cities. In Baltimore, off-premise per capita licenses were positively associated with percent Black (LaVeist & Wallace, 2000). Nationally, a continuous density map of alcohol retailers across the U.S. showed socioeconomic disadvantage, percent Black and percent Latino all to be strongly and positively associated with store density in a nonlinear fashion, with much steeper rises at the highest levels (Berke et al., 2010). Moreover, demand did not appear to be the likely driver, because the associations were essentially absent in non-urban areas.

In this paper, we investigate density, clustering, and business turnover of vice stores (fast food and liquor) as a function of neighborhood racial and socioeconomic characteristics in Chicago. Studies have documented several negative health and social consequences from vice store density, and vice stores are important markers of neighborhood inequality, demarcating and reproducing racially-inscribed space and socioeconomic boundaries. With that in mind, it is important to study whether population changes produce any retail change.

The public health impact of vice stores

A primary consequence of liquor store exposure is alcohol consumption. Living in predominantly Black neighborhoods is associated with greater distilled spirits use and negative consequences (Jones-Webb & Karriker-Jaffe, 2013), suggesting a link to greater availability and marketing of alcohol in Black neighborhoods. Indeed, in New Orleans, liquor store density was associated with at-risk drinking—each additional store per 1,000 tripled the odds of at-risk drinking (Theall et al., 2011). Alcohol outlet density has also been linked to social disorder,

crime and violence. Theall et al. (2011) contend that outlet density facilitates high-risk behaviors such as drug use and exchange and creates a spatial focus for both physical and social disorder. St. Jean (2007)'s research supports this claim, finding that liquor stores generate robberies, providing offenders busy locations with numerous cash-carrying customers who are potentially distracted or incapacitated.

Liquor stores, are therefore of concern not only because they increase consumption, but because they are often associated with crime and violence (Toomey et al., 2012). In Minneapolis, total alcohol density was associated with violent crime, with stronger and more consistent relationships for on-premise locations (Toomey et al., 2012). Bar density is also associated with increased likelihood of emergency room visits for intimate partner violence (Cunradi, Mair, Ponicki, & Remer, 2012), and bar business hours are positively related to violent crime, after controlling for outlet density (Schofield & Denson, 2013).

There is growing evidence on the health risk of exposure to fast food. A number of studies have shown effects in adult chronic disease such as cardiovascular outcomes (Alter & Eny, 2005; Morgenstern et al., 2009), BMI and obesity risk (Bodor et al, 2010; Dubowitz et al, 2012), dietary intake (Jeffrey, Baxter, McGuire, & Linde, 2006; Li, Harmer, Cardinal, Bosworth, & Johnson-Shelton, 2009; L. V. Moore et al., 2009), and overall mortality rate (Daniel, Paquet et al, 2010). Among children, though some studies have failed to document a relationship between fast food exposure and overweight (e.g., Fraser & Edwards, 2010; Lee, 2012) in others, fast food is associated with obesity (Currie, DellaVigna, Moretti, & Pathania, 2009; Davis & Carpenter, 2009). One longitudinal study detected outcomes including consumption, BMI and percentage of body fat; and associations varied over geographic space, suggesting that exposure may

differentially affect people in different environmental contexts (Fraser, Clarke, Cade & Edwards, 2012).

Neighborhood and retail change in Chicago

If vice stores are retail staples in Black neighborhoods, what happens to them when neighborhoods change? Wealth buys some degree of isolation from the nuisance of fast food (Smoyer, Spence, & Amrhein, 2006), suggesting that an increase in affluent residents should result in fewer such restaurants. Chicago is ideally suited to study retail and neighborhood change, a city that is at once sclerotic in the reduction of racial segregation and yet changing significantly. Poverty and racial segregation are stubborn in Chicago communities: poverty in 1960 and 2000 were concentrated at .78, and in those 40 years, not one community changed from predominantly Black to White (Sampson, 2012). Still, the Near South Side, once characterized by vacant rail yards, dilapidated SRO (single-room-occupancy) hotels, and warehouses, now boasts condos and chic restaurants, and in neighborhoods like Grand Boulevard, the biggest change is perhaps the razing of public housing, including the nearby Robert Taylor Homes. Now, “hard as it might be to imagine, \$500,000 homes are being erected next to boarded-up buildings at the center of what was a low-rise slum just years earlier” (Sampson, 2012)(p.10). Similar changes were apace where the Cabrini-Green projects once stood, with market-rate homes selling for as much as \$410,000, and new stores arriving, ranging from Starbucks, to upscale national stores, and health clubs (Miller, 2008). And in some South Side neighborhoods, Black residents have been the drivers of change, with more affluent residents buying homes in areas where poverty levels were high (Pattillo, 2007).

If neighborhood affluence increases, or the proportion of Black residents decreases, this may result in decrements in vice store density as retail corridors change to suit new residents’

perceived tastes. On the other hand, stigmatizing neighborhood reputations are durable, locking communities into processes that reproduce inequality and negative conditions such as poverty, crime and disorder (Sampson, 2012). Considering that Black neighborhoods in Chicago generally remain Black, perhaps influxes of White or affluent residents may not be enough to entice new retailers into changing neighborhoods.

Study Aims

Our aim was to investigate the spatiality and turnover of vice stores in Chicago between 1995 and 2008. We asked the following questions: First, concordant with extant literature, is vice store density associated with the proportion of Black residents, after controlling for population characteristics related to retail siting (i.e., median household income, median age, population density)? Second, do fast food and liquor stores display mutual co-tenancy? Preferred co-tenancy refers to retailers' desired location in proximity to other store types. For example, shoe stores reportedly seek proximity to dress stores and banks desire locations near grocers (Teska Associates, 2012). Industry pundits argue that in Black neighborhoods, fast food restaurants garner high sales when proximal to liquor stores (Melaniphy, 1992). Do we find evidence in Chicago that fast food and liquor stores tend to co-locate, and cluster spatially? If so, does that clustering vary by population characteristics? Third, what predicts the likelihood of a store turning over, and what characterizes the persistence of vice stores? That is, what differentiates the arrival of yet another vice store, compared to a different type of store?

Method

Geography

We studied the density and change of stores in the city of Chicago, the United States' 3rd most populous city in 2010 at 2,695,598 (census.gov), despite having lost 6.9% of its residents between 2000 and 2010. In the 1990s, Chicago's population was growing after decades of

decline—as were many U.S. cities—and the 2000 census showed a gain of 112,000 residents, the first increase since the 1950s (The Brookings Institution Center on Urban and Metropolitan Policy, 2003). However, although there was growth overall, this varied across neighborhood: downtown, the West Side, and North Side grew, while the South Side and suburban Cook county lost population. Moreover, White populations declined markedly from the central city, with a loss of almost 150,000 residents (The Brookings Institution Center on Urban and Metropolitan Policy, 2003). Much of the overall growth was due to immigration, with Mexicans and Central Americans constituting $\frac{1}{2}$ of foreign-born residents. Still, Black-Latino dissimilarity was the highest of any U.S. city at 81.4, compared to 57.1 in New York City and Newark's 67.7 (The Brookings Institution Center on Urban and Metropolitan Policy, 2003). Historically and currently one of the most racially segregated cities, Black-White dissimilarity is reported at 82.5, which is somewhat lower than in 1990, when it was 90.6 (Spatial Structures in the Social Sciences).

Chicago is bounded on the east by Lake Michigan, and has large Black populations on the South and West Sides. These areas, and the rest of the city, can be further decomposed into 77 Community Areas, which are social and cultural geographies originally developed by researchers at the University of Chicago in the 1930s, and that are still used to conduct population, health and other surveys. To define city and Community Area boundaries, we used spatial boundaries defined by shapefiles accessible at the City of Chicago website.

Data sources

In 2009, we obtained store locations by purchasing archival data on retail outlets from Dun and Bradstreet. Dun and Bradstreet (DNB) is a corporation that provides commercial information and insight on businesses. Their D-U-N-S (Data Universal Numbering System)

Number uniquely identifies business entities on a location-specific basis, and once assigned, the numbers are neither reused nor assigned to other businesses ("The D-U-N-S Number,"). Key among DNB's work is assigning credit ratings to businesses, and providing business credit information to others, including payment history, public filing, corporate relationships, and business summaries. To do so, the corporation tracks millions of businesses and obtains reporting from establishments on an annual basis. Although there are no penalties for misreporting, doing so puts a company at risk for future borrowing and credit (Walls & Associates, 2009). Data derived from these annual reports provide the basis for our dataset.

We sought retail outlets that existed in 1995, and characterized the two store types with Standard Industrial Classification (SIC) codes of 5812 ("eating places"—"primarily engaged in the retail sale of prepared food and drinks for on-premise or immediate consumption") and 5921 ("liquor stores"—"primarily engaged in the retail sale of packaged alcoholic beverages, such as ale, beer, wine, and liquor, for consumption off the premises."). "Fast food restaurants" (FFRs) comprise a subset of eating places, and Dun and Bradstreet restricted the search to restaurants in this category, that were either (multi) national chains (e.g. McDonald's, Church's) or local establishments (e.g., Harold's Chicken Shack). Data cleaning to remove duplicate listings resulted in a final dataset of N=1,138 retail outlets, of which 593 (52.1%) were FFRs and 545 (47.9%) were liquor stores.

After obtaining the list of store locations, we mapped and tracked store trajectories as follows. First, using the address information in the Dun and Bradstreet database, all stores were geocoded by a GIS firm to 1990 Chicago census block groups, along with appended block group ID, lat/lon coordinates for the block group centroid, and census data. Next, we appended Dun and Bradstreet data that indicated whether the business changed from Time 1 (1995) to Time 2

(2008). Dun and Bradstreet reported whether the same store—matching by D-U-N-S Number—was operating at the original address at Time 2. If a different business was operating, the original set of attributes for the new business were recorded, including the retail category by SIC code, the block group ID and lat/lon coordinates, and Census 2000 and 2010 data for the same variables as 1990 (although income was not collected in 2010).

We conducted analyses after filtering out block groups with many stores, but few residents: this is downtown Chicago, or "The Loop". Austin et al (Austin et al., 2005) defined this commercial area as a 3 km radius from the intersection of Dearborn & Madison. We were slightly more conservative, using a 2 km radius from the lat/lon of the intersection as given by Google Maps, in order not to eliminate the beginnings of wealthy residential areas that abut the Loop, such as the Gold Coast.

Analytic Plan

We used census data from 1990 and 2010 to characterize the population in 1995 and 2008, and 2000 census data to look at neighborhood change preceding store locations in 2008. Census variables quantified population characteristics that are central in retail siting (e.g., population density, median household income), reflective of the population change Chicago has seen over the past several years (e.g., change in total population relative to the city's overall rate), and that are common indicators of gentrifying neighborhoods in general (e.g., change in proportion of homeowners). Table 1 lists the census variables used in each research aim.

In Aim 1, we analyzed the distribution of vice stores across the city in two ways. First, we used a spatial point process model to estimate the (log) intensity of store locations as a function of percent Black, after accounting for census covariates. Analyses first included all vice stores, and then were stratified by FFRs and liquor stores only. Second, we aggregated the stores

at the block group level and modeled the block group number of stores as a function of census variables. This was done using two methods - a Generalized Additive Model (GAM), and a geostatistical regression model where the errors are spatially correlated. Because the results from the latter method did not differ substantially from the spatial point pattern analysis, we report only the point process model:

$$\log \lambda = \text{Population} + \text{Population density} + \text{Median age} + \text{Median household income} + \% \text{Black}$$

Where, in this log-linear model, the natural logarithm of the intensity λ is given by an equation involving the census variables. Thus, if the estimated coefficient for a given population characteristic is β , a unit increase in that characteristic corresponds to an increase in store intensity by a factor of $\exp(\beta)$. We fit both linear and quadratic models, using converted latitude and longitude coordinates for each store to UTM (Universal Transverse Mercator) units. Intensity of stores was therefore quantified as the number of stores per meter square.

In Aim 2, we assessed the co-tenancy (spatial clustering) of vice stores. Using the point data of store locations and the estimated intensity from the point process model in Aim 1, we estimated the inhomogeneous K function (Diggle, 2003). This is a global statistic that describes as a function of distance, the degree of clumpiness/clustering of stores after accounting for their respective inhomogeneous densities. We estimate the K function using locations of fast food stores alone, liquor stores alone, and fast food and liquor stores together. We also look at co-clustering of fast food with liquor stores and vice versa, using a slight variation of the K function known as a cross-K function. The cross-K function between fast food and liquor stores represents the expected number of stores of one type within distance r of a randomly selected store of the other type, normalized by the local densities of each. As in other research on fast

food clustering (Naa Oyo A. Kwate & Loh, 2010), we used an inhomogeneous density because we do not expect vice stores to be evenly distributed across the city. The expression for the cross K estimates are given by

$$\hat{K}_{\text{cross}}(r) = \frac{1}{|A|} \sum_{x \in X} \sum_{y \in Y} \frac{1\{|x - y| \leq r\}}{\lambda(x)\lambda(y)}$$

Where $|A|$ is the area of the observation region, X and Y represent two sets of locations, $\lambda(x)$ is the (possibly estimated) density at location x and r is a distance. In the regular K function, $Y=X$ so that the pairs (x,y) come from the same point pattern.

Besides considering the global K functions, we examine the individual components that form these K functions and see how they vary with the census variables W . These individual components K_x are the contributions by the points x to the global K function. In particular, we set $r=400\text{m}$, and regress the contributions K_x as follows: first we model the odds that K_x is zero or not,

$$\log \left(\frac{P(K_x > 0)}{P(K_x = 0)} \right) = \alpha + \beta W$$

A location x with $K_x = 0$ means that it has no neighboring vice stores within 400m. Then, we fit a log-linear model to the non-zero (positive) values of K_x

$$\log K_x = \alpha_1 + \beta_1 W$$

In Aim 3, we investigated store change alongside population change. Using a binary response variable where 1=store changed and 0=no change, we fit a logit GAM model using census and store type as covariates in addition to spatial splines to model the probability of store

turnover. To examine population change we use data at the census tract level, one spatial level higher than the block groups to which stores were initially geocoded. The GAM model allows for non-linear relationships between the response and the covariates, and we initially fit the model with smooth functions of all the covariates. Those covariates whose estimated functions are linear were then replaced with linear terms and the model re-fit. Next, with (a) 1=type changed vs. 0=no type change, we assess determinants of vice stores being replaced by a store from a different retail category (e.g., apparel); and with (b) 1=not vice store vs. 0=still vice store, we investigate whether newly arrived stores are yet another vice store (where 0 corresponds to either a vice store that remained in business, or a new vice store).

Finally, we performed an analysis using a larger spatial scale—Community Areas. In addition to continuous census variables at the Community Area level, we included a categorical variable, also based on census data, that summarizes the population, such as “stable upper/middle class” “serious decline” or “gentrification” (Nathalie P. Voorhees Center for Neighborhood and Community Improvement, 2003). To improve clarity in interpretation, we reduced the original typology from seven categories to five. Two Community Areas, which were categorized with labels that were not reducible to the typology were eliminated from the analysis. Because these were small areas, both of which had very few stores, we do not expect much of an impact on the results.

Results

Distribution of vice stores by population characteristics

Figure 1 maps all vice store locations in 1995 across the city. The circled area with a high density of outlets indicates The Loop, and as noted earlier, we excluded the downtown area from the models that follow. Table 2 shows the estimates from the point process model, for all

vice stores, and FFRs and liquor stores separately. In the linear model for vice stores as a whole, population density and median income emerged as statistically significant. Per 100 increase in population density we find a 0.16% greater store intensity per meter square. Income was inversely related, with a reduction of 1% in store intensity per \$1000 increase in median income. In the quadratic model, both income and percent black were statistically significant. Figure 2 shows the plot for each coefficient. Initially, as percent Black increases, the intensity of vice stores increases as well, up to approximately 60% Black. Thereafter, greater proportions of Black residents results in lower intensity. Inspection of the x-axis reveals the high segregation levels in Chicago, with many areas having very high or very low percentages of Black residents, but few having a more mixed population. In contrast, areas with low median incomes have high vice store intensity, which recedes as income becomes higher. At approximately \$50,000, income is positively related to vice stores, though few areas have median incomes of \$60,000 or more.

For FFRs alone, population density and age were the sole significant predictors in the linear model, with each positively associated with restaurant intensity. In the quadratic model, income was also significant. The coefficients are very similar to those for the overall model: the quadratic coefficient for age was negative, indicating fewer restaurants in areas at the low and high ends of the range of age; while that for income was positive, indicating that more restaurants are present at the lower incomes, dropping and then increasing again as income increases. For liquor stores alone, in addition to population density and income (similar coefficients as in overall model), percent Black emerged as statistically significant. Here, each unit increase in percent Black resulted in .3% greater store intensity.

We repeated the analysis for new vice locations in 2008 (see Figure 3), using 2010 census variables (for which income was not measured). For liquor stores, results were similar to 1995; density increases by a factor of $\exp(0.0026)$ or 0.22% per 100 increase in population density, and by $\exp(0.0044)$ or 0.44% for each percent increase in % Black. Each year increase in median age was associated with a decrease by a factor of $\exp(-0.034)$ or 3%. When modeling the densities of all vice stores, population density was still significant but with a smaller effect, with density increasing by a factor of $\exp(0.0015)$ or 0.15%. Finally, for FFRs alone, none of the census variables were significant.

Vice store clustering

Figure 4 plots the inhomogeneous K function, which shows whether stores are located randomly and independently of each other, or whether they cluster together. The plot depicts a high degree of co-tenancy among vice stores; there is clustering among all vice stores, FFRs alone, and liquor stores alone. The dotted line at the bottom of the graphs shows the variation of the K function from simulated data sets based on the observed densities but without clustering; the estimates of K obtained from the data are much higher than the simulated data. FFRs are highly clustered among themselves to a distance of about 150m. A typical “short” block in Chicago measures approximately 427 feet, or 130m (City of Chicago, 2013a); FFRs are therefore often clustered at distances of about a block. Liquor stores are also highly clustered, and at distances of 50m or less. Vice store co-tenancy is similar to that of liquor stores alone. The dotted-dashed line shows the co-clustering of FFRs with liquor stores, i.e. whether liquor stores tend to cluster with FFRs and to what scale. This clustering is somewhat weaker, but it is still above what is expected from random variation for unclustered point patterns exhibiting the same densities. Moreover, when clustering occurs, it is at scales of 50m or less.

Next, we looked at clustering as a function of population characteristics, treating FFRs and liquor stores together. We found that as population density, percent Black and percent male increased, vice stores were less likely to be isolated (i.e. no other vice stores within 400m). For stores with at least one vice store within 400m, however, we find the relationship reversed, with co-tenancy ($\leq 400\text{m}$) decreasing with increasing population density and percent Black (percent male being not significant).

Store turnover

We explored whether a store changed over the period from 1995 to 2008, depending on store type, 1990 population characteristics, and change over time at the census tract level. Liquor stores had a lower probability ($p=.002$) of undergoing a business change, compared with FFRs, with odds of business change a factor of $\exp(-0.433)=.65$ lower than for FFRs (95% confidence interval (0.49, 0.86)). Among 1990 variables, median household income ($b=.015$, $SE=.0076$, per \$1000) and percent below poverty ($b=.0141$, $SE=.0066$) were statistically significant, with p values of .048 and .032 respectively. In both cases, an increase in the variable corresponds to an increase in probability of a business change. Though not significant at $p<.05$, census tracts with a higher percent of high school graduates had a higher business turnover, while areas with greater proportions of male residents had lower turnover.

We also repeated the analysis with 1=not a vice store vs. 0=still a vice store, indicating whether the location held a vice store in 2008. There are two ways to consider the baseline, i.e. what constitutes a 0 response. The first way is to include all store locations in 1995, where a response of 0 means a vice store location in 1995 that is still a vice store in 2008, regardless of whether a business change occurred or not. Here we find that census variables did not predict vice store persistence, although housing units, % Latino and % college degree approached

statistical significance with p values of .09, .10 and .07 respectively. The second way to operationalize a 0 response is to study only locations that experienced a business change. That is, we only include locations where a business change took place, and yet another vice store was operating in 2008. *Panel a* of Table 3 reports the full model with all census variables of interest, and *Panel b* reports a model with only statistically significant coefficients included. *Panel b* shows that liquor stores have a higher estimated probability of turnover to a non-vice store. Taken together with the findings above, this suggests that liquor stores are more likely than FFRs to remain in business over time, but if they close down, they are more likely to be replaced by a non-vice store. Additionally, increases in the percentages of foreign-born residents, Black residents, and residents with a college education are also associated with increased probability of turnover to non-vice.

Finally, we examined store turnover to non-vice stores at the Community Area level. We initially modeled store change using all the census variables at this larger spatial scale. In the full models, few new trends emerged, and many of the variables were not significant. Removing the non-significant variables in turn from the model, we are left with a model that suggests, like previous models, that liquor stores are less likely to turnover, but more likely to be replaced by non-vice stores. Odds of turnover to a non-vice store decrease with population. With respect to the population typology variable, with “stable upper/middle class” as the referent, we find that all the other categories have increased odds of turnover to a non-vice store, although only “mild-moderate decline” was statistically significant at $p=.03$; “gentrification” approached statistical significance at $p=.08$.

We also conducted exploratory analyses to assess whether areas with vice to non-vice turnover tend to be spatially proximate, after controlling for population characteristics. To do so,

for each Community Area, we obtained the number of stores that turned over, and of these, the number that were no longer vice stores. We then modeled that ratio as a function of the census variables together with spatial and independent errors. Spatial correlation in the response that cannot be accounted for by the census variables will then be captured by the spatial error component, leaving the independent error component to capture the remaining (uncorrelated) error. For example, if percent Black is spatially correlated and drives the spatial correlation in the number of stores that became non-vice, that should be accounted for in the main part of the regression; any remaining correlation (correlation in the residuals) can be thought of the excess correlation. If such excess correlation exists, maps of the spatial error component will show more structure (Figure 5) while those of the independent errors will look more random (Figure 6). These maps suggest that for the most part, there are lower ratios of vice to non-vice store turnover on the South Side than would be expected from the model with all census covariates.

Discussion

We examined the density, distribution and turnover of fast food restaurants and liquor stores as a function of population characteristics and neighborhood change in Chicago. We found that these vice stores were widely dispersed across the city, and most dense in areas where population density was also high. As hypothesized, income insulated against vice store exposure, but in a non-linear fashion, with exposure increasing after a certain income level. Because we employed secondary data from a commercial vendor, we could not distinguish store types. It may be that low and high ends of the income spectrum have higher exposure to vice stores, but of different types. For example, low income areas may face a preponderance of “corner liquor stores”, whereas high income areas retain chic wine stores. Percent Black also evinced a non-linear relationship. Social scientists have documented the depopulation of both

people and stores in Chicago's Black neighborhoods, particularly on the South Side. In 1950, Woodlawn had more than 800 commercial and industrial establishments, but by the 1990s, fewer than 90 remained, primarily small concerns, and with a high proportion of liquor stores. Wacquant (Wacquant, 2008), describing the corridor as a "lunar landscape", gives one shopkeeper's report: "It's very unfortunate but it seems that all that really grows here is liquor stores" (p. 53). Similarly, Wilson (1996) reports one resident's dismay: "When I walked down Sixty-third Street when I was younger, everything that you wanted was there. But now, coming back as an adult with my child, those resources are just gone, completely" (p. 5). The quadratic model may reveal that vice stores are more common in Black neighborhoods to a certain point; extremely segregated areas may face a retail lunar landscape, absent of even vice stores.

Unlike other studies in other cities (Block, Scribner, & DeSalvo, 2004; N.O.A. Kwate, Yau, Loh, & Williams, 2009), but comparable to other research in Chicago (Mari Gallagher Research & Consulting Group, 2006), we did not find fast food exposure alone to be correlated with the percentage of Black residents. However, concordant with other research, liquor stores were more prevalent in Black neighborhoods, controlling for income and other population characteristics. This racial patterning was true at two cross-sectional timepoints 13 years apart. We also found racial patterning in store co-tenancy. Vice stores tended to cluster together, often at distances of less than one block, and isolated stores were less likely in areas with many Black residents. This clustering may potentiate health and social risks for African American communities.

With regard to store turnover, fast food was less stable over time, particularly in areas with higher incomes and areas with high poverty. Liquor stores, once no longer in business, were more likely to be supplanted by non-vice stores. Contrary to hypotheses, population

characteristics, particularly those suggestive of gentrification, generally had little impact on the likelihood of turnover. In fact, more Black residents increased the likelihood that store locations switched from vice to non-vice. It should be noted that even neighborhoods with influxes of affluent residents can remain poor overall, as seen in two predominantly Black neighborhoods (Pattillo, 2007). Counterintuitive findings were also seen in mildly to moderately declining Community Areas, which had greater odds of vice to non-vice turnover. Here again, store type may play a role. We may speculate that more prosperous neighborhoods have large chains, which are more stable over time, while declining neighborhoods' smaller and more marginal establishments face greater turnover.

Study limitations

Some study limitations should be noted. We used DNB data to operationalize the vice environment, as it was the best source for purchasing historical data. But as has been frequently discussed in the literature, using commercial databases to source retail locations can be problematic. Not all stores that appear at street level may be in the vendor database, and some of those in the database may no longer exist at street level. In one study, compared to InfoUSA, DNB had the fewest stores. There was fair agreement (32%) between the two databases, and although agreement was highest for eating places and alcohol & tobacco stores, DNB had 7.6% fewer eating places and 6.3% fewer alcohol and tobacco stores (Hoehner & Schootman, 2010). Liese et al (Liese et al., 2010) compared three secondary data sources on food outlets in South Carolina to ground truthing, and DNB had concordance rates 76% for full-service restaurants, 93% for franchised limited service, and 73% for non-franchised limited service. Additionally over 100 limited service restaurants were identified during ground-truthing. Overcount errors, where listed stores are actually closed, occurred much less frequently (Liese et al., 2010).

If data discrepancies occurred in our study and varied by population characteristics, this would bias the results. Some research has shown that when disagreement occurred, it was not associated with population characteristics (Bader, Ailshire, Morenoff, & House, 2010). But in another study, agreement and coverage tended to increase with higher population density, less poverty and fewer Black residents. Compounding the issue is the possibility of false negatives due to different SIC codes used in different databases, and lack of standardized business classifications and common identifiers (Hoehner & Schootman, 2010). As well, mismatches between SIC classifications and other state regulatory categories are possible. For example, some alcohol outlets may be classified as grocers in vendor databases, as they sell a variety of packaged, processed, and prepared foods. The City of Chicago regulates nine classes of liquor licenses for on and off-premise consumption. The relevant license for liquor stores, the “Packaged Goods License”, pertains to grocery stores, convenience stores, and liquor stores (City of Chicago, 2013b). Taken together these studies suggest that researchers should ideally include multiple data sources to characterize neighborhood resources, cautiously interpret findings when using commercial databases, and conduct field research wherever possible (Hoehner & Schootman, 2010; Liese et al., 2010).

Our location precluded field concordance checks, but a brief visual inspection of our dataset and a “virtual” ground-truthing via Google Maps Street View showed that several stores were missing. For example in zip code 60653, one store, Jamaica Food and Liquor, which has a longstanding and notorious history in the community (Burns, 2012), did not appear in our dataset, but is visible in Street View (2011). As well, Calumet Food and Liquor and Vegas Food and Liquor (see St. Jean, 2007) and one other store were also found on the street but did not appear in the dataset. Still, virtual ground-truthing is not necessarily a solution, given that Street

View addresses may not match those listed in vendor databases, nor the actual store address on the street. For example, a Google Street View description of one Chicago store is displayed as 388 E. Pershing St., but the store itself has the address 343 on its frontage. The differing numbers and odd/even discrepancy in this case would yield inaccurate results in virtual ground truthing. A more general challenge is the likelihood of temporal mismatch between Street View photography and vendor data. Indeed, even when the timelines are quite close, change may be taking place. Google's photography of the corner of 69th and Dorchester in July 2011 reveals a decrepit red brick building with boarded up windows and doors. Yet, renovation on the building commenced almost immediately after Google's work; artist Theaster Gates rebuilt the space in the summer of 2011 into the Black Cinema House (Stoilas, 2012). Thus, although Street View may be useful for some applications (Rundle, Bader, Richards, Neckerman, & Teitler, 2011), it may not be for this purpose.

Future Research

In addition to studying changes in store prevalence and type over time, future research should look at how merchandising, sale volume, and alcohol consumption change alongside neighborhoods. While research shows that alcoholic beverage pricing tends to be uniform throughout regional markets (Bluthenthal et al., 2008) and is more related to volume than targeted marketing strategies (Harwood et al., 2003) merchandise varies by population characteristics. For example, malt liquor shelf space (Bluthenthal et al., 2008) and advertising (McKee, Jones-Webb, Hannan, & Pham, 2011) are positively related to area percent Black. Thus, it may be that even if stores remain in place over time, they shift from selling inexpensive and high potency alcoholic beverages such as malt liquor, or fortified wines such as Wild Irish Rose and Night Train. It is also possible that in some contexts, liquor stores may flourish as

population declines, such as if communities are destabilized. A Chicago storeowner noted that beer and whiskey became top sellers after the razing of the Robert Taylor Homes (Chicago Policy Research Team, 2010), and alcohol abuse and dependence increased after widespread fires in the wake of New York City's implementation of planned shrinkage (Wallace & Wallace, 1998). Studies should investigate the contextual effects undergirding liquor store density and population density.

Field research could investigate how retail corridors change in aesthetics. If store owners agree that "Gentrification is on the way. The yuppies are coming in. The area will have to change soon" (St. Jean, 2007, p. 92), store fascia may be remade to reflect and appeal to new residents. As well, research is needed to track changes in enforcement actions by municipalities. In 2012, Chicago initiated more aggressive policies for the suspension and revocation of liquor licenses. Rather than requiring major incidents, such as shootings, enforcement action was to be triggered by community complaints culled from 311 and city departments (Spielman & Esposito, 2012). Rich neighborhoods have strong capacities for institutional resistance owing to greater access and power; Chicago's gentrifying Mexican and Puerto Rican neighborhoods found that gentrifiers exerted considerable organizational pressure and elicited concerted actions among City Hall, funders and developers (Betancur, 2011). In Brooklyn's Fort Greene neighborhood, a tire sales store eventually closed after intensified monitoring and infractions (Sutton, under review). In the case of vice stores, it is unclear how complaints levied by affluent populations incite municipal action.

Conclusion

Exposure to fast food and liquor stores are associated with lower positions in the socioeconomic and racial hierarchy—both by population characteristics and spatial location.

And, these associations are generally durable over time. More research is needed to investigate how temporally linked disadvantage differentially exposes residents to health risks, and whether those risks translate into poorer health outcomes.

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