The Agglomeration of Urban Amenities: Evidence from Milan Restaurants

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Abstract

In many cities, restaurants and retail establishments are spatially concentrated. Economists have long recognized the presence of localized externalities that arise from spatial agglomeration as a possible explanation, but empirically identifying this type of spillovers has proven difficult. We test for the presence of agglomeration spillovers in Milan restaurant sector using the abolition of a unique regulation that until recently restricted where new restaurants could locate. Before 2005, Milan mandated a minimum distance between restaurants that effectively kept the spatial distribution of restaurants artificially uniform. As a consequence, restaurants were evenly distributed across neighborhoods. The regulation was abolished in 2005 by a nationwide reform that allowed new restaurants to locate anywhere in the city. Using administrative data on the universe of Milan restaurants and retail establishments between 2000 and 2012, we study how the spatial distribution of restaurants changed after the reform. Consistent with the existence of significant agglomeration externalities, we find that after 2005, the geographical concentration of restaurants increased sharply. By 2012, 7 years after the liberalization of restaurant entry, the city's restaurants had agglomerated in some neighborhoods and deserted others. By contrast, not much happened to the spatial concentration of retail establishments or even retail establishments that sell food, which were never covered by the minimum distance regulations and therefore were not directly affected by its reform. We also find that in neighborhoods where the number of restaurants grew the most after the reform, restaurants reacted to the increased competition by becoming more differentiated based on price, quality and type of cuisine.

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1 Introduction

In many cities, retail establishments tend to be spatially concentrated. Fifth Avenue in New York and Bond Street in London are world renowned clusters of upscale fashion stores. The Diamond Districts of New York and Los Angeles are large concentrations of jewelry stores. Car dealerships and furniture stores are often located near each other. Overall, more than half of stores in the US are located within 0.5 miles of a competitor (Datta and Sudhir, 2011).

Restaurants, bars and pubs are even more spatially concentrated (Couture and Handbury, 2017). The "Gourmet Ghetto" in Berkeley features a concentration of high quality restaurants, anchored by Chez Panisse. The 5th Avenue corridor in Brooklyn, the 18th Street corridor in Washington DC, and the Mission district in San Francisco, have emerged as growing clusters of restaurants in their respective communities. Many cities even have fast food alleys—zones characterized by clusters of fast food outlets (Yang 2012).

The idea that retailers and restaurants find it profitable to locate near their competitors may seem surprising. After all, proximity to competitors should lead to fiercer price competition. Economists have long recognized the presence of localized externalities that arise from spatial agglomeration as a possible explanation for geographical clustering (Marshall, 1920). Theoretical models have pointed out that agglomeration spillovers can act as an incentive for restaurants and stores to locate near each other.[1] A restaurant may generate demand externalities for neighboring rivals if its presence helps attract additional consumer traffic. Restaurants may also profit from shared foot traffic if customers are attracted by increased diversity of options. In this case, a consumer's expected utility from shopping in a larger cluster is higher than the the one in a small cluster.[2]

The presence of this type of agglomeration externalities, if they exist, has significant implications for neighborhoods and cities. Since restaurants and entertainment are among the consumption categories with the highest income elasticities (Aguiar and Bils, 2015), the

[1]Examples include Varian (1980); Stahl (1982); Wolinsky (1983); Dudey (1990); Fischer and Harrington (1996); Bester (1998); Arentze et al. (2005); and Konishi (2005). Fujita and Thisse (1996 and 2002) provide overviews.

[2]Theoretical models have shown that spatial concentration can reduce consumer's search costs (Wolinsky, 1993; Dudey, 1990). Agglomeration may also help sharing firm specific time varying idiosyncratic demand shocks, such as when a restaurant has unexpectedly a long line and its potential customers spill over to nearby establishments. Agglomeration externalities in the retail and restaurant sector are likely to be different from those in the tradable sector. Agglomeration economies in the tradable sector are typically thought of as stemming from productivity increases because of labor pooling or human capital spillovers, while agglomeration economies in the retail and restaurant sector depend on the attractiveness to consumer of geographically clustered establishments.

agglomeration of restaurants, bars and retail has been linked to increased attractiveness of certain urban neighborhoods to college educated professionals, and ultimately to increases of housing costs (Hurst et al 2013; Couture et al. 2020). The existence of strong forces of agglomeration in the restaurant and retail sector implies faster and potentially self sustaining gentrification. Thus, the endogenous agglomeration of this type of amenities is of obvious interest to policy makers seeking to manage gentrification of urban neighborhoods.

But empirically identifying this type of spillovers is difficult. The mere fact that restaurants and stores are geographically agglomerated within a city does not necessarily imply that agglomeration is caused by positive externalities. Spatial agglomeration may simply reflect the uneven spatial distribution of demand for restaurants and stores. For example, restaurants may concentrate near a touristic attraction, a ballpark, a busy subway stop or a university not because of any spillovers, but because that is where their potential customers are.[3] In some cities, spatial concentration may also reflect zoning regulations that define where stores and restaurants are allowed to locate.[4]

In this paper, we focus on restaurants in Milan. We test for the presence of agglomeration spillovers using the abolition of a unique regulation that until recently restricted where new restaurants could locate. Before 2005, Milan mandated a minimum distance between restaurants. This meant that new restaurants could not locate too close to an existing restaurant. The regulation mandated shorter distances in neighborhoods with more daytime population and longer distances in neighborhoods with less daytime population, with the effect of keeping the per capita number of restaurants generally constant across neighborhoods. This regulation effectively kept the spatial distribution of restaurants artificially uniform. The minimum distance regulation did not apply to retail establishments.

The regulation was abolished in 2005 by a nationwide reform that allowed new restaurants to locate anywhere in the city, irrespective of the location of existing restaurants. Using administrative data on the universe of Milan restaurants and retail establishments between 2000 and 2012, we study changes in the spatial distribution of restaurants after the reform. In the presence of agglomeration externalities, one might expect that in the years following the reform, Milan restaurants, freed from the minimum distance constraint, became more geographically agglomerated. Finding that the amount of agglomeration did not change would cast doubt of the existence of agglomeration benefits and would imply that the ag-

[3]Davis et al (2019) uncover large differences in demand across parts of New York city.

[4]Inside malls, anchor stores such department stores and national name-brand stores have been shown to generate positive externalities by drawing customer traffic not only to their own store, but also to other stores (Gould, Pashigian and Prendergast, 2005).

glomeration typically observed in many cities reflects unobserved heterogeneity in consumer demand across areas and/or zoning constraints.

We first establish empirically that before 2005 restaurants were distributed homogeneously across neighborhoods, confirming that the regulation was binding. A Kolmogorov test on the distance between the sample cumulative function and the theoretical uniform cumulative function fails to reject that the distribution of the per capita number of restaurants across neighborhoods in 2004 is equal to an homogeneous distribution. We also find no evidence of pre-trends in the geographical agglomeration of restaurants between 2000 and 2004, indicating that in the years before the reform the spatial concentration of restaurants in Milan was both uniform and stable.

The spatial distribution of restaurants changed dramatically after the 2005 reform. We find that after 2005, the geographical agglomeration of restaurants increased sharply. Some neighborhoods attracted a large numbers of new restaurants, while other neighborhoods lost most of their restaurants. By 2012, 7 years after the liberalization of restaurant entry, the city's restaurants were significantly more spatially concentrated than before liberalization. Three alternative measures of spatial dispersion across neighborhoods—the standard deviation of the per capita number of restaurants, the interquartile range; and difference between neighborhoods at the 90th and 10th percentiles—all increased sharply after 2004, suggesting that the reform resulted in more geographical inequality in the number of restaurants across neighborhoods. The magnitude of these increases is economically large and point to a profound shift in the degree of geographical concentration of restaurants in Milan, consistent with the existence of significant agglomeration externalities.[5]

Unlike Paris, London and Barcelona, Milan did not have a "restaurant area" in 2004. By 2012, Milan has developed several restaurants areas, consistent with the presence of significant agglomeration externalities. By contrast, not much happened to the spatial concentration of retail establishments or even retail establishments that sell food, which were never covered by the minimum distance regulations and therefore were not directly affected by its reform.

It is in principle possible that the winners attracted more restaurants because they have better fundamentals. If restaurants concentrated in areas with local characteristics that appeal to consumers—better transit, better local amenities, or lower crime—then our find-

[5]Our findings are consistent with Benmelech et al (2014), Shoag and Veuger (2014) and Bernstein et al (2019) who use bankruptcies to estimate spillovers on surrounding stores. They find that the number of nearby stores decreases following store closings, indicating that retailers generate significant positive spillovers on nearby businesses. See also Eppli and Benjamin (1994); Konishi (2005); Datta and Sudhir (2011); Vittorino (2011).

ings might simply reflect unobserved neighborhood heterogeneity, rather than agglomeration economies. Empirically, we find no evidence that restaurants clustered in neighborhoods with initially higher property values or better transit connections, or local attractions. In fact, the 2004 observable characteristics of neighborhoods are mostly orthogonal to the 2004-2012 change in number of restaurants. Importantly, we find no evidence that restaurants clustered in neighborhoods with more retail establishments in 2004 or where retail establishments were growing faster before the reform —arguably two good overall measures of an area's attractiveness to shoppers.

In the final part of the paper we study the effects of agglomeration on product differentiation on the part of restaurants. In the presence of agglomeration spillovers, increased spatial agglomeration benefits restaurants by attracting more consumers to a neighborhood, but it also increase competition by nearby rivals. Some theoretical models predict that restaurants will react to the increased competition by differentiating themselves from their nearby competitors more than that geographically isolated restaurants (Fujita and Thisse, 1996 and 2002).

We investigate whether restaurants located in neighborhoods that experienced large increases in agglomeration after the 2005 reform reacted by increasing product differentiation compared to restaurants located in neighborhoods where agglomeration did not increase or declined. We measure differentiation using restaurant-level data on the price of a meal, consumer quality ratings and the type of cuisine. A neighborhood that has restaurants with a diverse range of prices, qualities and types of cuisines is defined as having more differentiated restaurants than a neighborhood that has restaurants with similar prices, qualities and types of cuisines. Consistent with the theoretical predictions, we find that in neighborhoods where the number of restaurants grew the most after the 2005 reform, restaurants reacted to the increased competition by becoming more differentiated based on price, quality and type of cuisine.

This paper contributes to a growing literature that identifies endogenous amenities as an important feature of the economics of cities and neighborhoods, one with significant consequences for urban growth (Glaeser et al., 2001).[6] Cities which attract skilled residents have been shown to became endogenously more desirable, as their local amenities improve, and this in turn tends to magnifies sorting and income inequality (Diamond, 2016). Our findings indicate that a similar pattern may arises at the neighborhood level, with the en-

[6]Local amenities have been shown to change in response an area's residents and to affect which types of residents locate in an area. Examples include but are certainly not limited to Bayer, McMillan and Rueben (2004), Bayer, Ferreira and McMillan (2007); Baum-Snow and Hartley (2016), Couture and Handbury (2017).

dogenous clustering of restaurants in some area generating a self sustaining divergence across neighborhoods, which ultimately could lead to increased sorting of residents by income.

Our findings on product differentiation relate to the broader urban economics literature that has shown that urban density tends to benefit consumers due to increased variety of products supplied locally (Glaeser, Kolko, and Saiz, 2001; Handbury, 2012; Handbury and Weinstein, 2014; Couture, 2016).[7] Our findings are also consistent with cross-city evidence by Berry and Waldfogel (2010) and Schiff (2015), who document that the range of qualities and cuisines available in a city increase with its size.

The endogenous agglomeration of urban amenities is of particular interest to policy makers seeking to revitalize struggling neighborhoods. Forty percent of local governments in the US use retail incentives to foster local economic development (ICMA, 2009). In essence, this type of policies seek to move struggling neighborhoods from a bad to a good equilibrium by increasing the number of new store and restaurants (Shoag and Veuger, 2014).[8] The ultimate impact of these policies depends on whether retailers and restaurants generate positive externalities for nearby establishments. Similarly to the case of big push policies at the regional level that seek to move entire regions from a bad to a good equilibrium (Kline and Moretti, 2014), important questions for neighborhood revitalization plans are if the agglomeration forces exist in the retail and restaurant sector; and if so are they strong enough to sustain the new equilibrium. Our findings indicate that this may be the case for restaurants, at least in Milan.

The paper proceeds as follows: in Section 2 we describe the reform; in Section 3 we describe the data; in Section 4 we present the empirical results. Section 5 concludes.

2 The 2005 Reform

Before 2005, Milan had regulations that strictly limited entry into the restaurant sector. The regulations stem from a national law that mandated that municipalities enforce a minimum distance between restaurants. In practice this meant that municipalities in Italy could not issue permits for new restaurants that were geographically too close to an existing restaurant. Minimum distances were not uniform but were allowed to vary across cities and neighborhoods as a function of potential demand. The restriction applied not only to sit

[7] Seim (2006) finds that competition leads to spatial differentiation in the video rental industry.

[8] One example of successful neighborhood revitalization sparked by new restaurants is West Dallas. "This place was kind of like a desert with not so much to do. [...]. But with a dozen new restaurants, nowhere is becoming somewhere" (Xaykaothao, 2014).

down restaurants, but also to fast food, bars, cafes, and most other venues where food and drinks are consumed.[9] Retail establishments were not subject to the minimum distance constraint. We don't have the exact formula that was used to define the minimum distance in Milan. But we know that it was set based on the number of consumers—both residents and commuters—in each neighborhood. Specifically, the law mandated shorter distances in areas with more consumers and longer distances in areas with fewer consumers, with the overall goal of keeping the per capita number of restaurants generally constant across neighborhoods (Comune di Milano, 1999).

In practice, the minimum distance rule succeeded in creating a spatial distribution of the per capita number of restaurants that was generally homogeneous, with the same per capita number of restaurants in each neighborhood, as we show in Section 4.

In 1998, Italy adopted a sweeping reform of commerce legislation, known as the "Bersani Reform" (Viviano, 2008; Schivardi and Viviano, 2011). Among other things, the reform allowed regions to abolish the minimum distance rule for restaurants.[10] In response, the Lombardia region, where Milan is located, greatly relaxed the minimum distance constraints starting in 2005. In practice, this meant that starting in 2005 restaurants in Milan were effectively not subject to minimum distance constraints. Rather, a new restaurant could open anywhere it could find a suitable space (Comune di Milano, 2010).

3 Data

Our main source of data is an administrative dataset that includes the universe of all restaurants and retail establishments in the city of Milan between 2000 and 2012. We obtained it from the Planning Department of the City of Milan ("Settore Commercio e Attivit Produttive"). The data is of high quality because it is based on the licenses that establishments are required to obtain to operate.

For each establishment, the data reports address and category. Based on category, we divide establishments in two groups: restaurants and retail establishments. "Restaurants" include sit down restaurants, pizzerias, fast food, cafes, bars, pubs and cafeterias. "Retail"

[9] A small number of food service establishments were exempted from the minimum distance regulations, including eateries inside cinemas, theatres, clubs and other entertainment establishments.

[10] The law aimed at increasing competition in the Italian retail sector by reducing entry barriers and administrative constraints. It delegated most regulatory power to local governments. Viviano (2008) and Schivardi and Viviano (2011) provide a detailed description on the 1998 reform and evidence on its effects on workers and firms. They find that the reform had a positive effect on investment in ICT and employment and it reduced labor costs in large establishments. The conclude that more stringent entry regulations in Italy resulted in lower productivity and higher consumer prices.

includes all other establishments, excluding restaurants. We further subdivide retail into establishment selling food—bakeries, salumeria's, fruit and vegetable stores, butchers and groceries—and those not selling food. In 2004, the data contain 6057 restaurants, 24,751 retail establishments and 5051 food retail establishments.[11]

Our spatial unit of analysis is an Administrative Zone, which throughout the paper we refer to as "neighborhood". Administrative zones are defined by the city Planning Department to approximate neighborhoods. Milan has 180 administrative zones, with a mean daytime population of 8361 residents.

We augment our main dataset with information on daytime population by neighborhood from the 2001 Census of Population. Daytime population reflects not just the residential population but also the commuter population who works in a neighborhood. We define the per capita number of restaurants or retail establishments in each neighborhood as the number of restaurants or retail establishments in the neighborhood divided by the daytime population of the neighborhood (in thousands of people).

For a subset of restaurants, we were able to obtain information on cuisine type, price of a meal and consumer ratings of food, ambience and service from "Il Mangelo", which during our sample period was one of the most popular restaurant guides in Milan. While, Tripadvisor and Yelp are now widely used in Milan, they were not widely used in 2004. We hand-entered the data from the 2004 and 2012 print editions. The data are available for 811 restaurants in 2004 (13.3% of all restaurants; 37.1% of sit down restaurants) and 975 in 2012 (14.1% of all restaurants; 39.0% of sit down restaurants). While the Il Mangelo includes only a sample of the restaurants in the city, it covers all neighborhoods, price levels and cuisines.

We also collected data on real estate prices from "Agenzia delle Entrate". The data report mean sale prices per square meter by neighborhood based on the universe of transactions between 2000 and 2012, separately for commercial and residential properties. Finally, we added indicators for whether a neighborhood has a restaurant mentioned in the Michelin Guide (source: Michelin Guide); a subway stop (source: subway map), a college or university building (source: college and university directories); a significant tourist attraction (source: Lonely Planet Guide).

Table A1 shows the summary statistics. The unit of observation is a neighborhood. Entries are averages across all years. The average neighborhood has 4.1 restaurants per 1000 daytime residents and 15.6 retail establishments, of which 3.4 are food retail establishments.

[11] We drop 114 restaurants and 105 retail establishments with missing address.

4 Empirical Analysis

We first test whether before 2005 restaurants were distributed homogeneously across neighborhoods, as mandated by the minimum distance regulation (Sub-Section 4.1). We then study what happened to the the spatial agglomeration of restaurants and retail establishments after the 2005 reform (Sub-Section 4.2). Finally we document changes in product differentiation adopted by restaurants after the reform (Sub-Section 4.3).

4.1 Spatial Distribution Before the Reform

The map in the left panel of Figure 1 shows the number of restaurants by neighborhood (relative to the city average) in 2004—the year before the removal of entry constraints. The map shows significant differences across areas. This reflects differences in the daytime population in each neighborhood, i.e. the number of residents and commuters who live or work in each neighborhood. Since the minimum distance regulation required the distance to be set as a function of the potential number of customers in each neighborhood, we shouldn't expect a homogenous distribution of the absolute number of restaurants. The right panel of Figure 1 shows the per capita number of restaurants by neighborhood in 2004 (relative to the city average), where the per capita number is computed dividing the number of restaurants by daytime population. The map shows that in per capita terms, restaurants are significantly more homogenously distributed across neighborhoods.

A statistical test fails to reject that the distribution of the per capita number of restaurants across neighborhoods is equal to an homogeneous distribution. Specifically, the first row of Table 1 shows that a Kolmogorov test on the distance between the sample cumulative function and the theoretical uniform cumulative function yields a test statistics of 0.004 and a p-value of 0.994, indicating that restaurants are homogenously distributed across neighborhoods. Row 2 and 3 show that this is not the case for retail or food retail establishments: the test rejects the hypothesis of uniform distribution (p-values: 0.000 and 0.019, respectively).

We conclude that, consistent with the minimum distance regulation, the geographical distribution of restaurants shows no sign of geographical agglomeration in 2004: the per capita number of restaurants in 2004 is statistically similar in all neighborhoods. By contrast, the retail and food retail sectors, which have never been subject to entry constraints, are not homogenously distributed over space, but are more concentrated in some neighborhoods than others.

4.2 Spatial Distribution After the Reform

Changes in the Total Number of Restaurants. The lifting of the minimum distance regulations in Milan resulted in an increase in the total number of restaurants in the city. This is shown in Appendix Table A2, which reports the total number of restaurants in the period between 2000 and 2012. Columns 8 and 9 show that, while the number of restaurants was growing at a slow rate before the reform—a 0.5% mean yearly increase between 2000 and 2004 — it increased significantly faster after reform—a 1.62% mean yearly increase between 2004 and 2012. The fact that the number of restaurant increased significantly after the reform suggests that the entry regulation was binding for the entire city.

The Table also shows that this increase was limited to the restaurant sector, and did not extend to retail establishments or food retail establishments. In fact, their numbers grew at a *slower* pace after 2004 than before 2004. Thus, the increase in the number of restaurants did not reflect a city-wide surge in the entire retail sector, but was specific to the restaurant sector, which as the only one affected by the 2005 reform of minimum distance.

Changes in Geographical Agglomeration. For our purposes, the most interesting effect of the reform is not on the overall number of restaurants in Milan, but on their location. In the presence of forces of agglomeration, we should see that after the reform, restaurants, freed from the minimum distance constraint, tend to concentrate geographically. Finding that after 2004 restaurants remain homogeneously distributed across neighborhoods would cast doubt on the existence of agglomeration forces in this sector.

We first repeat the Kolmogorov test for whether the spatial distribution of restaurants is a uniform distribution, this time using 2012 data. Columns 3 and 4 of Table 1 report a test statistics of 0.316 and a p-value of 0.000. Thus, while the 2004 spatial distribution of restaurants was statistically indistinguishable from a uniform distribution, by 2012 the spatial distribution was statistically different from a uniform distribution. Put differently: in 2004–the year before the reform—each neighborhood had roughly the same per capita number of restaurants. By 2012—7 years after the reform—this was not true anymore.

The change occurred because restaurant growth after 2004 was highly heterogeneous across neighborhoods, with restaurants clustering in some neighborhoods and deserting other neighborhoods, ultimately resulting in a vast increase in spatial agglomeration. Of the 180 neighborhoods in Milan, 120 experienced an increase in the per capita number of restaurants between 2004 and 2012, with 50 neighborhoods experiencing a large increase (+20% or more). By contrast, 60 neighborhoods experienced a decrease between 2004 and 2012, with

10 neighborhoods experiencing a large decrease (-20% or more). The neighborhood with the largest percent gain added 60% restaurants relative to 2004. The neighborhood with the largest loss lost 75% of its restaurants relative to 2004.

Figure 2 shows visually the resulting increase in geographical dispersion. We divide neighborhoods in quartiles, based on their 2004-2012 growth in per capital number of restaurants and plot the evolution of the per capita number of restaurants overtime for each quartile. For easiness of comparison, we normalize the variable so that it is 0 in 2004 for all quartiles.

The Figure shows that in the years before 2004, the four groups had similarly flat pre-trends. The lack of pre-trends is important because it indicates that there is no evidence of the effects of the reform before the reform took place. This is true for all four groups of neighborhoods, irrespective of their post-reform experience. After 2004, however, the Figure shows an accelerating divergence in the per capita number of restaurants. Had the spatial distribution of restaurants stayed roughly uniform after the reform, the 4 lines would have been near each other. Instead, the four lines diverge dramatically, with the top two quartiles (Quartiles 3 and 4) experiencing a boom in the number of restaurants, the second quartile experiencing a modest increase and the bottom quartile experiencing a decline. The growth in the top quartile (Quartile 4) in particular appears to follow a convex trend, suggesting that agglomeration of restaurants in this group of neighborhoods may be accelerating, which would be consistent with self reinforcing agglomeration dynamics.

Figure 3 provides an alternative way of documenting the increase in agglomeration that took place after 2004. It shows the evolution over time of three alternative measures of spatial dispersion across neighborhoods: the standard deviation in the per capita number of restaurants, the difference in the per capita number of restaurants between neighborhoods at the 90th and the 10th percentile; and the interquartile range, which is the difference between neighborhoods at the 75th and the 25th percentile. These measures capture how spatially agglomerated restaurants are in each year. In a city where each neighborhood has roughly the same per capita number of restaurants, spatial agglomeration would be limited, and the three measures of dispersion would be low. By contrast, in a city where most of the restaurants are concentrated in a small number of neighborhoods, spatial agglomeration would be pronounced, and the three measures would be high. We are interested in how these three measures were trending in the years before the reform and how they have changed in the years after the reform.

The Figure shows that there is no evidence of an increase in agglomeration before the reform, consistent with what we found in Figure 2 above. Spatial agglomeration was stable

in the years before the reform. If anything, the 75-25 difference was slightly declining. By contrast, in the years after the reform, the standard deviation, the 90-10 difference and the 75-25 differences all increase sharply, suggesting that the reform has resulted in more geographical inequality in the number of restaurants across neighborhoods.

The top panel of Table 2 quantifies the changes in the three measures of spatial inequality. In the 2004-2012 period, the standard deviation increased by 0.563, significantly more than in the 2000-2004 period (0.029). Similarly, the 90-10 and the 75-25 percentile differences increased significantly more during the 2004-2012 period (+0.837 and +1.197) than the 2000-2004 period (-0.182 and -0.022). The last row in the panel reports the difference-in-difference estimates, obtained by taking the difference between the 2004-2012 change and the 2000-2004 change. Bootstrapped standard errors are reported in parenthesis. Entries show that for all three variables the difference-in-difference estimates are statistically significant. The magnitude of the increases is economically large and point to a profound shift in the degree of geographical agglomeration of restaurants in Milan.[12]

In principle, one may be concerned that the increased concentration of restaurants reflects unobserved changes in the location of consumers, rather than endogenous agglomeration triggered by the reform. Possible examples of shocks that could alter the location of consumers are changes in the location of office space or changes in the public transportation network.[13] To assess this possibility, we compare changes in the geographical concentration of restaurants with changes in the geographical concentration of retail establishments and food retail establishments.

The middle panel of Table 2 shows that the spatial concentration of the retail sector did not grow very much after the reform compared to before. In anything, the standard deviation grew significantly less in the period 2004-2012 (+0.380) than in the period 2000-2004 (+1.212). The same is true for the 75-25 percentile difference, which declined after the reform (-0.483), while estimates for the 90-10 percentile differences are too noisy to be informative. The bottom panel shows that the standard deviation in food retail sector did increase between 2004 and 2012, but such increase was statistically similar to the one in the period 2000-2004. The 75-25 and 90-10 percentile differences did not change after 2004. The

[12]We find similar results if we focus on restaurant employment, which we use as a measure of restaurant size. We find evidence of increased spatial dispersion in the number of restaurant employees by neighborhoods similar to the ones uncovered above for number of restaurants. What changes after the reform is the number of restaurants in each neighborhood, not their size as measured by employment.

[13]While neighborhood population and employment were generally stable over the past 20 years, Milan has been improving its public transportation, potentially altering the demand for restaurants across neighborhoods.

difference in difference estimates at the bottom of the two panels indicate that the agglomeration of retail establishments after the reform either declined or remained unchanged relative to the trend before the reform, and the agglomeration of food retail establishments remained unchanged. Thus, the increase in agglomeration after the reform was limited to the restaurant sector. These findings are inconsistent with the notion that the increased agglomeration in the restaurant sector reflects unobserved shocks to the location of consumers.

Overall, Tables 1 and 2 and Figures 2 and 3 paint a clear picture. While the overall number of restaurants in Milan increased after the liberalization of restaurant entry, the gains were far from uniform across areas. Some neighborhoods attracted large numbers of new restaurants, while other neighborhoods lost most of their restaurants. By 2012, 7 years after the reform, the city's restaurants were significantly more spatially concentrated than before the reform. The lack of pre-trends and the lack of any increase in the retail sector supports a causal interpretation of the increases in restaurant concentration after 2004 as an effect of endogenous agglomeration economies triggered by the 2004 reform.

Unlike Paris, London and Barcelona, Milan did not have a "restaurant area" in 2004. By 2012, Milan had developed several restaurants areas. Appendix Figure A1 maps the change in the per capita number of restaurants by neighborhood and shows where the growth occurred. Examples of neighborhoods that experienced particularly large increases in the concentration of restaurants are Administrative Zones number 101 and 104 ("Navigli"), 159 ("Isola") and 88 ("Idroscalo").

Neighborhood Characteristics. It is in principle possible that the winners among neighborhoods attracted more restaurants because they had better unobservables. If restaurants, freed up by the constraints of minimum distance regulation, concentrated in areas with characteristics that appeal to consumers—better transit, better local amenities, or lower crime—then our findings above might simply reflect unobserved neighborhood heterogeneity, rather than agglomeration spillovers.

We investigate whether the neighborhoods that attracted more restaurants after 2004 were neighborhoods with initially better observable characteristics. Since we observe some but not all the characteristics that may attract consumers, we also investigate whether the neighborhoods that attracted more restaurants after 2004 were neighborhoods that had more retail establishments in 2004 or where retail establishments were growing faster before 2004. The 2004 number of retail establishments and the 2000-2004 growth in the number of retail establishments are arguably two good overall measures of an area's attractiveness to

consumers before the reform. Retail was not regulated, so neighborhoods that were more attractive to consumers presumably had more retail establishments in 2004. For the same logic, up and coming neighborhoods that were becoming more attractive to consumers before 2004 presumably experienced a faster growth in establishments before 2004. Finding that after 2004 restaurants agglomerated in neighborhoods with a high number of retail establishments in 2004 or where the number of retail establishments was growing particularly fast may suggest that the increased concentration of restaurants reflected unobserved neighborhood characteristics, rather than forces of agglomeration.

Column 1 in Appendix Table A3 reports estimates of a regression of the change in the log per capita number restaurants between 2004 and 2012 in a neighborhood on its 2004 observable characteristics, including: mean housing price; mean price of commercial units (stores and restaurants), an indicator for the presence of a subway stop, an indicator for the presence of a college or university; an indicator for the presence of a major touristic attractions; daytime population; the number of restaurants; the mean price of restaurants; the mean quality ratings for restaurants; an indicator for the presence of a Michelin restaurant. Most coefficients are insignificant, suggesting that winners and the losers among Milan neighborhoods looked generally similar in 2004, at least based on the variables that we can measure. The only significant coefficient is the negative coefficient on the average price of restaurants. An F-test at the bottom reveals that the coefficients are jointly not different from 0 (p-value: 0.15).

In column 2 we add the 2004 number of retail and food retail establishments; while in column 3 we add the 2000-2004 change in the number of retail and food retail establishments. In column 4 we add both sets of variables. If neighborhoods that attracted more restaurants did so because of better unobservables, then we should see that these neighborhoods also had more retail establishments in 2004 or a growing number of retail establishments. Columns 2 to 4 indicate that this is not the case. The coefficients on retail and food retail are insignificant, both in levels and in changes, suggesting that the 2004-2012 growth in restaurants is orthogonal to the initial number of retail and food retail establishments; and their trend over time.

While we can't completely rule out that the winners attracted more restaurants because they have better unobserved fundamentals, the evidence in Appendix Table A3 does not support this concern. Overall, it appears that it is not possible to predict the identity of the winners based on their initial characteristics. The winners were not ex-ante systematically different from the losers, indicating that random factors may have played a role in selecting

which areas gained in new spatial equilibrium and which areas lost.

4.3 Changes in Restaurant Differentiation

Theoretical work has posited that when restaurants and stores agglomerate geographically, they have an incentive to differentiate themselves from their rivals (Fujita and Thisse, 1996 and 2002). Intuitively, a restaurant that locates near many competitors has a stronger incentive to differentiate itself from its rivals than a restaurant that is geographically more isolated.

In this Sub-Section, we test this hypothesis. In particular we investigate whether there is evidence of larger increases in product differentiation in neighborhoods where the number of restaurants significantly increased after the reform compared to neighborhoods where the number of restaurants increased less or decreased. To quantify product differentiation among restaurants in a given neighborhood, we use three alternative measures: the standard deviation of the price of a meal across restaurants within a neighborhoods; the standard deviation of consumer quality ratings; the diversity of cuisines. A neighborhood that has restaurants with a diverse range of prices, qualities and types of cuisines is defined as having more product differentiation than a neighborhood that has restaurants with similar prices, qualities and types of cuisines. Price refers to the price of an average meal in a restaurant and is measured in euros; food quality ratings range from 1 star to 6 stars;[14] type of cuisine is defined as an indicator for ethnic cuisine. The majority of Milan's restaurants in 2004 offered Italian cuisines, with only 27% offering other cuisines. We define any restaurant offering non-Italian food as "ethnic" and use the share of ethnic restaurants as a measure of diversity. There are not enough ethnic restaurants in this period to allow for an analysis that differentiates between cuisines of different countries.

In Figure 4, we divide neighborhoods in quartiles, based on their 2004-2012 growth in per capital number of restaurants and relate this growth to changes in dispersion of price, quality and cuisine types. For each quartile, the first panel shows the 2004-2014 change in the within-neighborhood standard deviation of the price of a meal. The second and third panel show the corresponding changes in the standard deviation of quality ratings and the share of ethnic restaurants, respectively. We don't interpret these relationships as causal. Rather, we interpret them as equilibrium relationships that document how price, quality and type of cuisine vary with the endogenous changes in number of restaurants in a given neighborhood.

[14] We also have consumer ratings for ambience and service. Our results are similar if we use those.

The first panel shows that neighborhoods that experienced a large increases in the concentration of restaurants—like those in the top quartile (Q4)—also experienced a significant increase in the dispersion of restaurant prices within the neighborhood. Thus, consumers looking for a restaurants in this group of neighborhoods could find a significantly more diverse set of price options after the reform (compared to before). By contrast neighborhoods that experienced small increases or decreases in the concentration of restaurants—like those in the bottom quartile (Q1)—experienced a decline in the dispersion of restaurant prices. Consumers looking for a restaurants in this group of neighborhoods enjoyed fewer options after the reform (compared to before) because they faced a more homogeneous set of price options. Neighborhoods in the middle—like the second and third quartiles (Q2 and Q3)—experienced modest increases in the dispersion of restaurant prices.

The second panel shows a similar pattern for quality ratings. Areas with large increases in the concentration of restaurants also experienced an increase in the dispersion of quality ratings; while areas with smaller increases or decreases in the concentration of restaurants experienced a decline in the dispersion in quality ratings.

The bottom panel focuses on type of cuisine–namely an indicator for ethnic cuisine. We interpret increases in the number of ethnic restaurants as increases in the diversity of type of cuisine. The Figure shows that the the share of ethic restaurants grew more in areas with large increases in the concentration of restaurants (Q3 and Q4) and grew less in areas with small increases or decreases in the concentration of restaurants (Q1 and Q2). Thus, consumers looking for a restaurants in neighborhoods in the top quartile could find a much more diverse set of cuisine options after the reform (compared to before). Consumers looking for a restaurants in neighborhoods in the bottom quartile could also find more diverse set of cuisine options, but the increase was smaller compared to the top quartile.[15]

Overall, these findings are consistent with the notion that restaurants located in neighborhoods where the concentration of restaurants increased reacted to the increased competition by differentiating themselves by price, quality and cuisine.

[15]We also find a positive (but non monotonic) relationship between the 2004-2012 growth in per capital number of restaurants and changes in mean price or mean ratings or changes in ratings (not shown in the Figure, but available on request), indicating that prices grew the most in areas with the largest increase in the number of restaurants.

5 Conclusion

We seek to understand what drives the agglomeration of restaurants that is observed in many cities of the world. Before 2005, unique among other cities, Milan restaurants were evenly distributed across neighborhoods. This was due to a minimum distance regulation that effectively kept the spatial distribution of restaurants artificially uniform. The abolition of the regulation in 2005 offers a singular opportunity to test for agglomeration spillovers in the restaurant sector.

Consistent with the existence of significant agglomeration externalities, we find that after 2005, the geographical concentration of restaurants increased sharply. By 2012, 7 years after the liberalization of restaurant entry, the city's restaurants had agglomerated in some neighborhoods and deserted others. The winners were not ex-ante systematically different from the losers, indicating that random factors may have played a role in selecting the new spatial equilibrium—namely which areas gained and which areas lost. We also find that in neighborhoods where the number of restaurants grew the most after the 2005 reform, restaurants reacted to the increased competition by becoming more differentiated based on price, quality and type of cuisine.

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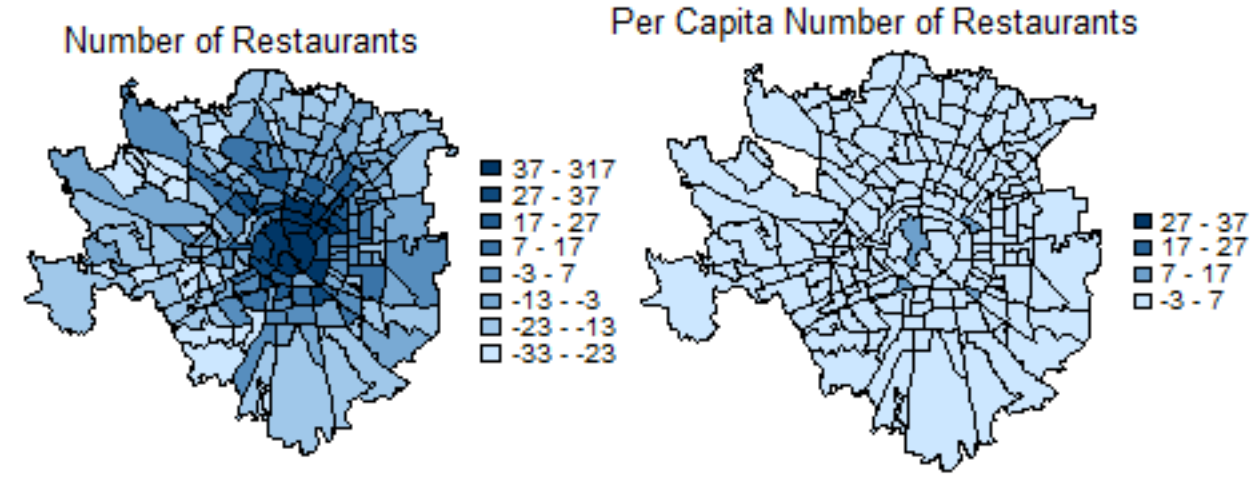
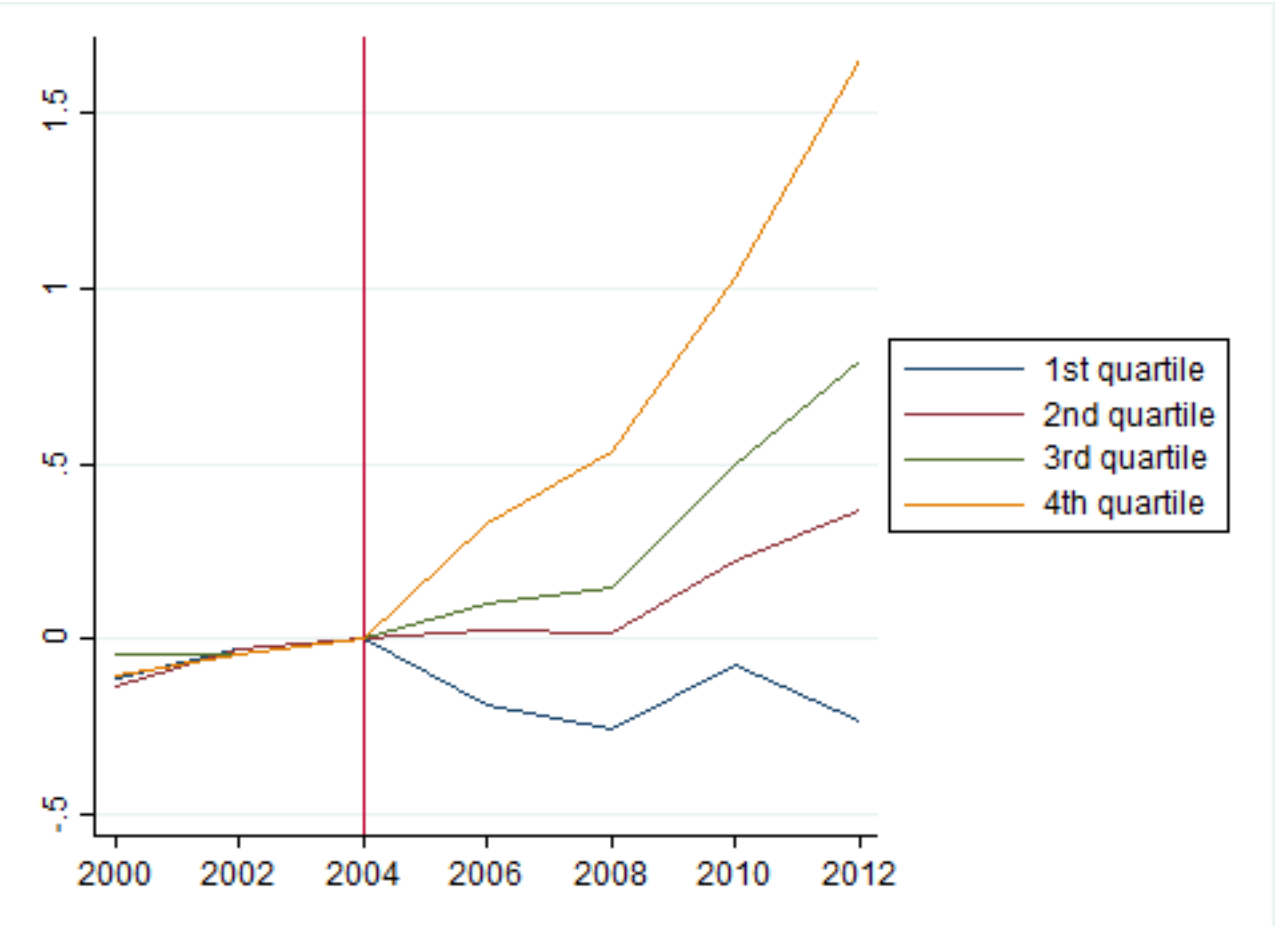
Figure 1: Number of Restaurants by Neighborhood in 2004 (Relative to the City Average)



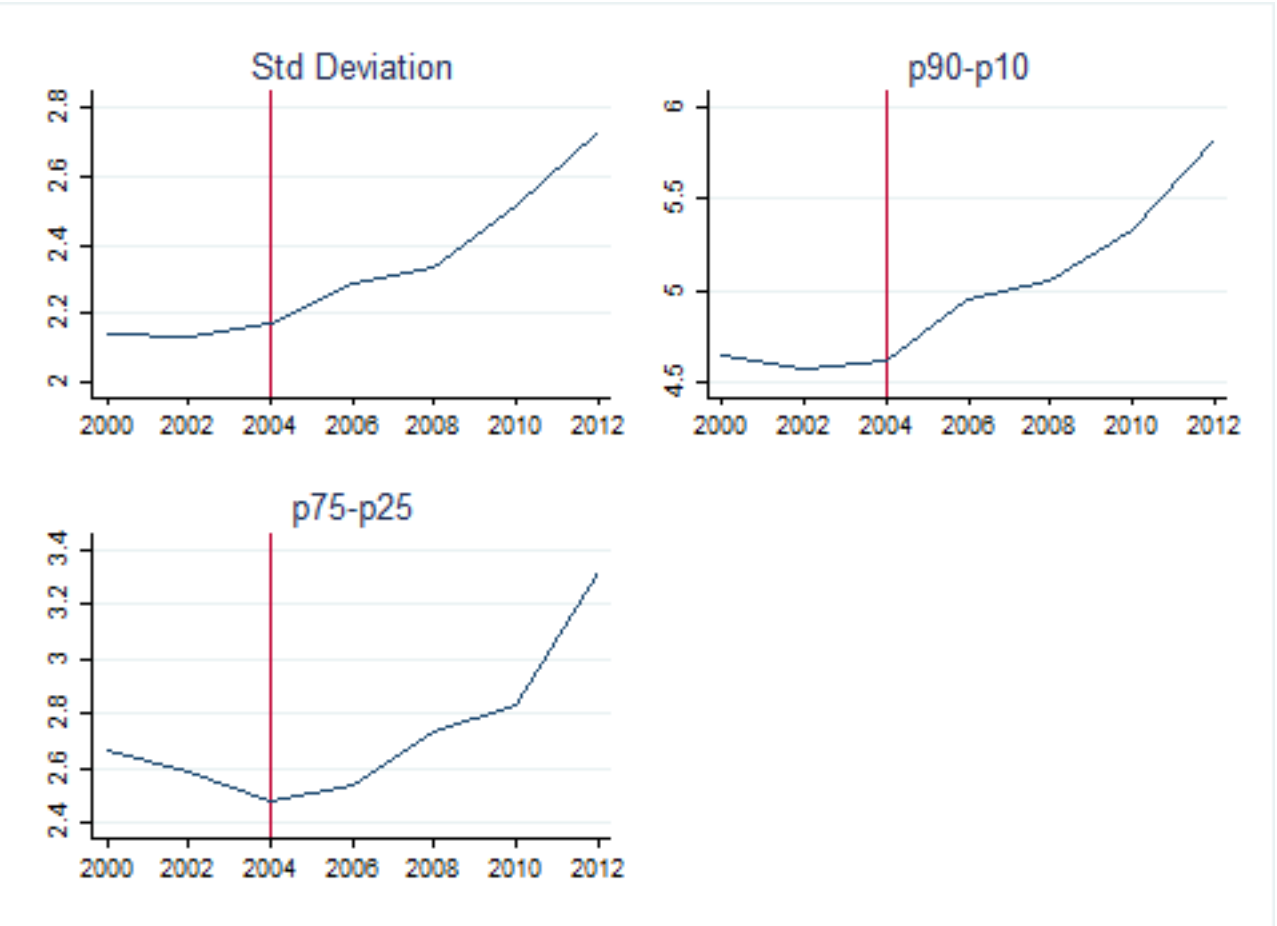
Notes: The panel on the left shows the number of restaurants in each neighborhood in 2004, relative to the city average. The panel on the right shows the per capita number of restaurants in each neighborhood in 2004, relative to the city average. There are 180 neighborhoods.

Figure 2: Per Capita Number of Restaurants, by Year and Quartile of 2004-2012 Growth



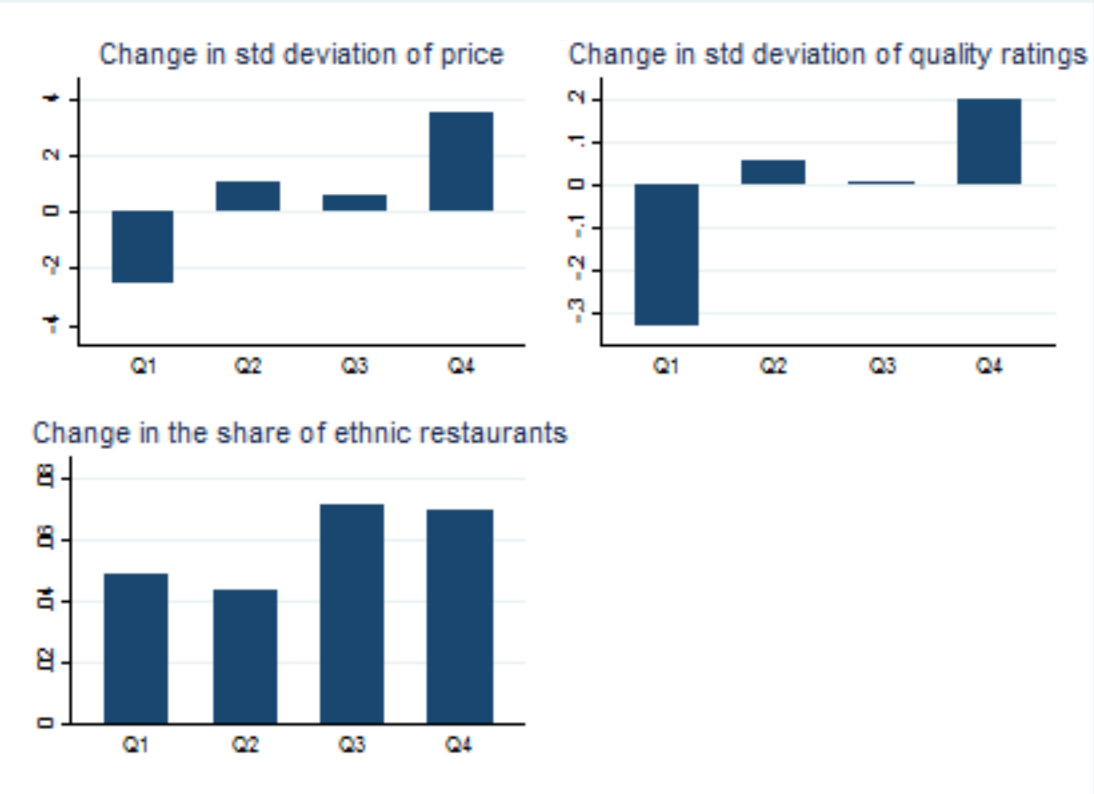
Notes: The unit of analysis is a neighborhood. There are 180 neighborhoods. For each quartile, the Figure shows the per capita number of restaurants between 2000 and 2012, normalized so that it has mean 0 in year 2004. Neighborhoods are divided into quartiles based on the percent change in per capita number of restaurants between 2004 and 2012. The first quartile includes neighborhoods with the smallest percent change between 2004 and 2012. The fourth quartile includes neighborhoods with the largest percent change between 2004 and 2012.

Figure 3: Three Measures of Spatial Dispersion, By Year



Notes: The unit of analysis is a neighborhood. There are 180 neighborhoods. For each year in the data, the first panel shows the standard deviation across neighborhoods of the per capita number of restaurants. The second panel shows the difference in the per capita number of restaurants between the neighborhood at the 90th percentile and the neighborhood at the 10th percentile. The third panel shows the difference in the per capita number of restaurants between the neighborhood at the 75th percentile and the neighborhood at the 25th percentile (interquartile range).

Figure 4: Changes in the Within-Neighborhood Dispersion of Restaurant Prices and Quality Ratings and in the Prevalence of Ethnic Cuisine



Notes: The unit of analysis is a neighborhood. There are 180 neighborhoods. Neighborhoods are divided into quartiles based on the percent change in per capita number of restaurants between 2004 and 2012. The first quartile includes neighborhoods with the smallest percent change in per capita number of restaurants between 2004 and 2012. The fourth quartile includes neighborhoods with the largest percent change between 2004 and 2012. For each quartile, the first panel shows the 2004-2014 change in the within-neighborhood standard deviation in the price of a meal. The second panel shows the 2004-2014 change in the within-neighborhood standard deviation in quality ratings. The third panel shows the percent change in the share of ethnic restaurants between 2004 and 2014.

Table 1: Kolmogorov Test for Homogeneity of Spatial Distribution of Restaurants Across Neighborhoods

	2004		2012	
	test statistic	p-value	test statistic	p-value
	(1)	(2)	(3)	(4)
Restaurants	0.004	0.994	0.316	0.000
Retail	-1.243	0.000	-1.324	0.000
Food Retail	0.104	0.019	0.340	0.000

Notes: Entries in the first row are from a Kolmogorov test on the distance between the sample cumulative function of per capita number of restaurants and the theoretical uniform cumulative function. Entries in the second and third row are from a Kolmogorov test on the distance between the sample cumulative function of per capita number of retail establishments (row 2) or food retail establishments (row 3) and the theoretical uniform cumulative function. The unit of analysis is a neighborhood. There are 180 neighborhoods.

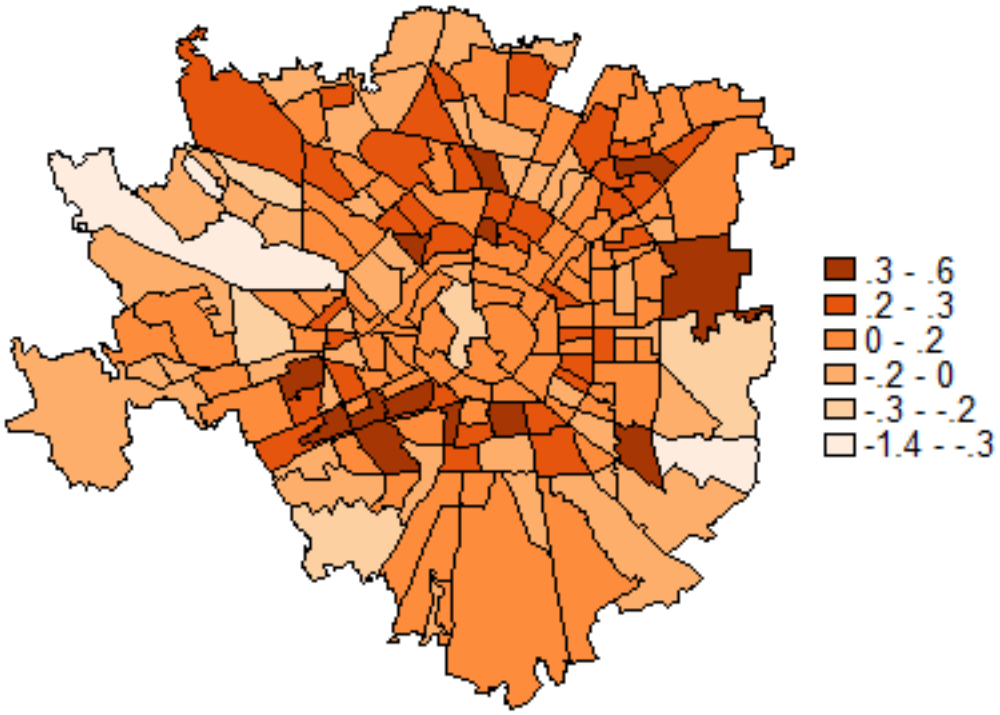
Table 2: Changes in Three Measures of Spatial Dispersion of Restaurants, Retail Establishments and Food Retail Establishments

	Std Dev	p75-p25	p90-p10
	(1)	(2)	(3)
		Restaurants	
Change 2000-2004	0.029	-0.182	-0.022
	(0.029)	(0.177)	(0.192)
Change 2004-2012	0.563***	0.837***	1.197***
	(0.106)	(0.207)	(0.427)
(Change 2004-2012) - (Change 2000-2004)	0.533***	1.019***	1.218***
	(0.114)	(0.296)	(0.488)
		Retail	
Change 2000-2004	1.212*	0.411	-0.319
	(0.672)	(0.591)	(0.719)
Change 2004-2012	0.380	-0.483	1.292
	(0.200)	(0.513)	(0.868)
(Change 2004-2012) - (Change 2000-2004)	-0.827*	-0.893	1.610
	(0.502)	(0.889)	(1.098)
		Food Retail	
Change 2000-2004	0.159	-0.066	-0.042
	(0.149)	(0.156)	(0.242)
Change 2004-2012	0.216***	0.305	0.090
	(0.091)	(0.215)	(0.260)
(Change 2004-2012) - (Change 2000-2004)	0.057	0.370	0.132
	(0.087)	(0.257)	(0.398)

Notes: The unit of analysis is a neighborhood. There are 180 neighborhoods. Bootstrapped standard errors (200 replications) in parentheses. $^{*}p < 0.1; ^{**}p < 0.05; ^{***}p < 0.01$

Online Appendix

Appendix Figure A1: Percentage growth of Restaurants 2004-2012



Notes: The map shows the percent change in the per capita number of restaurants in each neighborhood between 2004 and 2012, relative to the city average. There are 180 neighborhoods.

Appendix Table A1: Descriptive Statistics

	N	Mean	Std. Dev.
	(1)	(2)	(3)
Per capita number of restaurants	180	4.10	2.31
Per capita number of retail establishments	180	15.63	9.41
Per capita number food retail establishments	180	3.41	1.69
Daytime population	180	8361.57	8179.20
Price of a Restaurant Meal (Euro)	140	33.15	10.42
Consumer Food Quality Rating	140	6.96	0.57
Mean House Price (Euro/sq meter)	180	2590.24	730.88
Mean Commercial Price (Euro/sq meter)	180	2066.94	801.73
Neighborhood has a Michelin Restaurant	180	0.225	0.37
Share of Ethnic Restaurant in Neighborhood	159	0.322	0.219
Neighborhood Has a Subway Stop	180	0.33	0.47
Neighborhood has a College or University	180	0.02	0.16
Neigh. has a Significant Tourist Attraction	180	0.01	0.12

Notes: The unit of analysis is a neighborhood. There are 180 neighborhoods.

Appendix Table A2: Number of Restaurants, Retail Establishments and Food Retail Establishments, by Year.

	2000	2002	2004	2006	2008	2010	2012	2000-2004 Mean Yearly Change	2004-2012 Mean Yearly Change
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Restaurants	5887	5995	6057	6117	6178	6628	6841	0.50%	1.62%
Retail	22698	23740	24751	25094	26116	26809	25256	2.25%	0.25%
Food Retail	4951	4408	5051	4973	5136	4542	5145	0.50%	0.25%

Appendix Table A3: Change in Per Capita Number of Restaurant and Initial Neighborhood Characteristics

	(1)	(2)	(3)	(4)
Mean Housing Price in 2004 (Eur / Sq. Meter)	0.025	0.042	0.042	0.054
	(0.116)	(0.117)	(0.118)	(0.120)
Mean Commercial Price in 2004 (Eur / Sq. Meter)	0.143	0.177	0.022	0.045
	(0.775)	(0.781)	(0.786)	(0.797)
Subway Stop	-0.002	0.000	0.001	0.003
	(0.027)	(0.027)	(0.028)	(0.028)
College or University	0.066	0.062	0.060	0.059
	(0.075)	(0.075)	(0.075)	(0.075)
Tourist Attraction	-0.233	-0.242	-0.219	-0.216
	(0.145)	(0.163)	(0.148)	(0.165)
Number of Restaurants in 2004	0.005	0.006	0.003	0.005
	(0.007)	(0.011)	(0.007)	(0.011)
Daytime Population	-0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Mean Restaurant Price	-0.003*	-0.003**	-0.003*	-0.003*
	(0.002)	(0.002)	(0.002)	(0.002)
Mean Consumer Rating	0.015	0.012	0.014	0.012
	(0.029)	(0.029)	(0.029)	(0.030)
Michelin Rest. in Neighborhood	0.022	0.026	0.023	0.023
	(0.029)	(0.030)	(0.030)	(0.030)
Number of Retail Est. in 2004		-0.003		-0.002
		(0.003)		(0.003)
Number of Food Retail Est. in 2004		0.015		0.009
		(0.013)		(0.016)
Change in Retail Est. 2000-2004			-0.158	-0.133
			(0.106)	(0.114)
Change in Food Retail Est. 2000-2004			0.095	0.066
			(0.073)	(0.090)
Coefficients Jointly Significant (p-value)	0.15	0.19	0.15	0.24
R-squared	0.103	0.114	0.121	0.124

Notes: Each column is a separate regression. Standard errors in parenthesis. $^{*}p < 0.1; ^{**}p < 0.05; ^{***}p < 0.01$