Retail Zoning and Competition

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Abstract

Economists generally assume that zoning decreases competition, but we provide theory and evidence that zoning can have the opposite effect. Zoning keeps firms away from homes in order to protect home values. Preventing firms, such as liquor stores and gasoline stations, from locating near homes forces those firms closer together, increasing competition. We use a unique data set with detailed zoning maps for five product markets. We show that a smaller area of commercial zoning is correlated with lower prices and shorter distances between firms. The results indicate that regulators can use zoning to increase competition.

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1 Introduction

One of the most powerful tools for influencing competition at the local level is zoning. Economists generally focus on zoning's effect on the number of firms. With fewer firms, economists assume that zoning reduces competition. This is correct in many cases. However, zoning not only affects the *number* of firms; zoning also affects the *location* of firms. Regulations that keep businesses such as liquor stores away from homes might also force those businesses closer together and inadvertently increase price competition.

A simple location model illustrates the effect of zoning on competition. In the model, one neighborhood is zoned residential (consumers but no firms) while the other is zoned for mixed use (consumers and firms). Less space for commercial zoning decreases the number of firms, the distance between firms, and prices. Prices fall because, while there are fewer sellers, the decrease in distance dominates.

To test our predictions we use a unique data set with detailed zoning maps from 15 municipalities in Minneapolis–St. Paul, Minnesota.[1] We examine five types of retailers: full-service restaurants, bars, grocery stores, gas stations, and liquor stores. We use a two-stage model with the first stage estimating the number of firms as a function of zoning and demand, and the second stage estimating distance and price as functions of zoning and the predicted number of firms. We show that the space for commercial zoning is positively correlated with price and distance between firms. The results indicate that regulators can use zoning to increase competition. We believe the data patterns are important and worth exploring because they suggest that economists and regulators might usefully think about zoning in a new way.

1.1 Background on Zoning and Firm Location

Since the 1920s, zoning laws have implied a hierarchy of land uses to be protected with residential use at the top. The idea is that residential use should be protected from commerce and industry (Fischel, 1985, 21). Zoning protects home owners from negative external costs associated with nonconforming land uses and other unwanted intrusions (McMillen and McDonald, 2002). For example, an area zoned residential disallows commercial establishments such as liquor stores and gasoline stations from locating there. Many consumers value the stores but the stores can locate in other parts of town.

Zoning divides land into areas where some activities are permitted and others are prohibited. In general, zoning predates the entry and location of firms. When a new residential area is developed, zoning is enacted to protect the value of the home. Protecting home values is important to homeowners, because - for most Americans - homes are the largest component of total family wealth (Bucks et al., 2009). Protecting home values is also important to local politicians who rely on home value for property taxes and who want happy voters. Zoning can be changed, but changes are costly and often resisted.

In addition to averting external costs, the conventional wisdom suggests that zoning reduces competition. Giertz (1977, 50) argued that "(z)oning, justified as a means of internalizing externalities, may, in fact, be a powerful tool for promoting monopoly."[2] By restricting the number of people that can live or work on a given parcel of land (by, for example, requiring that homes be large and single family, or that retail space be single story), zoning can give land owners market power to restrict quantities and increase real estate prices (Giertz, 1977; Hamilton, 1978). Land use restrictions, such as high minimum lot sizes, increase housing prices well above construction cost in Boston (Glaeser and Ward, 2009) and Manhattan (Glaeser, Gyourko, and Saks, 2005).[3]

Research on retail establishments has also found that zoning has anti-competitive effects. Regulations can be anti-competitive when they restrict the number of retail licenses (Lewis, 1945), bar large retailers like Wal-Mart (Basker, 2007), or discourage entry (Suzuki, 2008). Regulations intended to protect city centers can encourage the entry of stores that are smaller than both consumers and firms prefer (Smith, 2006).

In contrast to the existing literature, we hypothesize that zoning increases competition, because zoning pulls firms closer than they would otherwise. This does not mean that without zoning firms would not locate, or cluster, close to competitors; only that they would not cluster as much. Forces other than zoning which draw firms together include land covenants and firm choice. First, land covenants (which function like zoning) restrict land use and can force firms into a denser commercial space. Second, firms choose to cluster to increase demand and decrease costs. On the demand side, firms cluster because consumers prefer businesses in certain locations. One of the earliest economic explanations for clustering was that firms cluster to attract consumers that want to minimize travel costs (Hotelling, 1929). Firms also cluster to attract consumers searching for optimal product characteristics (Wolinsky, 1983; Fischer and Harrington, 1996; Konishi, 2005), to provide a credible commitment to low prices (Dudey, 1990), to locate near consumers attracted by the marketing or reputation of competitors (Chung and Kalnins, 2001), and because consumers (residences, workplaces, or entertainment) are concentrated (Neven, 1986). On the supply side, firms cluster to decrease labor and other input costs (Marshall, 1920; Rosenthal and Strange, 2001), attract trained workers (Helsley and Strange, 1990), learn from other firms how to improve productivity (Glaeser et al., 1992; Shaver and Flyer, 2000; Furman et al., 2006), learn about demand from other firms (Ridley, 2008), and because spinoffs sometimes locate near parent firms (Buenstorf and Klepper, 2009; Klepper, 2007).[4]

The advantages of increased demand and decreased costs encourage firms to cluster by choice. The attraction of firms is, however, mitigated by an important disadvantage: price competition. When firms are closer to rivals the price competition is more intense. The intensity of the competition depends in part on the ability of the firm to differentiate its products (Picone, Ridley, and Zandbergen, 2009). Restaurants have great range for product differentiation, so we expect that if zoning forces restaurants into a smaller space, there will be only a small reduction in the number of restaurants because restaurants reap some advantages from clustering and restaurants can mitigate price competition by differentiating their products. On the other hand, if zoning forces liquor stores into a smaller space, the firms will have less range for differentiation and the intense price competition will result in far fewer firms. For this reason we study multiple product markets including both restaurants and liquor stores.

2 Theory

We use a simple location model to illustrate the effect of zoning on competition. One neighborhood is zoned residential (consumers but no firms) while the other is zoned for mixed use (consumers and firms). It is costly for consumers to travel from the neighborhood without firms to the neighborhood with firms. We model the neighborhoods as circles (or equivalently infinite lines) so that we can focus on interesting competitive effects and avoid technical problems associated with endpoints (Salop, 1979). We model the industry as monopolistically competitive; there are no regulatory limits on how many firms can enter, although there are limits on where they can locate.

Formally, $X > 0$ consumers per unit of distance are located on two circles. The sum of the circumferences of the two circles is normalized to one. The circle zoned for mixed use has circumference z and the circle zoned residential has circumference $1 - z$ where $z \in (0, 1)$. In other words, z is the fraction of the total space in which firms may locate. Each consumer purchases one unit of a firm's product according to preferences, prices, and location.[5]

A consumer living on a circle without firms travels the shortest possible distance to the circle with firms at cost α. The consumer then travels to a firm. On a circle with both consumers and firms, a consumer living at l^* (or a consumer who travels to l^* from the circle without firms) travels to firm i located at l_i (among the N firms located at l_1, ..., l_N) at a cost $t|l_i - l^*|$. The consumer's utility is $v - p_i - t|l_i - l^*| - a$ where v is the reservation price, p_i is the price firm i charges, and a depends on whether the consumer and firm are on the same circle. If the consumer lives on the circle with firms, then $a = e$ is the external cost[6] associated with proximity to a firm. If the consumer lives on the circle without firms then $a = \alpha$.

We can think of the mixed-use city center as a circle within a residential circle (Figure 1). Using the circle-within-a-circle framework, it is easy to calculate the distance between the residential and mixed-use neighborhoods (α).[7] While convenient and consistent with stylized facts, the circle-within-a-circle framework is not critical for the model. The distance between neighborhoods α does not affect the firm's strategy if we assume that all consumers purchase.

The number of firms (N) is endogenous. The total number of firms is limited by profitability. The location of firms is limited by zoning which prohibits firms from locating on the residential circle and determines the size of the mixed-use circle. All potential competitors (infinitely many) have the same technology. Fixed cost of entry is $F > 0$. Firms enter until economic profit $(p_i - c)q_i - F$ is zero.

Seller i charges price p_i and its nearest competitor j located distance z/N away charges p_j. A consumer living between the firms at distance $\hat{y}$ from firm i, or a consumer traveling to that location from the residential circle, is indifferent between purchasing from firms i and j located z/N apart. A consumer is indifferent when $v - p_i - t\hat{y} - a = v - p_j - t(z/N - \hat{y}) - a$. The distance from the indifferent consumer to i is $\hat{y} = (p_j - p_i)/2t + z/2N$.

Next we calculate demand for a given firm. We begin with the distance to the indifferent consumer $\hat{y}$, then double it because consumers are coming from both sides of the firm, then multiply by the demand density X. This gives us a firm's demand from consumers in the mixed-use neighborhood: $2X\hat{y}/z$. Demand in the mixed-use neighborhood is only a fraction z of the demand. A firm's total demand across the two neighborhoods is $q^c = 2X\hat{y}/z$. Substituting for $\hat{y}$ in q^c gives $q^c = X((p_j - p_i)/tz + 1/N)$. The best response function is then $p_i(p_j) = ((p_j + c)N + tz)/2N$. Assuming that firms are symmetric, the profit maximizing price is $c + tz/N$.

Firms enter until economic profit is zero; the equilibrium number of firms is

$$N^e = \sqrt{\frac{Xtz}{F}} \tag{1}$$

The equilibrium distance from a firm's nearest competitor[8] is

$$\Delta^e = \frac{z}{N^e} = \sqrt{\frac{Fz}{Xt}} \tag{2}$$

Given the equilibrium number of firms, the equilibrium price is

$$p^e = c + \frac{tz}{N^e} = c + \sqrt{\frac{Ftz}{X}} \tag{3}$$

When $z = 1$ the equilibrium price and number of firms (equations 1 and 3) are the same as the competitive equilibria from Salop (1979, 148).

Changes in population (X) affect equilibrium price (equation 3) through the number of firms (N). When population (X) increases, additional firms enter, those firms are closer together, proximity drives down prices, and volume-per-firm rises (because the percentage increase in demand exceeds the percentage increase in the number of firms). In markets characterized by monopolistic competition (like this one), when market demand is greater, the number of firms is greater, and demand for a given firm rotates and is more elastic. A firm's demand curve rotates so that it remains tangent to average cost, because free entry drives price to equal average cost. We use this model of monopolistic competition in the empirical analysis. We estimate price and distance as functions of the number of firms, and number of firms as a function of demand. Both price and the number of firms are functions of zoning.

Consider a simple example of the effect on competition of a smaller area of commercial zoning. In one market zoning is $\tilde{z} = 9F/Xt$, so there are three firms in equilibrium (Figure 1). In another market commercial zoning is smaller, so that the mixed-use area contracts by 4/9, the equilibrium number of firms (equation 1) will decrease from three to two. The equilibrium distance decreases by 33%, as does the equilibrium mark-up over marginal cost $(p^e - c)$. The number of consumers (total circumference of the residential plus mixed-use circles) is the same before and after the reduction in the area of commercial zoning. When the space zoned for firms is smaller, rival firms are forced closer together which increases competition. Prices are lower, but volume per firm is higher because there are fewer firms.

Proposition 1 *Restrictive zoning reduces the number of firms.*

Differentiating the equilibrium number of firms (from equation 1) with respect to zoning yields $\partial N^e/\partial z = \sqrt{Xt}/2\sqrt{Fz} > 0$ and $\partial^2 N^e/\partial z^2 = -\sqrt{Xt}/4z\sqrt{Fz} < 0$. The number of firms does not increase as fast as the space zoned for firms, because the number of potential consumers is fixed.

Proposition 2 *Restrictive zoning reduces the distance between firms.*

Differentiating the equilibrium distance between firms (from equation 2) with respect to zoning yields a positive sign.

Proposition 3 *Firms with more ability to differentiate their products cluster more.*

Let the distance from the marginal consumer to the firm be the product of the endogenous geographic distance and the exogenous product differentiation, which varies by product market. For example, exogenous ability to differentiate products is less for liquor stores than for full-service restaurants. To maintain the equilibrium, if exogenous product differentiation increases, endogenous geographic distance must decrease. Hence, geographic distance is inversely related to product differentiation. This result is well established in the theoretical literature (Irmen and Thisse, 1998).

Proposition 4 *Restrictive zoning reduces price.*

The derivative of equilibrium price (equation 3) with respect to zoning is positive; thus a smaller area in which firms can locate reduces price. Restrictive zoning leads to shorter distances between firms which causes more intense price competition. This result follows logically from the model, but contrasts with previous research on residential zoning (Giertz, 1977; Hamilton, 1978).

We also offer a novel explanation for why researchers might observe a positive correlation between price and the number of sellers. According to economic theory, the correlation between price and the number of firms should be negative (Dranove, Shanley, and White, 1993) but if researchers fail to control for zoning and other land-use restrictions, the relationship might appear positive. As the area of commercial zoning shrinks, prices fall, and with lower prices there are fewer firms. Hence, price and the number of firms are moving in the same direction.[9] Previously, researchers suggested two other explanations for a positive correlation. First, in industries with increasing returns to scale, price rises because average cost rises (Salop, 1979). Second, for reputation goods, as the number of firms increases, consumers have less information about the reputation of a given firm, demand becomes less elastic, and price rises (Satterthwaite, 1979).

Again, the model predicts that restrictive zoning and geographic boundaries force firms into a smaller set of locations, which decreases the distance between them. When firms locate closer together, they engage in more intense price competition. With lower prices, fewer firms are in a market. Thus, zoning can lead to lower prices and lower external costs associated with living near firms, but fewer firms, less variety, and longer travel distances between consumers and firms. Next, we test the model's predictions.

3 Data

We use 2005 data from 15 municipalities in the Minneapolis–St. Paul area (Bloomington, Brooklyn Park, Burnsville, Coon Rapids, Eagan, Eden Prairie, Edina, Golden Valley, Hopkins, Maple Grove, Minneapolis, Plymouth, Richfield, St. Louis Park, and St. Paul). We examine location patterns in five retail segments: full-service restaurants, bars, grocery stores, gas stations, and liquor stores. All five retail segments sell alcohol. Restaurants and bars are on-site alcohol firms, while grocery stores, gas stations, and liquor stores are off-site alcohol firms. On-site and off-site firms in Minneapolis–St. Paul are plotted in Figure 2.

We study alcohol markets because of the historical relationship between zoning regulation and alcohol sales. The justifications for zoning regulation in an alcohol market are two-fold: (1) Alcohol firms might create negative externalities for people in surrounding areas, including property and nuisance crimes (Carpenter, 2007); and (2) greater distance between consumers and firms discourages consumption.[10]

We use five data sources: (1) 2005 *Yellow Pages*, which we coded for this research; (2) zoning ordinances from 15 municipalities; (3) alcohol licenses, which provide names and addresses of licensees; (4) projections to 2005 from the 2000 U.S. Census of Population and Housing; and (5) GIS data on municipality and zoning boundaries and street networks. In section 6 we report additional data on gas retailers: price, wholesale cost, and location.

First, *Yellow Pages* data provide addresses and market types for full-service restaurants, grocery stores, and gas stations. Establishments choose *Yellow Pages* headings. We then geocode the firms based on street address information. There is an overlap of 60 firms who advertised in the *Yellow Pages* as both bars and full-service restaurants. Otherwise, retailers advertised in only one category.

Second, local government agencies supplied the zoning data. We exclude some small municipalities in the Minneapolis–St. Paul area which did not provide zoning information.

Third, alcohol license data give addresses for bars and liquor stores, as well as license numbers, issue and expiration dates, and types of licenses.

Fourth, projections to 2005 from the 2000 U.S. Census of Population and Housing were purchased from GeoLytics. Data elements include total population and median household income. GeoLytics data are specific to a Census block group. We compute weighted averages of block group data to derive characteristics of the area within a half mile, one mile, and two miles of each firm.

Fifth, we employ GIS data to construct variables for each firm's circular market area.

The final sample includes 2499 full-service restaurants, 288 bars, 1386 grocery stores, 280 gas stations, and 265 liquor stores.

4 Empirical Analysis

We begin the empirical analysis by defining the market (section 4.1). We then estimate the number of firms in the market as a function of zoning and demand to test proposition 1 (section 4.2). Estimating the number of firms forms the first stage of our two-stage analysis. The second stages are distance and price. We estimate distance as a function of zoning and the predicted number of firms to test proposition 2 (section 4.3). We also compare distance across product markets with varying degrees of product differentiation to test proposition 3. We describe corrections for spatial lag and error (section 4.4). Finally, we estimate retail gas price as a function of the predicted number of firms and zoning to test proposition 4 (section 6).

4.1 Market Definition

We use data from multiple municipalities in a metropolitan area. Within that area we define markets as a half-mile radius around a given firm. By using small markets we mitigate the problem of non-uniform demand. Even if part of the half-mile market is more populated than another part, people still should be willing to walk. In a half-mile market, the average distance to the firm is only a quarter of a mile. A quarter mile (400 meters) is often used to define service areas around transit stops, but the planning literature indicates that people are willing to walk even farther. People in cars are presumably even more willing to cover this distance. Hence, by defining markets as a half mile we believe that variation in demand should not be too great. On the other hand, defining markets as only a half mile could be too small, so we test the sensitivity of the market definition by also considering one-mile and two-mile markets.

Defining markets in this way is consistent with previous economic research on retailers. Hastings (2004) uses data on Southern California retailers, defining markets as firms within one mile. Netz and Taylor (2002) also use data on Southern California, defining markets with radii of a half mile, one mile, and two miles. Shepard (1991) uses data on the greater-Boston area with market definitions of a half mile, one mile, one-and-one-half miles, and two miles.

An alternative approach is to study isolated small towns as in Bresnahan and Reiss (1991). This approach is useful, but it is interesting to study not only isolated towns, but also urban areas. In addition to the research interest, there are methodological advantages to defining urban markets using circles around firms. There is probably less within-market heterogeneity of demand and cost in a small market with one-half mile radius than in a market defined as a town. Consumers might not be willing to travel across town for retailers such as grocery stores or gas stations. Hastings (2004), for example, reports that gas retail markets are one mile in radius. Defining markets remains a challenge for researchers, although sensitivity tests can bolster evidence.

We determine the fraction of the market zoned for alcohol firms using geocoded zoning maps. For example in Figure 3, zoning (shaded) restricts the space in which liquor stores can locate, so they are in close proximity. We define market characteristics as weighted averages of population characteristics for areas that overlap the circular market.

4.2 Number of Firms

Because the number of firms is endogenous, we use two-stage least squares. In the first stage we estimate the number of firms (equation 1 from the theory) as a function of zoning and demand.

$$N_{mi} = \beta_{4,0} + \beta_{4,Z} Z_i + \beta_{4,X} X_i + \gamma_{4,g} + \epsilon_{4,mi} \tag{4}$$

The dependent variable is N_{mi}, the number of firms in a circular market in which firm i is at the center of a geographic market with a fixed radius (of a half mile, one mile, and two miles). The product market type is $m \in 1, ..., 5$, where the five market types are restaurants, bars, grocery, gas, and liquor stores. Z_i is the share of the geographic market for firm i zoned for firms; X_i are demand characteristics in the market of firm i; γ_g are zip-code fixed effects; and ϵ_{mi} is the error term. The "4" subscript indicates the equation number.

Zoning (Z_i) is the fraction of the area of the circle that is zoned for firms. High values for zoning indicate that firms can locate in more of the area. We obtained geocoded zoning maps from each of the 15 municipalities indicating the type of establishment allowed in a particular space (for example, residential, commercial, industrial) and zoning requirements specific to alcohol vendors. For identification of the effect of zoning on the number of firms we rely on the timing of zoning. In general, zoning predates the entry and location of firms. When a new residential area is developed, zoning is enacted to protect the value of the home. Zoning can be changed but it is costly and resisted by incumbents, especially homeowners.

We use zip-code fixed effects (γ_g) to account for unobserved demand and entry cost across markets. We also control for demand characteristics (X_i) including median income, population, number of hotels, and length of major roads. Demand characteristics are defined for the firm's geographic market. If a firm's geographic market is 60 percent in one block group and 40 percent in another, then those weights are applied to the demand characteristics. Some of the demand controls have ambiguous signs. For example, the number of firms might increase with median income because of higher willingness to pay. On the other hand, the number of firms might decrease with income if higher-income people want to keep certain businesses away from their homes, because they associate those businesses with noise, congestion, or odor.

4.3 Distance between Firms

The second stage (5) estimates the distance to the nearest firm as a function of the predicted number of firms from the first stage (as in equation 2 from the theory). The second stage tests Proposition 2 which predicts a positive relationship between the distance between firms and the space zoned for firms. In markets with greater area of commercial zoning, more firms enter, and they disperse.

$$\Delta_{mi} = \beta_{5,0} + \beta_{5,Z} Z_i + \beta_{5,N} N_{5,mi} + \gamma_{5,g} + \epsilon_{5,mi} \tag{5}$$

where the dependent variable Δ_{mi} is the mean Euclidean distance between a firm at the center of a circular market and each of its competitors within a given radius.

Consistent with theory, demand factors are excluded from the distance equation, except through zip-code fixed effects (γ_g) and through the number of firms. Recall from equation 2 that demand enters through the number of firms. In markets with higher demand, there are more firms, those firms are closer together, firm proximity to other firms drives down prices, and volume per firm rises.

If a firm has no competitors in a given radius, then distance is set at the market radius (0.5, 1, or 2 miles). The share of firms that are local monopolists varies from 20% for liquor stores to 1% for full-service restaurants in the half-mile market, and from 18% to less than 1% in the one-mile market. To account for the concentration of firms at the outer limit of the circle, we use a Tobit estimator which accounts for spatial autocorrelation. We also conduct regressions without local monopolists; the results, not shown here, are similar.

We test Proposition 3 by comparing the magnitudes of the different marginal effects across the five product markets. The five types of products have substantially different abilities to differentiate. We use multiple product classes not only to examine product differentiation, but also to more-accurately measure clustering. Using a single product class can mislead because agglomeration might be due to a limited choice set rather than business strategy (Picone, Ridley, and Zandbergen, 2009).

4.4 Spatial Lag and Error

The observations might be subject to two types of spatial effects. First, the error terms for firms within a certain distance might be correlated. This spatial error effect arises from similarities in market characteristics not explicitly captured by the explanatory variables. Spatial errors lead to biased standard errors (Anselin, 1988). Second, the degree of spatial differentiation at one location might be correlated with the degree of differentiation at another location within a certain distance. This spatial lag effect might be introduced by procedures used to construct explanatory variables at the area level, or because market areas of nearby firms overlap. Unless corrected, the spatial lag leads to biased parameter estimates.

To control for the spatial lag effect, we rewrite equation 4 as

$$N_{mi} = \beta_{6,0} + \beta_{6,Z} Z_i + \beta_{6,X} X_i + \gamma_{6,g} + \rho W_{6,lag} N + \epsilon_{6,mi}, \tag{6}$$

where ρ is the parameter indicating the spatial lag effect and W_{lag} is the spatial lag weight matrix. In the weight matrix, each entry for firm i is equal to 1 divided by the number of i's competitors if firm $j \neq i$ is in i's market and is a center of the market, and each entry for firm i is equal to 0 if firm j is either not in i's market or if j is not a center firm.

To control for spatially autocorrelated errors, we rewrite equation 4 as

$$N_{mi} = \beta_{7,0} + \beta_{7,Z} Z_i + \beta_{7,X} X_i + \gamma_{7,g} + \lambda W_{7,error} + \epsilon_{7,mi} + \mu_{7,mi}, \tag{7}$$

where ϵ_{mi} is the vector of errors for all firms, λ is the coefficient indicating the level of spatial error, μ is an independently and normally distributed error term with constant variable, and W_{error} is the spatial error weight matrix; W_{error} is an inverse function of the Euclidean distance between any two markets so that closer firms are more weighted for spatial correlation. In the matrix, the off-diagonal entries are the negative exponential of the distance between firms i and j and the diagonal entries are zero. We estimate equations 6 and 7 for the number of firms (N_{mi}) using maximum likelihood.

We then repeat the above steps for the distance to the nearest competitor (Δ_{mi}).

5 Results

5.1 Summary Statistics

Summary statistics appear in Table 1. We list product markets from left to right according to the fraction of the half-mile market in which firms are local monopolists. The fraction of firms that are local monopolists rises monotonically from full-service restaurants to liquor stores. Firms are more likely to be local monopolists if they have less ability to differentiate their products, consistent with Proposition 3.

In the tables, we report results for half-mile, one-mile and two-mile markets. We regard the half-mile market as most relevant because there is the least demand variation within market.

5.2 Number of Firms

We are particularly interested in the effect of zoning on the number of firms, their proximity to other firms, and their prices. We begin with the number of firms.

As zoning relaxes, we expect more firms to enter. Consistent with Proposition 1, the fraction of the area zoned for firms has a positive relationship with the number of firms in every product market for every market definition (Table 2). For restaurants, grocery stores, and liquor stores, the relationship between area zoned for firms and the number of firms is positive and statistically significant for all three market definitions (half-mile, mile, and two-mile markets). For bars and grocery stores, the relationship is positive and significant for some market definitions. The implication is that alcohol zoning regulations tend to be binding for these firms. For example, for the half-mile market, a 0.02 increase in the fraction zoned for firms is associated with an additional restaurant. The effect is slightly smaller for bars, but in percentage terms it is even greater because there are almost nine times as many bars as restaurants in the sample.

In general, population is positively related to the number of firms. It is no surprise that there tend to be more firms in densely populated areas. The exception is gas stations which are rarely found in densely-populated downtown areas.

The relationship between income and the number of firms varies by firm type. Restaurants and (surprisingly) gas stations tend to locate near high-income residents, but for other firm types the number of firms is lower in high-income areas. The number of hotels and length of major roads are generally positively and significantly related to numbers of restaurants, bars, and grocery stores in the area.

The spatial autocorrelation parameter estimate for ρ is not statistically significant for any product market. Not surprisingly, results without controlling for spatial autocorrelation (not shown) are similar. The spatial error parameter estimate for λ is statistically significant for several product markets and market area definitions.

5.3 Distance between Firms

We also assess how zoning affects the distance between firms. We expect the distance between firms to increase as the area of commercial zoning expands. Consistent with Proposition 2, the distance between firms is positively related to the area zoned for firms for the majority of firms and market sizes (Table 3). For bars and gas stations, the relationship is positive and statistically significant for all three market definitions (half-mile, mile, and two-mile markets). In the half-mile market, the relationship is positive and significant for all product markets. In the half-mile area, if zoning expands by 0.1, then distance between firms increases by 30 to 50 feet for restaurants, bars, grocery stores, and liquor stores. For one and two mile markets, the marginal effects are considerably larger than for the half-mile market.

We expect the distance to the nearest competitor to decrease as the number of firms increases as suggested by equation 2 from the theory. Indeed, we find a negative relationship between distance and the number of firms for all five product markets and all three market definitions (Table 3).

As in the first-stage of the analysis, the spatial autocorrelation parameter estimate for ρ is not statistically significant for any product market. The spatial error parameter estimate for λ is statistically significant for about half of the product markets for each market area definition.

6 Evidence from Gasoline Prices

This study, like much of the industrial organization literature, infers price competition from market structure (Bresnahan and Reiss, 1991; Berry, 1992). In the case of the retail gas market, however, we can more directly estimate the effect of zoning on price competition.

Theory predicts that demand affects price through the number of firms. In markets with higher demand, there are more firms, those firms are closer together, proximity drives down prices, and volume per firm rises. In markets characterized by monopolistic competition (like this one), when market demand is greater, more firms enter, and individual firm demand rotates and is more elastic.

6.1 Price Analysis

We use the same first stage for the number of firms (equation 4). In the second stage, we estimate the effect of zoning and the predicted number of firms on both distance (equation 5) and price (equation 8). Distance and price are jointly estimated.

$$p_{mi} = \beta_{8,0} + \beta_{8,Z} Z_i + \beta_{8,N} N_{mi} + \beta_{8,c} c_{mi} + \beta_{8,t} t_i + \gamma_{8,g} + \epsilon_{8,mi} \tag{8}$$

The price equation also includes marginal cost (c_{mi}) measured as the wholesale gas price plus taxes, and transportation cost (t_i) measured as mean household income. We use income to proxy for transportation cost because we anticipate that higher income people find it more costly (in opportunity cost) to drive a few miles to save a few cents on gasoline. Other than income, demand only enters the price equation through the zip-code fixed effect (γ_g) and through the number of firms (consistent with equation 3 from the theory). We also estimate price with demand variables to test our specification.

6.2 Price Data

We use 2005 data for the Minneapolis–St. Paul metropolitan statistical area from the Oil Price Information Service (OPIS). OPIS acquires the data from credit card companies, direct feeds, and other survey methods. OPIS has prices for most retailers, regardless of whether the station is company operated, jobber owned, or dealer operated. The data include retailers from Abes Stop N Shop in Andover to Winnetka Citgo in Minneapolis. We use July 2005 data on gas retail locations, retail prices, wholesale costs, and taxes. The wholesale cost varies little in the half-mile market (coefficient of variation is 0.037), but varies more in the one-mile market (coefficient of variation is 0.67). There are 765 observations in the sample.

We merged OPIS gas stations with the *Yellow Pages* gas stations by address. *Yellow Pages* firms that do not have an exact address match with an OPIS firm are linked to the OPIS firm via ArcGIS spatial matching, which links the *Yellow Pages* firm to the nearest OPIS firm. All spatial matches fell within 0.2 miles of one another.

6.3 Price Results

The price regression results are reported in Table 4. We are particularly interested in the relationship between zoning and price competition. Theory predicts that when the area zoned for firms is greater, price is higher (equation 3). The results demonstrate this positive relationship and support Proposition 4. An additional 10 percent of a market zoned for firms (as a share of the total space in the market) is associated with a \$0.06 to \$0.08 increase in the retail price of gas per gallon, depending on whether the market is defined as a half-mile, one-mile, or two-mile, and whether we control for spatial lag and spatial error.

Firms with higher wholesale costs more than pass on those costs to consumers. The number of firms has an insignificant effect on price. On the one hand, more firms tend to drive down prices. On the other hand, markets with more space for firms tend to have more firms and higher prices. While zoning captures some of the space restrictions, it does not capture topography.

In a separate regression (not reported but available from the authors), we included demand (income, population, hotels, and road length) directly in the price regression, in addition to both the zip-code fixed effects and the indirect effect of demand through the number of firms. The coefficients were not statistically significant for any of the demand shifters in any of the market sizes. Furthermore, the coefficients of interest were unchanged. This result is consistent with theory that demand affects price through the number of firms.

7 Discussion and Conclusions

Zoning not only affects the number of firms, but also where the firms locate. Zoning and natural boundaries force firms into a smaller area, which decrease distances between firms and thereby lowers prices. Lower prices drive out firms (or induce less entry) so the remaining firms each serve more consumers (because of a fixed number of consumers). With fewer firms prices rise somewhat, but net prices will be lower due to greater proximity between firms. Hence, zoning can lead to lower prices and lower external costs associated with living near firms, but fewer firms (less variety) and longer travel distances from consumers to firms.

One might expect zoning to confer market power by restricting the locations of competitors, but zoning can actually increase competition by forcing firms to locate closer together. Hence, an unintended consequence of zoning is greater price competition, which might be socially beneficial in many markets, though not necessarily in alcohol markets. Furthermore, while prices might fall, consumer travel costs might increase. Also, one might expect negative relationships between the number of firms and prices, and between the number of firms and their distances apart, but the relationships can be positive as the space for firms changes. More space, perhaps due to lenient zoning, allows more entry, greater distances between firms, and higher prices.

The empirical findings are consistent with the theory. First, a smaller area of commercial zoning is associated with fewer firms. The firms are squeezed together, which can intensify competition. Second, the distance between firms is decreasing in the area of commercial zoning. Third, geographic distance decreases with the ability to differentiate products. Fourth, prices are lower when the area of commercial zoning is smaller. The empirical analysis does not prove causality, but it is consistent with the theory.

The novel predictions about zoning and competition offer a continuing research agenda. First, the theoretical predictions can be tested in cities such as Houston, which is the only large U.S. city that does not have formal zoning (Siegan, 1972), and in some European cities, which often have highly restrictive zoning. Second, the predictions can be tested with other methods, supporting or refuting the direction of the effect, and providing more-accurate estimates of the magnitude of the effects. Third, future analysis could model optimal zoning by comparing the social benefit (lower price, externality, and aggregate fixed cost) to the social harm (higher transportation cost and less variety).

The results imply that zoning does not necessarily benefit businesses. Firms might oppose zoning that keeps firms away from residential areas, not only because such zoning pushes firms farther from customers, but also because such zoning pushes firms closer to their competitors. On the other hand, firms can diminish the competitive intensity of proximity through product differentiation. Furthermore, zoning can reduce the number of firms.

Despite the policy importance of zoning, there have been few theoretical and econometric studies of zoning. To our knowledge, this is the first study to provide theory and evidence that zoning can increase competition. Our results suggest that planners evaluating zoning should consider not only externalities, but also competitive effects.

Notes

[1]The Minneapolis–St. Paul metropolitan area is advantageous for this study because it does not have oceans or mountains that create edges and complicate agglomeration estimation.

[2]See also (Glaeser and Kahn, 2004, 2519–20).

[3]By restricting consumer and retail density, zoning can also exacerbate sprawl (Fischel, 1998). See Nechyba and Walsh (2004) for a discussion of the economics of sprawl.

[4]Agglomeration studies have considered many industries including retail and wholesale gas (Pinske and Slade, 1998; Pinske, Slade, and Brett, 2002; Netz and Taylor, 2002; Barron, Taylor, and Umbeck, 2004), manufacturing (Ellison and Glaeser, 1997; Marcon and Puech, 2003; Duranton and Overman, 2005; Klepper, 2007), and movie theaters (Davis, 2006). Empirical analyses also examined product space agglomeration (Stavins, 1995; Mazzeo, 2002), temporal agglomeration of scheduled flight departure times (Borenstein and Netz, 1999), and temporal agglomeration of movie release dates (Corts, 2001; Einav, 2007). For a review of the empirical literature on agglomeration economies see Rosenthal and Strange (2004).

[5]We focus on the competitive region because Salop (1979) shows that the monopoly and super-competitive regions occur only under restrictive conditions.

[6]Presumably consumers would want to be closer to firms, but firms can be noisy, smelly, or provide a bad view.

[7]To calculate the distance between neighborhoods in the circle-within-a-circle framework, we take the distance in circumferences $z = 2\pi r$ and $1 - z = 2\pi\hat{r}$ and solve for the difference in radii $\hat{r} - r$. The distance is then $\alpha = |(1 - 2z)/2\pi|$. The circle-within-a-circle framework requires that $z < 1/2$. This is consistent with our data indicating that $z < 1/2$ in all five product markets for all three market definitions (Table 1), but the theory requires only $z < 1$.

[8]Rather than measuring distance to the nearest competitor, we can measure average distance to all competitors: $\Delta^* = \nu z/(4(\nu - 1))$ where $\nu = N$ if N is even or $\nu = N + 1$ if N is odd. These two measures of distance, Δ^e and Δ^* , are equivalent in the sense that both distances are increasing in z and decreasing in N.

[9]In this paper, price and the number of firms change when zoning alters the geographic space. Analogously, price and the number of firms changes when innovation alters the product space (Trajtenberg, 1989; Petrin, 2002; Eizenberg, 2009).

[10]For a comprehensive review of the literature on alcohol regulation and consumption see Cook and Moore (2000).

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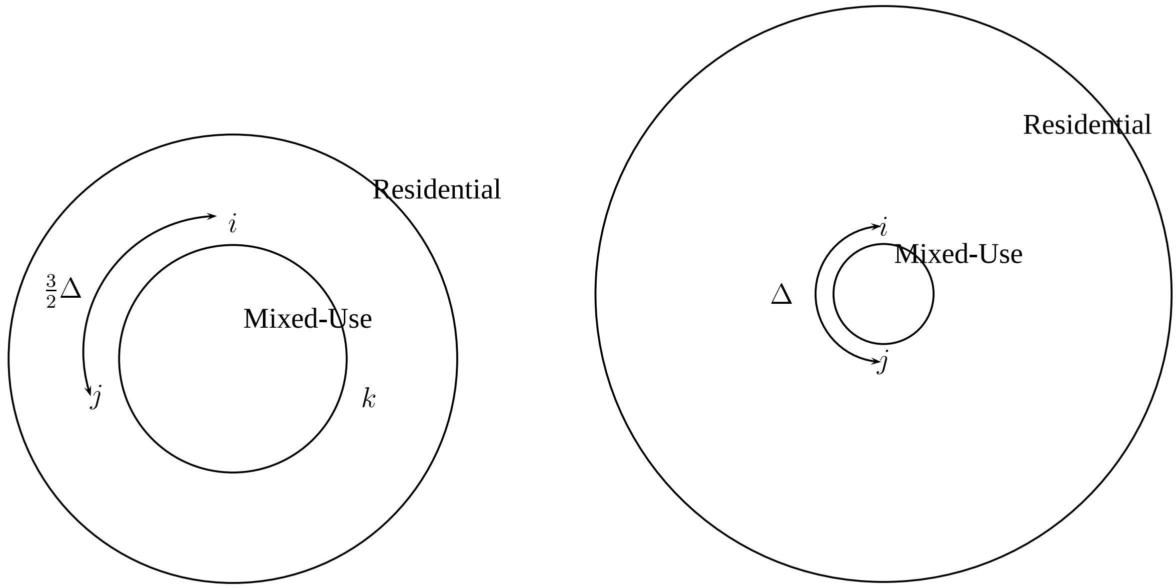

Figure 1: As the area of commercial zoning (mixed-use) falls, the number of firms and their distance apart falls.

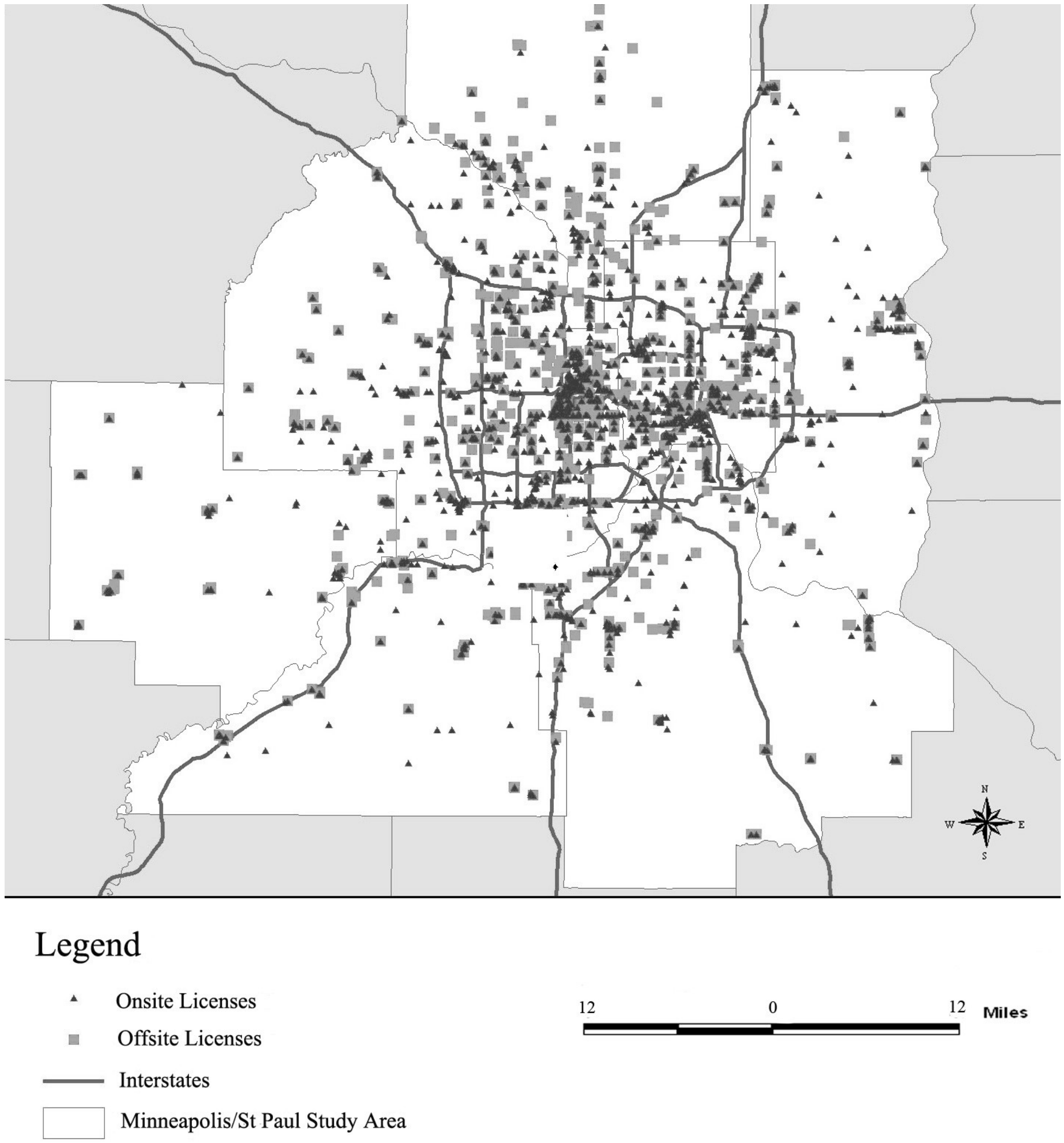

Figure 2: Onsite and offsite alcohol sellers in Minneapolis–St. Paul.

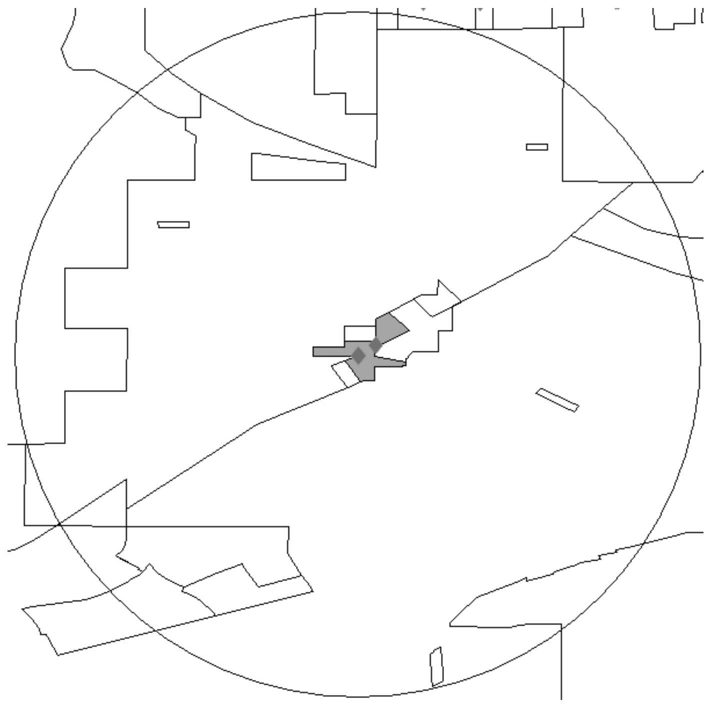

Figure 3: Zoning (shaded) and locations of two liquor stores.

Table 1: Summary Statistics

A. Half-mile market	Restaurants (N=2499)		Bars (N=288)		Grocery (N=1386)		Gas (N=280)		Liquor (N=265)	
	Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev	Mean	StdDev
Distance (miles)	0.06	0.12	0.10	0.16	0.11	0.17	0.15	0.20	0.21	0.21
Number of firms	32.91	56.97	24.22	45.68	7.69	8.31	1.43	0.57	2.71	2.09
Fraction monopoly firms	0.01		0.01		0.03		0.03		0.20	
Fraction zoned	0.20	0.28	0.24	0.19	0.10	0.12	0.18	0.14	0.07	0.11
Median income (000)	47.29	27.32	43.28	26.34	46.32	32.48	34.02	27.18	39.34	25.83
Population (000)	3.05	2.34	3.53	2.29	3.49	2.67	2.21	1.66	2.39	1.99
Number of hotels	5.68	6.56	5.04	5.08	3.41	1.97	3.10	1.36	3.29	1.56
Length of major roads	0.55	0.62	0.47	0.52	0.35	0.25	0.17	0.24	0.25	0.26
Gas price							2.06	1.16		
Gas wholesale cost							1.91	0.07		
B. One-mile market	Restaurants		Bars		Grocery		Gas		Liquor	
Distance (miles)	0.06	0.11	0.11	0.18	0.11	0.18	0.16	0.20	0.25	0.23
Number of firms	66.38	96.65	43.36	71.41	20.15	22.30	1.88	0.98	4.75	4.68
Local monopoly firms	0.00		0.01		0.01		0.01		0.18	
Fraction zoned	0.17	0.26	0.06	0.13	0.10	0.23	0.37	0.10	0.08	0.14
Median income (000)	54.81	28.62	50.89	27.72	50.70	30.10	35.80	26.46	38.24	22.14
Population (000)	12.08	8.52	14.50	8.31	12.95	9.27	8.31	5.99	9.15	6.91
Number of hotels	13.74	12.57	10.28	9.34	8.47	6.10	4.58	4.35	5.18	4.29
Length of major roads	1.22	1.58	0.90	1.17	0.65	0.82	0.28	0.27	0.31	0.28
Gas price							1.33	0.90		
Gas wholesale cost							1.29	0.87		
C. Two-mile market	Restaurants		Bars		Grocery		Gas		Liquor	
Distance (miles)	0.06	0.12	0.11	0.18	0.13	0.18	0.16	0.20	0.25	0.23
Number of firms	159.82	186.97	93.53	131.05	61.28	64.5	4.43	2.61	11.06	10.88
Local monopoly firms	0.00		0.00		0.00		0.01		0.13	
Fraction zoned	0.29	0.28	0.09	0.05	0.26	0.09	0.42	0.18	0.11	0.11
Median income (000)	43.23	33.27	45.72	35.95	47.42	38.57	40.56	41.31	36.56	34.98
Population (000)	38.86	28.04	39.78	30.46	37.45	32.41	30.52	33.98	29.56	30.11
Number of hotels	21.92	17.19	18.03	13.51	14.58	9.27	9.15	4.95	8.89	5.42
Length of major roads	1.94	2.18	1.59	1.91	1.18	1.37	0.49	0.29	0.52	0.31
Gas price							1.94	0.53		
Gas wholesale cost							1.87	0.85		

Table 2: First-Stage Results: Number of Firms

A. Half-mile market	Restaurants (N=2499)		Bars (N=288)		Grocery (N=1386)		Gas (N=280)		Liquor (N=265)	
Fraction zoned	56.47**	(2.08)	41.45**	(7.00)	3.97**	(1.33)	0.086	(0.054)	6.67**	(0.74)
Median income (000)	0.042**	(0.006)	−0.026	(0.029)	−0.021**	(0.003)	0.013**	(0.002)	0.0012	(0.004)
Population (000)	0.53*	(0.21)	2.044*	(0.93)	2.71**	(0.074)	−0.21**	(0.041)	0.24*	(0.098)
Number of hotels	5.14**	(0.13)	5.31**	(0.50)	0.35**	(0.086)	0.0024	(0.033)	0.049	(0.071)
Length of major roads	11.53**	(0.89)	13.46**	(4.32)	0.53	(0.63)	0.28	(0.30)	−1.90**	(0.68)
Constant	−16.25**	(1.35)	−31.53**	(4.40)	1.98	(1.2)	0.69*	(0.31)	2.25**	(0.40)
χ^2 test	2563.42**		342.45**		976.71**		110.46**		106.47**	
ρ (lag)	0.07	(0.04)	0.06	(0.04)	0.05	(0.03)	0.03	(0.02)	0.07	(0.05)
λ (error)	0.11**	(0.04)	0.06	(0.04)	0.06**	(0.02)	0.05**	(0.02)	0.03	(0.02)
B. One-mile market	Restaurants		Bars		Grocery		Gas		Liquor	
Fraction zoned	97.54**	(3.45)	85.43**	(23.74)	4.92**	(1.49)	2.25**	(0.73)	30.026**	(1.71)
Median income (000)	0.0052	(0.0054)	−0.0064	(0.023)	−0.0074**	(0.001)	0.0014**	(0.0004)	−0.0044	(0.001)
Population (000)	0.60**	(0.22)	0.48	(0.53)	1.79**	(0.047)	−0.026	(0.022)	0.29**	(0.033)
Number of hotels	2.95**	(0.12)	3.50**	(0.40)	0.49**	(0.052)	0.018	(0.017)	0.044	(0.042)
Length of major roads	14.20**	(0.87)	14.44**	(3.034)	5.20**	(0.43)	0.075	(0.29)	−0.14	(0.64)
Constant	−24.17**	(2.024)	−23.92**	(7.24)	−4.31**	(1.29)	0.023	(0.495)	1.78**	(0.499)
χ^2 test	2783.97**		264.46**		1184.87**		98.65**		76.76**	
ρ (lag)	0.07	(0.05)	0.05	(0.03)	0.05	(0.05)	0.03	(0.03)	0.05	(0.05)
λ (error)	0.10**	(0.03)	0.06	(0.04)	0.08**	(0.03)	0.05**	(0.02)	0.04	(0.03)
C. Two-mile market	Restaurants		Bars		Grocery		Gas		Liquor	
Fraction zoned	105.85**	(11.087)	75.94	(51.064)	11.41**	(2.98)	9.56**	(0.67)	25.38**	(2.68)
Median income (000)	0.0065	(0.0052)	−0.003	(0.013)	−0.0063**	(0.001)	0.0013**	(0.0002)	−0.0034**	(0.001)
Population (000)	0.0062**	(0.0001)	0.047	(0.034)	1.95**	(0.044)	0.0064**	(0.001)	0.36**	(0.034)
Number of hotels	2.64**	(0.12)	6.063**	(0.46)	0.99**	(0.078)	0.038	(0.034)	0.039	(0.049)
Length of major roads	7.47**	(0.77)	10.44**	(3.18)	5.26**	(0.54)	0.10	(0.24)	−0.39	(1.042)
Constant	−161.35**	(6.46)	−42.22**	(9.91)	−21.41**	(2.04)	0.16	(0.50)	1.072	(0.95)
χ^2 test	2987.67**		364.21**		890.64**		103.24**		68.64**	
ρ (lag)	0.09	(0.06)	0.06	(0.04)	0.05	(0.04)	0.04	(0.03)	0.05	(0.04)
λ (error)	0.10**	(0.02)	0.08**	(0.03)	0.05	(0.03)	0.06**	(0.02)	0.05	(0.04)

Includes zip-code fixed effects. Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$

Table 3: Second-Stage Results: Distance (miles) to Nearest Competitor within Given Radius

A. Half-mile market	Restaurants		Bars		Grocery		Gas		Liquor	
	(N=2499)		(N=288)		(N=1386)		(N=280)		(N=265)	
Fraction zoned	0.060**	(0.016)	0.10**	(0.031)	0.063*	(0.031)	0.008**	(0.003)	0.065**	(0.005)
Number of firms	−0.114	(0.096)	−0.613	(0.376)	−3.379**	(0.080)	−71.116**	(15.65)	−22.14	(20.025)
Constant	0.12**	(0.0015)	0.34**	(0.020)	0.11**	(0.032)	0.56**	(0.096)	0.342**	(0.053)
χ^2 test	352.28**		40.67**		160.17**		46.12**		56.12**	
ρ (lag)	0.10	(0.07)	0.08	(0.07)	0.04	(0.03)	0.04	(0.03)	0.07	(0.05)
λ (error)	0.08	(0.06)	0.06	(0.05)	0.05**	(0.02)	0.05	(0.03)	0.06**	(0.02)
B. One-mile market	Restaurants		Bars		Grocery		Gas		Liquor	
Fraction zoned	0.34	(0.21)	0.24**	(0.08)	0.047	(0.038)	0.055**	(0.009)	−0.41	(0.33)
Number of firms	−0.21**	(0.04)	−0.83**	(0.26)	−3.32	(2.49)	−33.62	(19.71)	−7.803	(4.62)
Constant	0.07**	(0.0036)	0.15**	(0.02)	0.18**	(0.075)	1.18**	(0.037)	0.15**	(0.040)
χ^2 test	364.41**		32.98**		138.34**		46.98**		49.24**	
ρ (lag)	0.05	(0.05)	0.05	(0.05)	0.05	(0.05)	0.03	(0.03)	0.05	(0.05)
λ (error)	0.05	(0.05)	0.05**	(0.02)	0.05**	(0.02)	0.05	(0.03)	0.05	(0.03)
C. Two-mile market	Restaurants		Bars		Grocery		Gas		Liquor	
Fraction zoned	0.13	(0.19)	0.21**	(0.045)	0.002	(0.005)	0.075**	(0.016)	−1.01	(0.56)
Number of firms	−0.126	(0.082)	−0.578**	(0.109)	−0.887**	(0.057)	−75.09**	(14.78)	−15.28	(11.72)
Constant	1.54*	(0.019)	0.17**	(0.017)	1.13**	(0.005)	0.71**	(0.025)	1.43**	(0.021)
χ^2 test	276.98**		51.84**		114.97**		43.87**		53.98**	
ρ (lag)	0.05	(0.04)	0.06	(0.05)	0.05	(0.04)	0.05	(0.04)	0.04	(0.05)
λ (error)	0.05	(0.04)	0.06**	(0.02)	0.06**	(0.02)	0.04	(0.04)	0.06**	(0.02)

Includes zip-code fixed effects. Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$

Table 4: Second-Stage Results: Gasoline Prices

A. Half-mile market	Jointly determined with distance		Spatial lag and error	
Fraction zoned	0.67**	(0.094)	0.60**	(0.089)
Number of firms	−0.011	(0.022)	−0.011	(0.018)
Gas wholesale cost	1.22**	(0.17)	1.20**	(0.15)
Median income (000)	0.021	(0.019)	0.019	(0.018)
Constant	−0.36	(0.322)	−0.41	(0.31)
Zip code fixed effects	included		included	
χ^2 test			32.18**	
ρ (lag)			0.03	(0.03)
λ (error)			0.04	(0.03)
B. One-mile market	Jointly determined with distance		Spatial lag and error	
Fraction zoned	0.78**	(0.078)	0.74**	(0.078)
Number of firms	−0.001	(0.006)	−0.002	(0.006)
Gas wholesale cost	1.003**	(0.11)	1.24**	(0.14)
Median income (000)	0.018	(0.01911)	0.016	(0.013)
Constant	−0.031	(0.025)	−0.028	(0.023)
Zip code fixed effects	included		included	
χ^2 test			29.76**	
ρ (lag)			0.04	(0.04)
λ (error)			0.03	(0.04)
C. Two-mile market	Jointly determined with distance		Spatial lag and error	
Fraction zoned	0.708**	(0.101)	0.635**	(0.112)
Number of firms	0.0007	(0.0001)	0.0007	(0.0004)
Gas wholesale cost	1.072**	(0.122)	0.785**	(0.087)
Median income (000)	0.019	(0.015)	0.023	(0.017)
Constant	2.001**	(0.221)	3.542**	(0.201)
Zip code fixed effects	included		included	
χ^2 test			32.42**	
ρ (lag)			0.04	(0.04)
λ (error)			0.04	(0.03)

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$