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Department of Economics
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Opening Hours Decision and Competition in the Motor Vehicle Inspection Market

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Opening Hours Decision and Competition in the Motor Vehicle Inspection Market*

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Abstract

This paper examines the effect of competition on a firm's choice of opening hours in the motor vehicle inspection market. Competition affects the incentive inspection firms face when choosing opening hours, which influences the probability that consumers find service time that best matches their preferred time. We use 2SLS analyses to resolve the potential endogeneity of market entry decisions. Using a detailed monthly firm-level panel data for all inspection firms in Sweden, we find that increased competition, measured using both the number of firms in a geographic market and average distance to nearby competitors, leads to expanded opening hours. The probability that inspection firms offer services on weekends also increases with local competition.

JEL Classification: D22; L11; L84

Keywords: opening hours; competition; non-price competition; entry; motor vehicle inspection market

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1 Introduction

Decisions about opening hours are among the key choices firms make in many service and retail industries. Prior theoretical papers shed light that firms can use opening hours as a key strategic variable in competition (e.g., De Meza, 1984; Ferris, 1990, 1991; Inderst and Irmen 2005; Shy and Stenbacka, 2006, 2008): however, there has been no attempt to empirically examine how competition influences a firm's choice of opening hours specially in service industries. This paper aims to empirically analyze the effect of competition, measured using both the number of firms in a geographic market and the average distance to nearby competitors, on a firm's choice of opening hours in the motor vehicle inspection market.

We focus on the demand retaining and attracting mechanisms by which local competition influences inspection firms' choices of opening hours. Suppose consumers prefer to acquire car inspection services at their ideal (preferred) time with an attractive price. Firms can expand opening hours as a means to increase the probability that consumers find service time that best matches their preferred time. A firm's opening hours choice, however, involves an important trade-off: although expanding opening hours attracts additional demand, it also brings cost to the firm (e.g., salary, overtime payment...etc). When choosing optimal opening hours, a station's manager should weigh the cost of having longer opening hours against the cost of having shorter opening hours. The costs associated with having shorter opening hours will depend on the reaction of consumers when they do not find the inspection services at their preferred time. The cost of having shorter opening hours is lower for a firm if consumers are willing to postpone or advance their transaction when the firm do not offer their ideal time (loyalty and lack of choice can explain such behaviour). On the other hand, when consumers do not find the inspection service at their ideal time, they may switch to alternative providers and this behaviour is likely to be more prevalent in markets where there are large number of service providers. This short analysis indicates that in markets where it is easy for consumers to switch, stations have stronger incentives to provide longer opening hours.

We explore the causal effect of competition on opening hours in the context of car roadworthiness test market. This paper relies on unique data that contain monthly station-level information on opening hours and sales volume of all car inspection stations that serve about 5 million vehicles each year in Sweden. The data set covers the period from March 2012 to May 2015. We have rich information on the length of opening hours and the number of weekends a station provides services in a given a month. One can therefore examine not only how long a station provides inspection service but also when a station provides service. The data also allow us to control for a station’s volume of inspections, which can also be a proxy for the size of a station. We also know the entry dates and geographical locations of all inspection stations. Moreover, we have additional transaction-level data that contain the residence addresses of around 460,000 car owners and the addresses of the corresponding station each owner visited to acquire inspection service. This information allow us to measure the distance each car owner needs to travel for inspection service, and we use the calculated distances to reasonably define a geographic market for each station.

To examine whether competition affects firms’ choice of opening hours, we start the analysis by controlling for station specific characteristics along with chain and time dummies. The results suggest a positive and significant effect of competition on opening hours. While the results indicate a positive association, they may not ensure a causal effect of competition on opening hours (e.g., firms’ market entry decisions may depend on incumbent firms’ capacity, which may also influence opening hours decisions). We employ 2SLS analysis to resolve the potential endogeneity of both the number of firms in a market and average distance to closest competitors. We use population size at a municipality level to instrument our two measures of competition. Our main control variable, volume of inspections, is also potentially endogenous with respect to opening hours. Longer opening hours are likely to increase a station’s volume of inspections. We construct a variable to serve as an instrument for volume of inspections. We use the average volume of inspections of stations in other markets¹ as a predictor of a given station’s volume

¹In the identification section, we present a detailed discussion on how we choose the

of inspections for a particular month. Because two stations that belong in the same chain type and age category² are likely to have comparable sales performance, we can use one station's sales performance to predict the other station's sales performance.

Our results that control for the endogeneity of market entry decisions provide evidence that competition has a positive and significant effect on a firm's choice of opening hours. When the number of competing firms in a market increases by 10% (which, given the mean number of competing firms in a market in our data, corresponds to an increase of about 1 firm), opening hours per week on weekdays increases by 0.74% (which, given the mean opening hours in our data, corresponds to about 22 minutes) and the probability of providing services on weekends at least once in a given month increases by 1.29 percentage points (which is equivalent to a 3.31% increase, given the 39% probability of providing services on weekends in our data)³.

When the average distance to three closest competitors decreases by 10% (which, given the mean distance in our data, corresponds to decreasing distance by 2.2 km), opening hours per week on weekdays increases by 0.48% (which, given the mean opening hours in our data, corresponds to 14.36 minutes) and the probability of providing services on weekends at least once in a given month increases by 0.84 percentage points (which is equivalent to a 2.15% increase, given the 39% probability of providing services on weekends). Our results also suggest that early opening, defined as providing services before 8 a.m. at least twice a week on weekdays, increases with local

other markets in a way that does not violate the exclusion restriction requirement.

²Stations' age is divided in to five categories.

³Since our variables are in logarithmic form, a decreasing effect of competition is built in to the model. For example, entry of a station into a monopoly market (which is a 100% increase in the number of stations in a market) translates into 5.4% increase in opening hours per week and 9.8 percentage points increase in the probability of providing services on weekends. Given the average 49.26 opening hours per week on weekdays and 32.6% probability of providing services on weekends for monopoly stations in our data, an additional station in a monopoly market increases opening hours on weekdays by 2.66 hours per week and the probability of providing services on weekends by 30%. However, the transformation of a market from two service providers to three service providers (which corresponds to a 50% increase in the number of stations in a market), leads to 3.17% increase in opening hours per week and 5.5 percentage points increase in the probability of providing services on weekends in a given month.

competition. We do not, however, find a significant relationship between local competition and late opening, defined as providing services after 5 p.m. at least twice a week on weekdays.

In principle, competition policy analyses should incorporate both price and non-price factors that affect consumer welfare. However, competition analyses rarely focus on non-price effects (Matsa, 2011). The results of our study, therefore, provide important empirical evidence for competition authorities and courts to consider opening hours effects in competition law enforcement.

Our paper contributes to a scant empirical literature on competition in opening hours. Closest to our study, Agnes and Christoph (2016) primarily examine the forms of strategic interaction in opening hours between rival firms in Austria retail gasoline market. Their empirical results reject the idea of opening hours decisions being strategic complements. Based on cross-sectional variation, they also find that opening hours increases as distance to the closest station decreases, but the estimation does not control for potential endogeneity of distance between closest competitors. Our paper uses monthly panel data and accounts for the endogeneity of market entry decisions to identify a causal relationship between competition and opening hours. We also measure opening hours not only using how long a station provides services but also using when a station provides services. Unlike gasoline stations, which normally operate multiple businesses, car inspection firms in Sweden are not allowed to operate any other business than car inspection services, which enables us to isolate the effect of competition on opening hours particularly related to the car inspection business.

The existing theoretical literature on opening hours primarily focuses on examining the consequences of deregulating⁴ opening hours. In that respect, the literature generates mixed results. Some theoretical studies find that liberalization of opening hours in the retail industry leads to demand shift from small firms to large firms (Morrison and Newman, 1983; Tanguay et

⁴Opening hours have been regulated in the retail industries of many countries. In recent years, countries are deregulating opening hours moving away from the restriction.

al., 1995)⁵. On the other hand, Wenzel (2011) finds that deregulation of opening hours does not necessarily favour large retail firms at the expense of independent small retail firms. He shows that as long as there is small cost efficiency differences between the two firm types, small size independent firms can still benefit from deregulation. Inderst and Irmen (2005) study duopolistic competition in the retail industry where retailers can compete both in opening hours and prices. They show that retailing firms use opening hours as a means to differentiate their products, prices of both retailers increase following deregulation, and both retailers are better off under deregulation. The theoretical literature on opening hours indicates that a firm's choice of opening hours has an important impact on consumers' where to buy decisions.

In our study, opening hours can be one dimension of service quality - longer opening hours brings cost to the firm but potentially benefits consumers. Therefore, our work relates to an empirical literature that primarily focuses on competition in service quality. For example, Cohen and Mazzeo (2004) analyze competition and branch network expansion decision in the retail banking market. Olivares and Cachon (2009) find that General Motors dealerships operating in more competitive markets have more inventory holdings than dealerships operating in less competitive markets. Watson (2009) finds a mixed result between competition and variety of products firms offer in U.S. retail market for eyeglasses. Matsa (2011) examines the effect of competition on product availability at U.S. supermarkets and finds that increased competition reduces shortfalls. Bloom et al. (2015) find that increased competition among hospitals improves quality of services measured by survival rate from emergency heart attack and management quality.

The remainder of the paper is organized as follows. Section 2 gives a brief description of the Swedish Car Inspection Market. Section 3 describes the

⁵In these theoretical works, large firms are characterized by low prices and high access cost whereas small firms are associated with high prices and low access cost to consumers. When firms start to compete on the basis of opening hours, the probability that consumers find the service at their ideal time increases. This, in turn decreases the opportunity cost of time they need to spend on business transaction, which is against small firms competitive advantage in terms of access cost over large firms.

data and different measures of competition. Section 4 outlines the specification of the model and identification strategy. Section 5 presents main results and various robustness checks. We conclude in Section 6.

2 Swedish Car Inspection Market:- An Institutional Background

In Sweden, all car owners are required by law to periodically⁶ inspect the road-worthiness of their cars by licensed inspection firms. The car inspection market had been served by a partly state owned monopoly inspection firm⁷ until the government deregulated the market in June, 2010. After the deregulation, private inspection firms start to provide inspection services and during the period of our study (March 2012 to May 2015), seven chain companies⁸ and two single-station companies had served the whole market.

The government deregulated the market to introduce competition and improve consumer surplus through increased accessibility to inspection services in terms of both geographically and longer opening hours, reduced prices and better service quality. To promote competition among service providers, the government decided to divestiture the monopoly company, AB Svensk Bilprovning. Accordingly, in 2012 around one third of the company (70 stations) was sold to a private firm, Opus Bilprovning AB. Furthermore, the state and the other owners divided the remaining asset of the monopoly company between themselves and each established a separate inspection firm. After the separation, the state owns 87 stations holding the old company name, AB Svensk Bilprovning, and the other owners left with 55 stations to operate under a new company name, Besikta Bilprovning i Sverige AB.

⁶Presently, there is 3-2-1-1 system. This means, brand-new vehicles should undergo their first mandatory inspection when they are three years old and the second inspection when they are five years old. Afterwards, the vehicles must be inspected annually.

⁷The state owns 52% and auto insurance companies and different associations own the remaining 48% of it. The Auto Insurance companies own 12% and include: Holmia Forsakrings AB, Folksam omsesidig sakforsakring, Lansforsakringar Wasa Forsakrings AB, If Skadeforsakrings AB, Trygg Hansa Forsakrings AB. The associations include: Motorbranschens Riksforbund (12%), Motormannens Riksforbund (5%), Motorforarnas Helynkerhetsforbund (5%), Kungliga Automobil Klubben (5%), Svenska Taxiforbundet (3%), Sveriges Akeriforetag (3%) och Svenska Bussbranschens Riksforbund (3%).

⁸One of the chain companies, Applus Bilprovning AB, sold its five stations to Dekra Bilprovning AB and exited the market in January 2013.

Table 1: Mean and median of competition measures, and total number of stations over the year

Year	No. of stations	No. of competitors (Fixed-radius approach)		No. of competitors (Variable-radius approach)		Avg. Distance of nearby competitors	
		Mean	Median	Mean	Median	Mean	Median
2012	270	6.8	3	6.5	3	28.2	25.1
2013	314	8.4	4	7.8	4	23.8	19.1
2014	380	9.8	5	8.9	5	20.5	13.1
2015	422	10.8	5	9.6	5	18.1	11.0

Notes: Distance is measured in kilometers and represents the average distance to three nearby competitors

Inspection firms need to obtain accreditation from a government agency, Swedish Board for Accreditation and Conformity Assessment (SWEDAC). The market is closely monitored by Swedish Transport Agency, which provides the rules and regulations that inspection firms need to follow such as which equipment and methods to use, as well as on the competence of inspection technicians. To avoid distorting incentives, the law prohibits inspection firms to provide any services other than car inspection services. During the period of our study, the number of inspection stations has been increasing throughout Sweden. Table 1 presents the evolution of the number of stations during the sample period. At the end of 2012, there were 270 stations that provide inspection services. As of May 2015, there were 8 inspection firms with a total of 422 stations that provide vehicle inspection services.

3 Data, Measurement and Descriptive Statistics

This section begins with a detail description of the data in our study and the different measures of competition. We conclude the section with early descriptive statistical evidence.

3.1 Data

The Swedish Transport Agency provides us data that represent all inspection stations that operate in Sweden. The study uses station-months level panel data that cover the period from March 2012 to May 2015. The data contain detailed information on the length of opening hours per week in a given month for each station and the number of weekends a station provides

inspection service in a given month. The data also include monthly number of inspections conducted by each station. We also know market entry dates and geographical locations of each inspection station. We obtained the size of population at municipality level (*Population*) from Statistics Sweden and the total number of registered cars at municipality level (*#Vehicles*) from government agency, Transport Analysis. The final data set consists of around 9,100 station-months observations, for a total of 30 months, representing all licensed inspection stations that serve about 5 million vehicles each year in Sweden. The months that represent the summer time (June, July and August) are not included in the data set⁹.

We measure opening hours of a station in four different ways. The dependent variable, *Weekdays*, measures the total number of hours per week on weekdays a station provides service in a given month. The second dependent variable, *Weekend*, is a dummy variable which takes a value of one if a station provides inspection service at least once¹⁰ on weekends (i.e, on Saturdays) in a given month. The third outcome variable, *Early*, is a dummy variable that takes a value of one for providing services before 8 a.m. at least twice a week on weekdays of a given month. Finally, *Late*, is a dummy variable for providing service after 5 p.m. at least twice a week on weekdays of a given month. To control for station size, we use the number of inspections (*#Inspection*) conducted at a station level. We also control for station age (*StationAge*), by computing the number of days from entry date¹¹ to a given month of inspection service. Table 2 presents descriptive statistics for all variables.

⁹During the summer period, a number of stations do not provide inspection services and the opening hours of those that provide services are also not regular.

¹⁰Our results remain robust when we define *Weekend* as a dummy variable for providing service at least two times on weekends in a given month.

¹¹We use December 21, 2010 as entry date of the stations (190) that were owned by the monopoly company that was later partly sold to private firms. These stations obviously have been in the market before December 21, 2010, However, after the deregulation of the market the monopoly company was reorganized and obtained a new license as of December 21, 2010.

Table 2: Summary Statistics of Variables

Variable	Mean	Median	Std. dev.	Min	Max
Outcome variables					
<i>Weekdays(hours)</i>	49.87	50.00	7.41	13.30	78.00
<i>Weekend(dummy)</i>	0.39	0.00	0.49	0.00	1.00
<i>Early(dummy)</i>	0.85	1.00	0.35	0.00	1.00
<i>Late(dummy)</i>	0.47	0.00	0.50	0.00	1.00
Competition measures					
<i>Distance(Km)</i>	22.36	15.97	22.39	0.89	137.45
<i>#Stations (Variable-radius)</i>	8.31	4.00	9.99	1.00	54.00
<i>#Stations (Fixed-radius)</i>	9.05	4.00	11.02	1.00	50.00
Covariates					
<i>#Inspections</i>	1599.00	1173.00	1334.00	3.00	9023.00
<i>StationAge(days)</i>	610.41	542.00	408.37	0.00	1765.00
Instruments					
<i>Population(Municipality)</i>	97464.89	42187.00	166117.40	2565.00	911989.00
<i>#Vehicles(Municipality)</i>	44438.96	23449.00	65324.99	1759.00	375811.00
<i>#OtherMktInsp</i>	1566.48	1867.94	762.76	17.00	3907.00

3.2 Measures of Competition

We use two different approaches to measure our main variable of interest, local competition. The first approach measures competition at a station level using the average distance to three closest competitors (*Distance*). The second approach measures competition using the number of competing stations (*#stations*) within a station’s circular geographic market. The second approach involves two steps to measure competition. In the first step, we need to define a circular catchment area for each station using information on customer flow. There are two methods to determine catchment area. The first method uses fixed radius circular area to determine the catchment area of each station. In our study, we use a fixed radius of 14 km¹² to define catchment area of each station. We refer to this approach, henceforth, as fixed radius¹³. While the fixed radius method is convenient to implement

¹²While many other studies use arbitrary radius for lack of customers’ origin data, our study benefits from a data that contain the addresses of around 460,000 car owners and the corresponding station each car owner visited for inspection service. 14 km is the distance the median (50th percentile) customer at the national level needs to travel for inspection service.

¹³Several studies use this method. For example, Bloom et al. (2015) uses 15 km fixed radius to define catchment area for English public hospital market. Bennet et al. (2013) uses 0.2 mile fixed radius to define catchment area for inspection facilities in New York

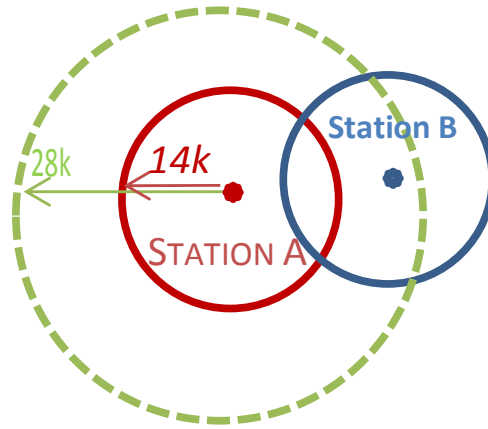


Figure 1: Graphical illustration of the measure of competition: Notes: The red circle shows the 14 km radius catchment area for Station A. Station A will have an overlapping catchment area (at least to some extent) with the catchment area of any station within the dashed green circle in the figure (i.e., any station within 28km radius of station A). Therefore, the measure of competition based on 14 km radius catchment area for Station A includes all stations within a 28 km radius.

and exogenous to local area factors¹⁴, it does not account for potential variations in local markets characteristics and differences in certain attributes¹⁵ across stations. The second method, tries to resolve the limitations of the fixed radius approach.

The second approach uses information on customer flow of station i to determine a radius that defines a catchment area specific to station i . This method requires the addresses of each station's customers to compute the distribution of travel distances. In our study, we have data that contain the addresses of around 460,000 car owners throughout the municipalities of Sweden and the corresponding station each owner visited to acquire inspection services. After calculating the Euclidean distance each owner traveled, we compute the median customer's travel distance at municipality level¹⁶.

state vehicle emission market.

¹⁴Since the radius is fixed across markets, it is less likely for local market characteristics and station specific factors to influence the size of a catchment area.

¹⁵We expect that stations in densely populated areas to have smaller catchment area than stations operating in sparsely populated areas. Similarly, we do not expect big size and small size stations to have equal size catchment area.

¹⁶For example, for inspection stations in Lund municipality, the median customer travels

Table 3: The length of opening hours per week for stations above and below the mean competition

<i>Panel A</i> <i>Competition is measured using the average distance of closest competitors</i>						
Competition	Average	10th	25th	50th	75th	90th
Above Mean	50.3	40	45	50	55	63
Below Mean	49.2	45	45	47	55	55
<i>Panel B</i> <i>Competition is measured using the number of competing firms in a market</i>						
Competition	Average	10th	25th	50th	75th	90th
Above Mean	50.9	40	45	50	55	63
Below Mean	49.5	45	45	47	55	55

In our study, station i 's catchment area is defined using the travel distance of the median customer (50th percentile)¹⁷ of stations located in station i 's municipality. We refer to this method, henceforth, as variable radius.

Once we determine the catchment area, in the second step, we measure local competition for station i using the number of competing stations ($\#stations$) within the area double the size of station i 's catchment area. For example, for stations located in Lund municipality (catchment area is 19 km radius), we measure competition by counting the number of rival stations within 38 km radius (i.e., twice the catchment area). We use 38 km radius geographic market to count the number of rival stations since stations in Lund municipality have to compete for customers (will have an overlapping catchment area) with any station that is less than 38 km away from them. Figure 1 presents graphical illustration on how to define geographic market based on catchment area.

Table 1 reports the evolution of our measures of competition over time. At the end of 2012, when we measure competition using average distance to closest competitors, the average station has three nearest competitors within 28.2 km. This figure has reduced to 18.1 km at the end of May, 2015. We observe similar increasing trend in local competition over time when the number of service providers in a market measures competition. Using the variable (fixed) radius approach, there were on average 6.5 (6.8) stations per

around 19 km, whereas the median customer for stations in Stockholm municipality travels around 8.5 km.

¹⁷Our results remain robust when we use the 75th percentile travel distance to define catchment area.

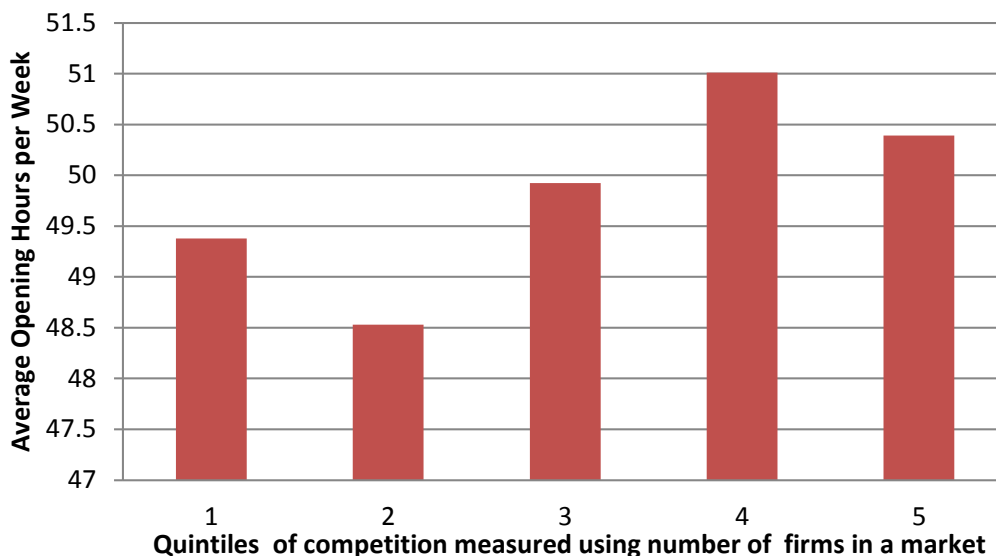


Figure 2: Opening hours by quintiles of competition: Notes: We divided our competition, measured using the number of competitors in a market (variable radius), into quintiles from lowest value (first) to highest value (fifth) along the x-axis. We show the average opening hours per week in a given month in each of the quintiles on the y-axis.

geographic market at the end of 2012, whereas as of May 2015, the figures increase to 9.6 (10.8) stations.

3.3 Preliminary data analysis

As an early descriptive evidence to the relationship between competition and opening hours, Table 3 presents comparison of opening hours per week between stations operating in markets above and below the mean level of our measures of competition. Panel A and B of Table 3 shows the comparison when competition is measured using distance and number of competitors respectively. In both panels, the average and the median length of opening hours per week are longer for stations operating in highly competitive markets than for stations operating in less competitive markets. In both Panel A and B, for example, for stations that operate in markets with above the mean level of competition, the median station opens 3 hours longer than the corresponding median station that operates in markets below the mean level of local competition.

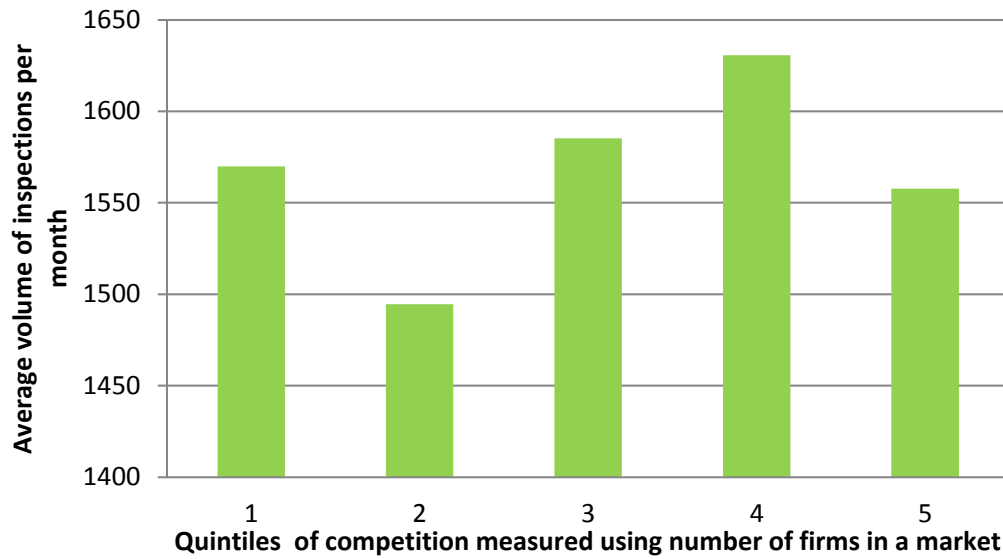


Figure 3: Average number of inspections by quintiles of competition: Notes: We divided our competition, measured using the number of competitors in a market (variable radius), into quintiles from lowest value (first) to highest value (fifth) along the x-axis. We show the average number of inspections per month in each of the quintiles on the y-axis.

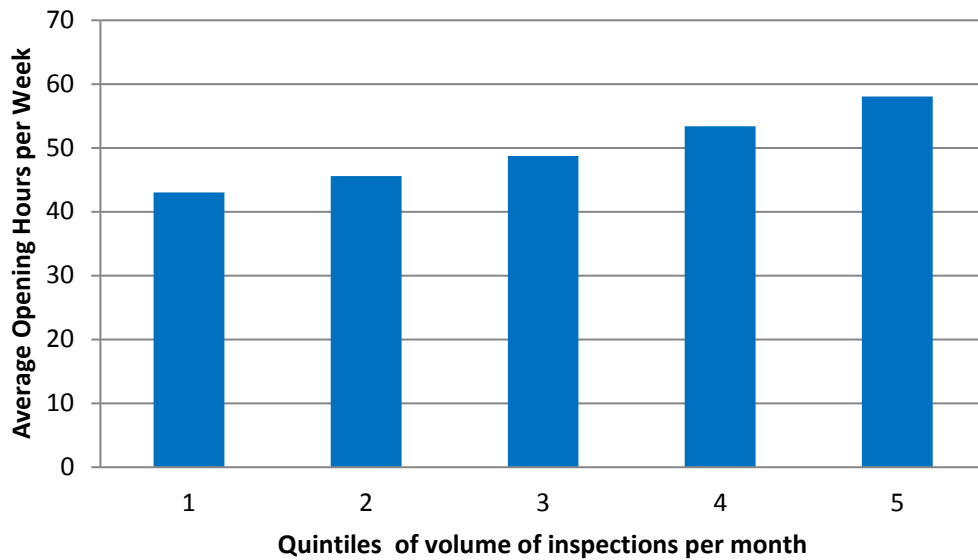


Figure 4: Opening hours by quintiles of volume of inspections: Notes: We divided volume of inspections into quintiles from lowest value (first) to highest value (fifth) along the x-axis. We show the average opening hours per week in a given month in each of the quintiles on the y-axis.

Figure 2 provides early evidence on the relationship between competition and opening hours. Figure 2 divides our measures of competition (using the number of competitors in a market)¹⁸ into quintiles¹⁹ and shows the average opening hours in each bin. The figure suggests that there is a non-linear association between average opening hours per week and local competition. In similar way, Figure 4 divides the volume of inspections into quintiles and shows the average opening hours per week in each bin. There is a clear positive relationship that stations' opening hours increase with volume of inspections.

To further explore the non-linear relationship between opening hours and competition, Figure 4 divides competition (measured using the number of firms in a market) into quintiles and shows the average number of inspections in each bin. Figure 2 and Figure 4 indicate that differences in stations' average number of inspections across bins can explain the non-linear association between opening hours and competition. In Figure 2, for example, stations in bin two operate in more competitive environment than stations in bin one, but provide on average shorter opening hours than stations in bin one. Furthermore, in Figure 4, we see that stations in bin one conduct on average a larger number inspections than stations in bin two. We observe similar association between stations in bin four and bin five. This is a clear evidence that differences in the average number of inspections between the bins explain the non-linear association between opening hours and competition observed in Figure 2. In the next section, we rigorously examine if there is a causal relationship between opening hours and competition.

¹⁸Figure 5 in the Appendix , presents similar analysis when we measure competition using the average distance to three closest competitors.

¹⁹Whenever there is a tie in splitting the distribution into quintiles, the Stata code makes sure that equal values end up in the same bin. In what follows, each bin may not contain equal number of observations.

4 Estimation and Identification

4.1 Econometric Framework

The goal is to examine the effect of competition on a firm’s choice of opening hours. To do this, we estimate the following regression model that describes the relationship between opening hours and competition:

$$\begin{aligned} \text{OpeningHours}_{icty} = & \beta_1 + \beta_2(\text{COMP}_{ity}) + \beta_3(\#\text{Inspections}_{ity}) \\ & + \beta_4(\text{StationAge}_{ity}) + \text{Year}_y + \text{Season}_t + \text{Chain}_c + \epsilon_{ity} \end{aligned} \quad (1)$$

Where i and c index station and chain respectively, t and y stand for months and years respectively. *OpeningHours* stands for our two outcome variables of interest:²⁰ *Weekdays*, the length of opening hours per week in a given month; or *Weekend*, a dummy variable which takes a value of one for providing services at least once on weekends (i.e., on Saturdays) in a given month. *COMP* stands for a level of competition a station faces measured using both the number of competing stations in a geographic market (*#Stations*) and the average distance to three closest competitors (*Distance*).

The main control variable is *#Inspections*, which stands for the volume of inspections conducted by a given station. The volume of inspections can capture differences in station size.²¹ To capture national shocks to (common trends in) the opening hours of all stations, we include a full set of yearly dummies, *Year*.²² We include, *Season*, which stands for monthly seasonal

²⁰In a separate analysis, we further examine if competition affects a station’s choice of early and late openings. We define early opening, *Early*, using a dummy variable for providing services at least twice a week before 8 a.m. in a given month, and late opening, *Late*, using a dummy variable for providing services at least twice a week after 5 p.m. in a given month.

²¹Syversson (2004) uses plant output as a measure of plant size in analyzing how spatial substitutability affects the productivity of plants in the U.S. ready-mixed concrete industry.

²²In some regressions, we may substitute monthly dummies (30 month-year dummy variables) for the yearly dummies.

dummy variables, to capture for example monthly seasonal changes in aggregate demand. Finally, we control for unobserved chain level differences like working hours policy or differences in cost efficiency by including a full set of dummy variables for chain types, *Chain*. ϵ_{iyt} is an error term that captures all unobservable factors. All the variables except the dummy variables are included in logarithmic form.²³ The main coefficient of interest is β_2 ,²⁴ which measures the elasticity of opening hours with respect to competition when the outcome variable is the length of opening hours.

4.2 Identification

If inspections stations choose locations that maximize sales (profit), there may be unobservable factors in the regression model that may affect our measures of local competition. For example, a firm’s market entry decision depends on incumbent firms’ capacity, which may also influence opening hours decisions; or market level distribution of consumers’ preferred (ideal) time to acquire the service can affect firms’ opening hours decisions and may also be correlated to local competition.

In addition to the endogeneity of market entry decisions, one might also worry about the endogeneity of volume of inspections with respect to opening hours. Longer opening hours is likely to increase a station’s volume of inspections. This means that unobservables that affect a station’s optimal opening hours will also impact the station’s volume of inspections. In the presence of such concerns, the estimates of the coefficients of both local competition and volume of inspections may be biased.

The primary strategy to identify the parameters of our interest is to control station specific and other variables. The data we use allow us to control for major variables which otherwise might cause a worry if we miss to include

²³The logarithmic transformation builds in to the model a diminishing effect of competition on opening hours.

²⁴When competition is measured using the average distance to three closest competitors (*Distance*), a negative value of β_2 is an indication that an increase in distance (which is an indicative of a decrease in competition) is negatively associated with opening hours. When competition is measured by the number of nearby rival stations (*#Stations*), a positive sign on β_2 is an indication that an increase in the number of rival stations (which is an indicative of an increase in competition) is positively associated with opening hours.

them. The volume of inspections (sales) is a primary control variable which can also capture differences in station size. The age of a station may also represent the experience of a manager and technicians, which can influence the choice of optimal opening hours. Time and chain type dummies also capture factors that differ across time and chain types respectively. However, OLS estimation may still produce biased estimates of the coefficients of interest for potential reasons discussed above.

In order to resolve the potential bias in estimating the effect of competition on opening hours, our strategy is to use 2SLS²⁵ analyses. To implement IV regression, we require potential instruments for both volume of inspections and measures of competition. The instruments must be correlated to the endogenous variables but should not directly affect stations' choice of opening hours. To overcome the endogeneity of competition, we use population size²⁶ at a municipality level as an exogenous source of variation in local competition. The first stage analyses show that the population size of station i 's municipality is strongly correlated to the level of competition station i faces, namely, average distance to three closest competitors and the number of service providers in station i 's geographic market.

For population size to serve as a valid instrument, it must not affect the choice of opening hours through other channels, except through the variables that are included in the regression model. One potential mechanism for population size to affect opening hours (other than competition) may be through affecting a station's volume of inspections, which we included in the regression equation. Thus, given our control variables, it is less likely for population size to systematically influence opening hours through other factors in the error term.

We propose the average volume of inspections in other markets for a

²⁵When the dependent variable is the length of opening hours, there is no enough variation in the data to identify the parameters of interest based on within station variation. As a result, we present our results based on pooled 2SLS analyses, which identifies parameters of interest based on cross-sectional variation.

²⁶Olivares and Cachons (2009) use population size to instrument for the number of car dealers in a market in their study of the impact of competition on inventory. As an alternative, we show in the robustness analyses section that our results remain robust to using the number of registered cars at municipality level to instrument local competition.

given month as a potential instrument for a station's volume of inspections. A particular chain usually operates in different counties²⁷. To instrument for station i 's volume of inspections in a given month, we use the average volume of inspections (to that particular month) of other stations, which are within the same chain²⁸ and age category²⁹ to station i , but are located outside station i 's county. The idea behind the instrument is that stations that share some 'common characteristics' tend to have comparable sales performance. Thus, the average volume of inspections conducted by stations that share some 'common characteristics' to station i may be a strong predictor of station i 's volume of inspections.

In the first stage analyses, we show that average number of inspections in other markets has a strong explanatory power to a given station's volume of inspections. For validity of the instrument to hold, we also need that unobserved factors that affect choice of opening hours should not be correlated across markets of different counties. We argue that, given the chain fixed effects and monthly seasonal dummies, the average volume of inspections of stations that share some 'common characteristics' to station i but located outside of station i 's county, are less likely to be correlated to the unobserved components of the regression equation for station i 's choice of opening hours.

Given the above potential instruments for local competition and volume of inspections, we use the following first stage equations for the relationship between our endogenous variables and instruments:

²⁷Sweden is divided into 21 counties and 290 municipalities.

²⁸Nine firms serve the market during the sample period and two of them are single-station firms that operate not in more than one county. For these firms, the average sales instruments are constructed based on stations that belong in other chains. For these stations, we use the average sales of any stations that are within their age category but outside of their respective county.

²⁹We divided the age of stations into five categories: less than 1 year old; between 1 and 2 years old; between 2 and 3 years old, between 3 and 4 years old and finally greater than 4 years old.

$$\begin{aligned}
Distance_{icty} &= \delta_1 + \delta_2(POP_{my}) + \delta_3(\#OtherMktInsp_{ity}) \\
&+ \delta_4(StationAge_{ity}) + Season_t \\
&+ Year_y + Chain_c + \zeta_{ity}
\end{aligned} \tag{2}$$

$$\begin{aligned}
\#Stations_{icty} &= \theta_1 + \theta_2(POP_{my}) + \theta_3(\#OtherMktInsp_{ity}) \\
&+ \theta_4(StationAge_{ity}) + Season_t \\
&+ Year_y + Chain_c + \omega_{ity}
\end{aligned} \tag{3}$$

$$\begin{aligned}
\#Inspections_{icty} &= \lambda_1 + \lambda_2(POP_{my}) + \lambda_3(\#OtherMktInsp_{ity}) \\
&+ \lambda_4(StationAge_{ity}) + Season_t \\
&+ Year_y + Chain_c + \eta_{ity}
\end{aligned} \tag{4}$$

Where POP_{my} is the population size of municipality m of station i for year y , that we use it to instrument local competition ($Distance$ and $\#Stations$); $\#OtherMktInsp$ is average volume of inspections conducted by stations, which are within the same chain and age category to station i but located outside of station i 's county, and serves as an instrumental variable for station i 's volume of inspections. The other variables are similar to equation 1. Except the dummy variables, $Season$, $Year$ and $Chain$, all the variables are in logarithmic form.

5 Main results

5.1 Results from OLS Estimation

We start by presenting results from OLS estimation of equation 1 for our two outcome variables, $Weekdays$ and $Weekend$. In all regressions, we correct standard errors for potential arbitrary hetroskedasticity and serial correla-

Table 4: The impact of competition, measured using Distance to closest competitors, on opening hours

Variable	Dependent Variable = $\ln(\text{Weekdays})$			Dependent Variable = Weekend		
	Pooled OLS [1]	Pooled OLS [2]	IV 2SLS [3]	Pooled OLS [4]	Pooled OLS [5]	IV 2SLS [6]
$\ln(\text{Distance})$	-0.019** (0.009)	-0.034*** (0.006)	-0.050*** (0.014)	-0.076*** (0.018)	-0.086*** (0.016)	-0.088*** (0.027)
$\ln(\#\text{Inspections})$		0.133*** (0.021)	0.115*** (0.013)		0.363*** (0.025)	0.435*** (0.047)
$\ln(\text{StationAge})$		-0.016*** (0.005)	-0.013*** (0.003)		-0.034*** (0.010)	-0.052*** (0.010)
Year	NO	YES	YES	NO	YES	YES
Season	NO	YES	YES	NO	YES	YES
Chain	NO	YES	YES	NO	YES	YES
Adjusted R^2	0.0155	0.5034		0.0289	0.4128	
Observations	9177	9144	9136	9177	9144	9136

Notes: $\ln(\text{Weekdays})$ stands for the logarithm of the total weekdays' opening hours per week in a given month. Weekend is a dummy variable for opening at least once on weekends of a given month. Distance measures level of competition for a station using the average distance (Km) to three nearby rival stations. The unit of observation is station - months pair for the period from March 2012 to May 2015. We instrument for Distance with population size at municipality level and for $\#\text{Inspections}$ with average number of inspections conducted by other stations located outside of station i 's county. Clustered standard errors at the station level are presented in parentheses. Except in columns 1 and 4, where no control variables used, all the other specifications include all the control variables: $\#\text{Inspections}$, number of inspections conducted; StationAge , age of a station in terms of number of days; Year , yearly dummies; Season , monthly seasonal dummies and Chain , chain type dummies. *** indicates significance at 1% level and ** significance at 5% level.

tion by clustering at station-level. The OLS estimates of -0.034 and -0.086 in columns 2 and 5 of Table 4 indicate that competition, measured using the average distance to nearby competitors, is positively correlated to both opening hours on weekdays and the probability of opening on weekends. More specifically, decreasing the average distance to three nearby competitors (increasing competition) by 10%, increases opening hours per week on weekdays by 0.325% and the probability of opening on weekends by 0.819 percentage points. When we measure competition using the number of competing stations in a market (in columns 2 and 5 of Table 6), increasing the number of competitors by 10%, increases opening hours per week on weekdays by 0.172% and the probability of weekend opening by 0.629 percentage points. Overall, we observe a positive correlation between competition and service opening hours. The OLS results, however, may be biased by factors unaccounted in the regression model. To verify that the positive associa-

Table 5: First stages

Variable	$\ln(\text{Distance})$	$\ln(\#\text{Inspection})$	$\ln(\#\text{Stations})$	$\ln(\#\text{Inspection})$
	OLS [1]	OLS [2]	OLS [3]	OLS [4]
$\ln(\text{POP})$	-0.655*** (0.028)	0.251*** (0.035)	0.429*** (0.029)	0.251*** (0.035)
$\ln(\#\text{OtherMktInsp})$	0.154** (0.065)	0.569*** (0.055)	-0.094 (0.091)	0.569*** (0.055)
$\ln(\text{StationAge})$	-0.062*** (0.019)	0.131*** (0.015)	0.025 (0.023)	0.131*** (0.015)
KP rk stat	53.329		29.376	
F-statistic	287.76	69.25	102.28	69.25
Adjusted R^2	0.6246	0.5540	0.2931	0.5540
Observations	9137	9136	9137	9136

Notes: The dependent variables are specified at the top of each column. *Distance* measures competition using the average distance to three nearby competitors. *#Stations* measures competition using the number of competitors in a market. *#Inspections*, stands for the number of inspections conducted at a given station. We instrument *Distance* and *#Stations* using *POP*, population size at a municipality level. We instrument *#Inspections* for station *i* using *#OtherMktInsp*, average number of inspections conducted by other stations but located outside of station *i*'s county. Clustered standard errors at the station level are presented in parentheses. All columns include all the control variables of the second stages of the 2SLS regressions: *StationAge*, age of a station in terms of number of days; *Year*, yearly dummies; *Season*, monthly seasonal dummies and *Chain*, chain type dummies. All the variables, except the dummy variables are in logarithmic form. We report the F-statistics for the joint significance of the two excluded instruments. Kleibergen-Paap Wald rk F- statistics for weak instrument test are also reported. *** indicates significance at 1% level and ** significance at 5% level.

tion between competition and opening hours is causal, we present the IV regression results.

5.2 First Stages

As discussed before, our measures of competition and volume of inspections are potentially endogenous. We proposed to instrument competition with population size (*POP*) and volume of inspections with average number of inspections in other markets (*#OtherMktInsp*). Columns 1 and 2 of Table 5 report the first stages for competition and volume of inspections respectively, where we measure competition using the average distance to three nearby competitors (*Distance*). Columns 3 and 4 of Table 5 report estimates of the first stages for competition and volume of inspections respectively, where we measure competition using the number of competitors in a market (*#Stations*).

The estimates of the first stages show that population size strongly ex-

Table 6: Results Using Number of Competitors to Measure Competition

Variable	Dependent Variable = $\ln(\text{Weekdays})$			Dependent Variable = Weekend		
	Pooled OLS [1]	Pooled OLS [2]	IV 2SLS [3]	Pooled OLS [4]	Pooled OLS [5]	IV 2SLS [6]
$\ln(\#\text{Stations})$	0.011 (0.008)	0.018*** (0.005)	0.077*** (0.024)	0.065*** (0.019)	0.066*** (0.015)	0.135*** (0.042)
$\ln(\#\text{Inspections})$		0.141*** (0.022)	0.114*** (0.017)		0.378*** (0.025)	0.434*** (0.047)
$\ln(\text{StationAge})$		-0.016*** (0.005)	-0.011*** (0.004)		-0.035*** (0.010)	-0.049*** (0.010)
Year	NO	YES	YES	NO	YES	YES
Season	NO	YES	YES	NO	YES	YES
Chain	NO	YES	YES	NO	YES	YES
Adjusted R^2	0.0027	0.4785		0.0191	0.4023	
Observations	9177	9144	9136	9177	9144	9136

Notes: $\ln(\text{Weekdays})$ stands for the logarithm of the total weekdays' opening hours per week in a given month. Weekend is a dummy variable for opening at least once on weekends of a given month. $\#\text{Stations}$ measures level of competition for a station using the number of rival stations in a market. The unit of observation is station - months pair for the period from March 2012 to May 2015. We instrument $\#\text{Stations}$ using POP , population size at a municipality level. We instrument $\#\text{Inspections}$ for station i using $\#\text{OtherMktInsp}$, average number of inspections conducted by other stations but located outside of station i 's county. Clustered standard errors at the station level are presented in parentheses. Except in columns 1 and 4, where no control variables used, all the other specifications include all the control variables: $\#\text{Inspections}$, number of inspections conducted; StationAge , age of a station in terms of number of days; Year , yearly dummies; Season , monthly seasonal dummies and Chain , chain type dummies. *** indicates significance at 1% level and ** significance at 5% level.

plains both measures of competition. As expected, average number of inspections in other markets significantly predicts the volume of inspections for a given station. Most importantly, both instruments are powerful. Bound, Jaeger, and Baker (1995) and Stock, Wright, and Yogo (2002) pointed out that weak instruments lead to biased estimates. Since we have two instruments and two endogenous variables, the usual F -test for weak-identification test would be misleading (Stock and Yogo, 2005). We, therefore, report in Table 5 the cluster and heteroskedasticity-robust *Kleibergen-Paap F-statistics*. The stock-Yogo critical value for a model with two instruments and two regressors is 7.03 for maximum 10 percent size distortion. Since the *Kleibergen-Paap F-statistics* values of 53.33 and 29.38 well exceed the the critical value, the statistical test supports a claim that our IV estimates do not suffer from weak instrument problem.

Before reporting the 2SLS results, we examine a reduced form relation-

ship between our instruments and measures of opening hours, *Weekdays* and *Weekend*. Given that competition increases with population size, we would expect opening hours to increase with population size. In similar reasoning, given that volume of inspections is positively affected by average number of inspections in other markets ($\#OtherMktInsp$), we also expect a positive relationship between opening hours and $\#OtherMktInsp$. The Appendix table 8 presents the results of the reduced form. The estimates indicate that both population size and $\#OtherMktInsp$ have a positive and significant effects on opening hours per week on weekdays and the probability of opening on weekends.

5.3 Results from IV Estimation

The first stages and reduced form analyses suggest that there exists a direct relationship between competition and opening hours. We investigate using IV regression if the positive association is a causal relationship. Columns 3 and 6 of Table 4 provide 2SLS estimates of the effects of competition (measured using *Distance*) on opening hours per week on weekdays and the probability of opening on weekends respectively. The competition coefficients have point estimates of -0.05 and -0.088, which indicates that decreasing the average distance to three nearby competitors (increasing competition) by 10% (which corresponds to 2.2 km, given the average distance of 22.36 km in our data), leads to 0.48% increase in opening hours per week on weekdays, and 0.84 percentage points increase in the probability of opening on weekends³⁰. The results are statistically significant at 1% level.

Columns 3 and 6 of Tables 6 report 2SLS estimates when we use the number of competitors in a market to measure competition. The competition coefficients are positive and statistically significant at 1% level, strengthening the previous results that competition leads to an increase in service opening

³⁰The descriptive statistics in Table 2 show that the average opening hours per week on weekdays is 49.87 and the probability for a station to provide service at least once on weekends in a given month is 39%. If we use the averages as baselines, a 10% (2.2 km) decrease in the average distance to three nearby competitors leads to 14.36 minutes increase in opening hours per week and a 2.15% increase in the probability of opening at least once on weekends in a given month.

hours. In this case, increasing the number of competitors by 10% (which corresponds to adding 0.83 station, given 8.3 average number of competitors per market in our data), leads to 0.74% (which, given the mean opening hours in our data, corresponds to about 22 minutes) increase in opening hours per week on weekdays, and 1.29 percentage points increase in the probability of opening at least once³¹ on weekends for a given month.

In alternative interpretation, entry of a station into a monopoly market (which is a 100% increase in the number of stations in a market) translates into 5.4% increase in opening hours per week on weekdays and 9.8 percentage points increase in the probability of opening on weekends³². However, the transformation of a market from two service providers to three service providers (which corresponds to a 50% increase in the number of stations in a market), leads to 3.17% increase in opening hours on weekdays per week and 5.5 percentage points increase in the probability of opening on weekends in a given month.

In a separate analyses, we also examine if competition affects a firm's choice of whether or not to open early (before 8 a.m.) and late (after 5 p.m.). We define early opening, *Early*, as a dummy variable for opening at least twice a week before 8 a.m. on weekdays in a given month and late opening, *Late*, as a dummy variable for opening at least twice a week after 5 p.m. on weekdays in a given month. The fixed effects 2SLS results are reported in Appendix table 9. The estimates indicate that competition affects early opening positively and significantly. However, we find no statistically significant relationship between competition and late opening. A 10% increase in the average distance to three nearby competitors translates into 4.63 percentage points increase in the probability of early opening. Similarly,

³¹In the robustness analysis section, we show that when we define *Weekend* as a dummy variable for opening at least twice on weekends in a given month, a 10% increase in the number of stations in a market (which corresponds to adding 0.83 station if we use the 8.83 average number of stations per market in our data as a baseline), leads to 2.2 percentage points increase in the probability of opening on weekends.

³²Given the average 49.26 opening hours per week on weekdays and 32.6% probability of opening on weekends for monopoly stations in our data, an additional station in a monopoly market increases opening hours on weekdays by 2.66 hours per week and the probability of opening on weekends by 30%.

a 10% increase in the number stations in a market, increases early opening probability by 5.1 percentage points.

The control variables also reveal some results. The 2SLS point estimates of the volume of inspections coefficients are positive and statistically significant at 1% level, suggesting that both *Weekdays* and *Weekend* increase with the volume of inspections. A 10% increase in volume of inspections translates into 1.14% increase in opening hours per week on weekdays and 4.14 percentage points increase in the probability of opening on weekends. We also found that opening hours decreases as stations become older.

Overall, the results provide evidence that competition has a positive and statistically significant effect on opening hours. Competition tends to create incentives for inspection firms to expand their opening hours on weekdays and to provide services on weekends. The results are robust to different specifications and different measures of competition. In the next section, we present a robustness analyses.

5.4 Robustness Analyses

In this section, we report on a number of checks to test the robustness of our results. The results are reported in Table 7, where each entry (like the dashed circle) represents a separate regression and contains the estimates of the coefficients on competition and volume of inspections. The first row contain the baseline pooled 2SLS results.

Using alternative instrument for measures of competition. In the main analyses, we use population size at a municipality level as an instrumental variable for our measures of competition. To further verify the robustness of the IV results, we use the number of registered cars at a municipality level as an instrumental variable for measures of competition. The results are reported in the second row of the table. We find that using the alternative instrument hardly impacts our baseline results.

Defining catchment area based on the 75th percentile travel distance. When we determine catchment area for station i in the variable radius approach, we use the median (50th percentile) customer travel distance of sta-

Table 7: Sensitivity analysis of the impact of competition on opening hours

Specification	Variable	2SLS	2SLS	2SLS	2SLS
		<i>Weekdays</i> (1)	<i>Weekdays</i> (2)	<i>Weekend</i> (3)	<i>Weekend</i> (4)
Baseline	<i>COMP</i>	-0.050*** (0.014)	0.077*** (0.024)	-0.088*** (0.027)	0.135*** (0.042)
	<i>#Inspections</i>	0.115*** (0.013)	0.114*** (0.017)	0.435*** (0.047)	0.434*** (0.047)
Number of vehicles	<i>COMP</i>	-0.051*** (0.015)	0.082*** (0.026)	-0.089*** (0.028)	0.143*** (0.045)
	<i>#Inspections</i>	0.116*** (0.013)	0.116*** (0.017)	0.436*** (0.047)	0.437*** (0.046)
75%ile catchment area	<i>COMP</i>		0.155*** (0.052)		0.271*** (0.097)
	<i>#Inspections</i>		0.088*** (0.030)		0.388*** (0.064)
Fixed radius catchment area	<i>COMP</i>		0.059*** (0.017)		0.103*** (0.031)
	<i>#Inspections</i>		0.114*** (0.014)		0.433*** (0.046)
At least 2 times on weekends	<i>COMP</i>			-0.149*** (0.025)	0.229*** (0.046)
	<i>#Inspections</i>			0.292*** (0.047)	0.289*** (0.057)
Station fixed effects	<i>COMP</i>	-0.183 (0.137)	0.203 (0.147)	-0.333** (0.146)	0.370** (0.155)
	<i>#Inspections</i>	0.084*** (0.022)	0.074*** (0.018)	0.384*** (0.058)	0.367*** (0.054)

Notes: The dependent variables are specified at the top of each column. Each entry in the table (like the dashed circle) represents separate regression and presents the estimates of the coefficients on competition and the volume of inspections. Columns 1 and 3 contain results when we use average distance of three nearby competitors to measure competition. Columns 2 and 4 report results when we use the number of rival stations in a market to measure competition. All regressions control for station age and year, monthly seasonal and chain dummies. All the variables, except the dummies are in logarithmic form. The baseline results in the first row of the table correspond to our specifications in columns (3) and (6) of both Table 4 and Table 6. The unit of observation is station - months pair for the period March 2012 to May 2015. Clustered standard errors at the station level are presented in parentheses. *** indicates significance at 1% level and ** significance at 5% level.

tions located in station i 's municipality. Now, we define catchment areas based on the travel distances of the 75th percentile customer of the respective municipality. The results are reported in the third row. The coefficient on competition when the dependent variable is *Weekdays*, becomes 0.16 (baseline result was 0.08) and when the dependent variable is *Weekend*, becomes 0.27 (baseline result was 0.14). These results support the positive effect of competition on service opening hours.

Fixed radius catchment area. In our main analyses, we use the variable radius approach to define catchment area, where stations' catchment areas

differ across stations based on local market characteristics. An alternative to this approach is the fixed radius approach³³, which defines equal size catchment areas to all stations regardless of their locations. We use the travel distance of the median customer at the national level (14 km) to define stations catchment areas. Row 4 presents the results. The coefficients on competition are still positive and significant at 1% level and magnitudes are slightly lower than the baseline results.

Opening at least two times on weekends for a given month as a dependent variable. One of our dependent variables, *Weekend*, is a dummy variable which takes a value of one for opening at least once on weekends (i.e., on Saturdays) for a given month. We now define *Weekend* as a dummy variable which takes a value of one for opening at least twice on weekends for a given month. We estimate the model with the new definition and report the results in row 5. The coefficient on competition measured using the average distance to nearby competitors becomes -0.15 (main result was -0.09). When we measure competition using the number of competitors in a market, the coefficient on competition becomes 0.23 (main result was 0.14). The results based on the alternative definition strengthen the main results that the probability of opening on weekends increases with competition.

Including station fixed effects. In the identification section, we stated that due to lack of enough within variation in the data when the dependent variable is *Weekdays*, we presented our main results based on Pooled 2SLS regression that identifies parameters based on cross sectional variation. To support the argument, we estimate the model by 2SLS after controlling station fixed effects and report the results in the last row of Columns 1 and 2 for our two measures of competition. The results show that when we control for station fixed effects in the 2SLS regression, the standard errors of the competition parameter increase substantially (more than 500% and 850%). The substantial increase in standard errors of the competition coefficients may suggest that the variation in the data does not allow for within variation identification strategy. Our results, therefore, rely on cross sectional variation to identify the parameters when the the dependent variable is *Weekdays*

³³This approach is exogenous to local market and station specific factors.

and try to resolve the endogeneity concern using the IV regression strategy.

The effect of competition on the probability of opening on weekends when we include fixed effects, however, is still positive and significant at 5% level (reported in the last row of Columns 3 and 4). In fact, the magnitude of the competition effect increases substantially to -0.33 (from baseline result of -0.09) when we measure competition using the average distance to nearby competitors and to 0.37 (from baseline of 0.14) when we measure competition using the number of rival stations in a market.

5.5 Conclusion

Firms, particularly in service and retail industries, can expand opening hours to offer their customers more flexible service time, which will have an important impact on consumers' where to buy decision. Although the existing theoretical literature indicates the strategic importance of opening hours in the retail and service industries, empirical studies on competition in opening hours are sparse. In this paper, we examine how local competition affects a firm's choice of opening hours in the context of motor vehicle inspection market. We use unique monthly firm-level panel data that include rich information on all car inspection stations in Sweden from 2012 to 2015.

After controlling for the endogeneity of market entry decisions and sales volume, we find that opening hours increases with local competition. Stations offer longer opening hours and the probability of providing services on weekends also increases as stations face additional competition. We also find that stations tend to provide services early in the morning (before 8 a.m.) when they operate in highly competitive environment. Our results suggest that the effect of competition on opening hours is decreasing: adding one station into a monopoly market increases opening hours per week by 2.66 hours and the probability of providing services on weekends at least once in a month by 30%, whereas an additional station in a duopoly market leads to 1.56 hours increase in opening hours per week and 16.87% increase in the probability of providing services on weekends.

The results are robust to different model specifications and different mea-

asures of local competition. If we consider opening hours as one dimension of service quality, our results complement the empirical literature on competition in service quality. Our findings will be important for competition authorities and courts in competition law enforcement. While in principle competition policy is believed to consider both price and non-price dimensions, competition authorities tend to focus on price effects in competition analysis. One reason would be lack of empirical evidences on how non-price attributes of a product react to competition in a particular market. Based on a panel data set in the motor vehicle inspection market, we provide empirical evidence on the relationship between competition and opening hours, which is sparsely examined in the empirical literature. Our findings provide strong evidence that consumers enjoy expanded opening hours in markets where competition is intense.

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6 Appendix

Table 8: Reduced form

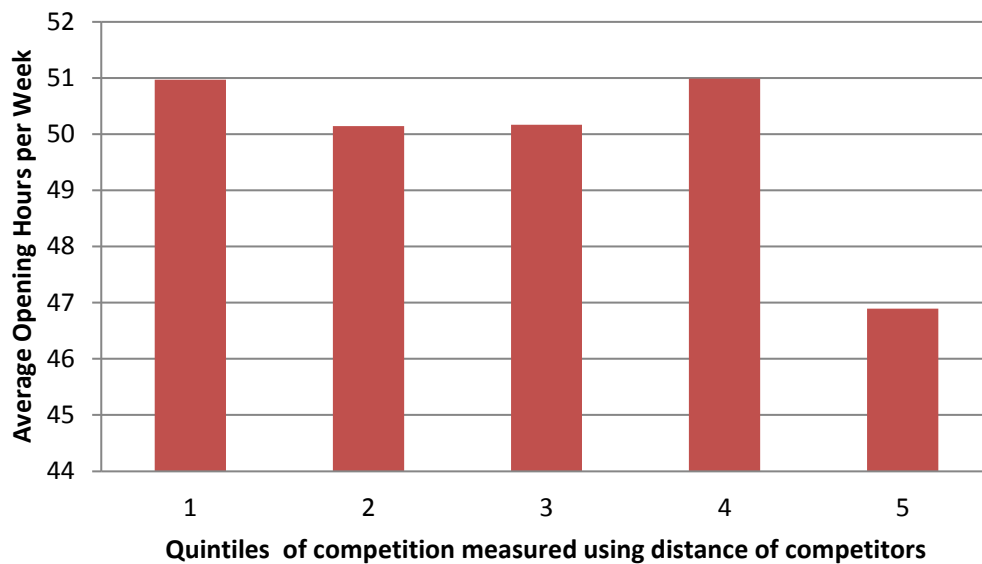
Variable	Dependent variable = $\ln(\textit{Weekdays})$	Dependent variable = $\textit{Weekend}$
	Pooled OLS [1]	Pooled OLS [2]
$\ln(\textit{Population})$	0.062*** (0.011)	0.167*** (0.017)
$\ln(\#\textit{OtherMktInsp})$	0.057*** (0.010)	0.234*** (0.038)
$\ln(\textit{StationAge})$	0.006** (0.003)	0.011 (0.009)
Year	YES	YES
Season	YES	YES
Chain	YES	YES
Adjusted R^2	0.279	0.227
<i>Observations</i>	9137	9137

Notes: The dependent variables are specified at the top of each column. $\ln(\textit{Weekdays})$ stands for the logarithm of the length of total weekdays' opening hours per week. $\textit{Weekend}$ is a dummy variable for opening at least once on weekends of a given month. We use population size at municipality level ($\textit{Population}$) and average number of inspections conducted in other markets ($\#\textit{OtherMktInsp}$) as instrumental variables for competition and volume of inspections respectively. The unit of observation is station - months pair for the period from March 2012 to May 2015. Clustered standard errors at the station level are presented in parentheses (there are 529 clusters in all regressions). All columns include all the control variables of the second stages of the 2SLS regressions: $\textit{StationAge}$, age of a station in terms of number of days; \textit{Year} , yearly dummies; \textit{Season} , monthly seasonal dummies and \textit{Chain} , chain type dummies. All the variables, except the dummy variables are in logarithmic form. *** indicates significance at 1% level and ** significance at 5% level.

Table 9: The impact of competition on early and late opening

Variable	Dependent Variable = <i>Early</i>		Dependent Variable = <i>Late</i>	
	2SLS [1]	2SLS [2]	2SLS [3]	2SLS [4]
$\ln(\text{COMP})$	-0.486** (0.217)	0.540** (0.209)	0.156 (0.186)	-0.173 (0.204)
$\ln(\#\text{Inspections})$	0.151** (0.071)	0.126* (0.065)	0.003 (0.033)	0.011 (0.029)
$\ln(\text{StationAge})$	-0.001 (0.010)	-0.002 (0.009)	0.007 (0.006)	0.007 (0.006)
Year	YES	YES	YES	YES
Season	YES	YES	YES	YES
Chain	YES	YES	YES	YES
Station	YES	YES	YES	YES
Observations	9136	9136	9136	9136

Notes: *Early* is a dummy variable for opening before 8 a.m. at least twice a week on weekdays. *Late* is a dummy variable for opening after 5 p.m. at least twice a week on weekdays. *COMP* stands for level of competition for a given station, where in columns 1 and 3 we use the average distance of nearby competitors and in Columns 2 and 4 we use the number of stations in a market to measure competition. The unit of observation is station - months pair for the period from March 2012 to May 2015. We use population size at municipality level and average number of inspections conducted in other markets as instrumental variables to instrument competition and volume of inspections respectively. Clustered standard errors at the station level are presented in parentheses. All the variables, except the dummy variables, *Early*, *Late*, *Year*, *Season*, *Chain* and *Station*, are in logarithmic form. In all columns, we control for: *#Inspections*, number of inspections conducted at station level; *StationAge*, age of a station in terms of number of days; *Year*, yearly dummies; *Season*, monthly seasonal dummies, *Station*, a set of station fixed effects and *Chain*, chain type dummies. ** indicates significance at 5% level and * significance at 1% level.



Quintiles of competition measured using distance of competitors
 Figure 5: Average Opening hours by quintiles of competition: Notes: We divided our competition, measured using the average distance to three nearby competitors, into quintiles from lowest value (fifth) to highest value (first) along the x-axis. We show the average hours of opening per week on weekdays in each of the quintiles on the y-axis.