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Deregulation, Choice and Competition in the Motor Vehicle Inspection Market*

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Abstract

I estimate a demand model for car inspection services to investigate car owners' choice of stations and its implications for competition, and to evaluate the impact on consumer welfae of removing the state monopoly on inspection services. Using detailed data on car owners' choices of station in the Swedish motor vehicle inspection market, I find that car owners are willing to pay SEK 41 or 9% more than the average price to avoid traveling one additional kilometer. Consumers are also found to respond to price, opening hours, and the size of the station. Stations that face more competitors also face more elastic demand with respect to price and opening hours. Improvement in spatial accessibility to stations following the removal of the monopoly increases welfare to the average consumer by SEK 100.

JEL Classification: D12; L11; L13; L89

Keywords: choice; deregulation; consumer welfare; demand elasticity; motor vehicle inspection market

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1 Introduction

Governments in several countries have adopted reforms that provide greater choice for users of public services (Besley and Ghatak, 2003; Hoxby, 2003; Musset, 2012). Governments are also turning to competing firms to provide services that have traditionally been provided by government agencies (Short and Toffel, 2015). An important motivation of such reforms is to create demand-side incentives for service providers to compete for customers by offering attractive options, implicitly assuming that the ability of consumers to swich providers will discipline firms.

With similar motivation, the Swedish government recently removed the monopoly on car roadworthiness testing services. Before July 2010, roadworthiness inspection services were solely provided by a state-owned monopoly firm. Beginning July 2010, the market has been opened for new entrants and presently both the state-owned firm and other private firms provide car inspection services, competing for customers. Besides improving spatial accessibility to inspection stations, the other goals of the reform were to encourage greater price competition, and improve service quality and opening hours. A prerequisite for these desirable outcomes is that car owners' choices of a station be influenced by price and non-price attributes. This paper investigates consumer preferences for station characteristics and their implications for competition, and evaluates the impact of eliminating the state monopoly on consumer welfare specifically attributable to spatial accessibility.

Using the station choices by more than 920,000 car owners in Sweden in 2017, I estimate conditional and mixed logit demand models for inspection services. The estimated model is used to answer the following questions: (1) How do distance, price, opening hours, station size and other service characteristics affect the choice of station? This enables me to quantify consumers' valuations of the attributes of stations (2) How much have consumers benefited from improved geographical accessibility? and (3) How does the degree of competition between stations affect the demand elasticities of price and opening hours?

This paper uses a unique individual-level data that contain detailed information about car owners and the characteristics of all inspection stations. The data was provided to me by the regulator of the market, the Swedish Transport Agency. For each station, the dataset contains rich information on the price of inspection, opening hours, monthly sales volume, whether the station provides drop-in service, ownership type, and the exact address where the station is located. For each car owner, the dataset also includes individual-level information on the exact address where the owner lives, which station s/he chose for inspection service, gender of the owner, age of the car, and whether the owner drives environmentally friendly car.

As with other spatially differentiated markets, I find that car owners put high value on proximity when choosing their preferred station, indicating that location is an important source of product differentiation. More specifically, owners are willing to pay SEK 41 or 9% more than the average price to avoid traveling one additional kilometer. Car owners are also more likely to choose a station with lower price and longer opening hours. The findings show that the average (median) elasticity of demand with respect to price is -0.91 (-1.02), whereas the average (median) elasticity of demand with respect to opening hours is 0.37 (0.44). The estimated demand elasticities vary between stations: stations that operate in highly competitive environments face higher demand elasticities, lending support to the notion that increased competition creates demand-side incentives for providers to meet consumers' needs.

As expected, the estimates indicate that competition decreases the likelihood of a station's being chosen. I also find that consumers attach a value of nearly SEK 43 to drop-in service. Consumers also value purchasing the service from state-owned stations by nearly SEK 34 more than purchasing the service from privately owned stations, indicating that either consumers attach value to the name of the state-owned incumbent company or the state-owned stations have unobserved attributes that are attractive to consumers. The findings also show that consumers have a preference for stations located in their own municipality than for stations located outside of their municipality.

Lastly, I examine the impact of abolishing the state monopoly on consumer welfare specifically attributable to improvement in the geographical accessibility to the stations. The number of stations increased from around 190 to 459 following the deregulation of the market and eventual entrance of private firms. Consequently, the distance to the nearest station decreased by 2.4 km for the average consumer. My welfare estimates indicate that the average consumer gained around SEK 100 in welfare from the improvement in spatial accessibility. The results of this paper indicate that even in markets where prices increased, spatial and other improvements in service attributes are essential to completely understand the welfare effects of changes in a market.[1] Since consumers value different characteristics of providers other than price, the welfare analysis could be biased if it fails to incorporate the non-price effects of market changes.

Many countries have regulations to carry out saftey and emision inspections for most types of motor vehicles. These regulations have created a multi-billion dollar industry involving hundreds of millions of car owners around the world. To the best of my knowledge, this paper is the first study to model demand for motor vehicle inspection services. My paper is part of the empirical industrial organization litraure that uses individual-level data to estimate demand models. This method is widely used to evaluate policy reforms that provide users of public services more choice of provider in health care (e.g., Beckert et al., 2012; Varkevisser et al., 2012; Gaynor et al., 2016; Santos et al., 2017), as well as in education (e.g., Hastings et al., 2005). These papers examine whether demand responds to quality in a setting where price is regulated. My demand analysis controls for price competition between providers. My paper is also broadly related to the literature on consumer choice in spatially differentiated markets (e.g., Thomadsen, 2005; Davis, 2006; Houde, 2012).

This paper is structured as follows. Section 2 describes the institutional features of the Swedish motor vehicle inspection market, Section 3 introduces the data, Section 4 presents the econometric strategy, and Section 5 presents the main results and welfare analyses. In Section 6, I carry out robustness

[1] Compared to the pre-deregulation period, the average price for car inspection service in Sweden has increased by SEK 150.

analyses. The last section concludes.

2 The Swedish Car Inspection Market: Institutional Background

In Sweden, all car owners are required by law to periodically[2] inspect the roadworthiness of their cars by licensed inspection firms. Until July 2010, a state owned monopoly was responsible for the provision of inspection services.[3] Beginning in July 2010, the government deregulated the car inspection services and opened the market to private inspection firms. To promote competition between service providers, in 2012 the government sold around 70 stations of the monopoly to a private firm. Furthermore, the state and the other co-owners agreed to split the remaining assets of the monopoly between themselves; each established a separate inspection firm. After the separation, the state owns around 90 stations and has continued operating under the old company name. The other co-owners left, operating 55 stations under a new company name. Before the deregulation, there were around 190 state-owned stations, providing services around the country. At the end of April 2017, a total of 459 stations owned by eight firms were providing inspection services throughout the country.

Car owners have the right to choose which station to visit for inspection. A vehicle has to pass the mandatory inspection to legally operate on the road. Cars that fail inspection have to be fixed and re-inspected within a time period set by the inspecting firm. Inspection firms need to obtain accreditation from a government agency, the Swedish Board for Accreditation and Conformity Assessment (SWEDAC). The market is closely monitored by the Swedish Transport Agency, which sets the rules and regulations that inspection firms need to follow, such as what equipment and methods to use, as well as on the competence of the inspection technicians. To avoid distorting incentives, inspection firms are not allowed to provide any services

[2]Presently, there is 3-2-1-1 system for non-commercial cars. This means, a new car should undergo the first mandatory inspection when it is three years old and the second inspection when it is five years old. Afterwards, the car must be inspected annually. Commercial cars should undergo inspection every year regardless of their age.

[3]The state owns 52% and different associations and insurance companies own the remaining 48%.

other than car inspection services. Price is not regulated, thus firms have the right to set the prices for their services.

3 Data and Descriptive Statistics

I use individual-level data from the Swedish Transport Agency on all mandatory car inspections conducted by all inspection stations that operated in Sweden from January 2017 to April 2017. This study focuses on station choices by individuals who own passenger cars and light trucks that weigh less than 3500 kg, so the dataset excludes vehicles owned by organizations and vehicles that weigh more than 3500 kg.[4] I further exclude station choices made by car owners for re-inspection services.[5] The final sample of the study contains station choices by 922,856 individuals at 452 stations operating throughout Sweden.[6]

For each car owner, the dataset provides detailed information on which station was chosen for the inspection, the gender of the owner, the age of the car, the exact address at which the the owner lives, and whether the car is environmentally friendly.[7] The dataset also contains rich information on the main characteristics of the stations. I know, for each station, the price of the inspection service, the number of opening hours per week in a given month, ownership type and whether the station provides drop-in service.[8] The dataset contains the market entry date of each station, which allows me

[4]The price of inspection services for a vehicle that weighs more than 3500 kg is different from the price for a vehicle that weighs less than 3500 kg.

[5]If a car fails an initial inspection, a re-inspection is required by law. I exclude station choices for re-inspection because the price is different from an initial inspection.

[6]I drop seven stations without opening hours data. These are termed "mobile" stations, which provide limited hours of services in some days of the month, based on the number of pre-booked customers. Only 1,733 car owners chose these stations and were thus excluded from the final dataset.

[7]A car is considered to be environmentally friendly if it is exclusively powered by renewable fuels or possesses a system for any form of clean fuel alternative in addition to fossil fuels.

[8]There are some stations that provide only pre-booked inspection services. The prices for pre-booked and drop-in services are different. Since the data can not tell me whether an individual visits a station with pre-booked appointment or not, I use the price for pre-booked services in this study. However, the prices for pre-booked and drop-in services are positively correlated ($\rho = 0.71$).

Table 1: Summary Statistics of Variables

Variable	Mean	Median	Std. dev.	Min	Max	N
Station Characteristics						
Price	450.078	450	33.545	299	750	452
Opening Hours (per week)	47.766	45	6.343	13.5	76	452
Station age (days)	1584.318	1812.5	723.4	3	2476	452
Sales[a] (No. of inspected cars)	797.668	603.988	608.538	53.667	3825.167	452
Pass rate[b]	0.749	0.741	0.053	0.565	0.882	452
Drop-in service	0.887	1	0.317	0	1	452
State owned	0.199	0	0.4	0	1	452
No. of competitors within a market	3.708	3	2.789	1	16	452
Distance to nearest station (km)	10.232	2.891	15.411	0.083	92.293	452
Avg. Dist. to 2 nearest stations (km)	13.243	5.556	16.728	0.270	95.756	452
Avg. Dist. to 3 closest stations (km)	15.869	8.440	18.007	0.876	110.060	452
Car owners characteristics						
female	0.347	0	0.476	0	1	922856
Car age (days)	4474.263	4104	2182.897	368	29305	922856
Green car	0.079	0	0.27	0	1	922856
Own municipality (chosen station)	0.787	1	0.41	0	1	922856
Distance to chosen station (km)	9.326	5.156	11.033	0.008	330.069	922856

Notes: [a]the average number of inspected cars in the last six months of 2016. [b]the average pass rate in the last six months of 2016.

to control for station age. As a proxy of station size, I use a station's average sales volume in the last six months of 2016. To capture proximity to an inspection station of a car owner's home, I compute straight-line distances using the geographical coordinates of the location at which the car owner lives and the locations of all stations providing inspection services. Finally, the degree of competition a station faces is measured in two ways, using the number of service providers in the station's geographic market[9] and distance to nearby competitors.[10]

3.1 Descriptive Statistics

Table 1 presents descriptive statistics of the characteristics of the inspection stations and car owners. Most car owners are male (65.3%). The average owner drives a car that is 4,474 days old. About 78.7% choose a station

[9]I use the actual travel distances of a station's customers to approximate the station's catchment area.

[10]Three versions: distance to the nearest, average distance to the two nearest and average distance to the three nearest.

Table 2: Distribution of Distances to the *Nth* Nearest Stations

Variable	Mean	Median	P90	Std. dev.	Min	Max
Distance to the nearest	6.558	3.121	16.400	7.979	0.006	146.150
Distance to the 2^{nd} nearest	13.036	7.656	30.458	14.239	0.075	178.689
Distance to the 3^{rd} nearest	18.301	12.669	40.708	18.673	0.443	216.301
Distance to the 4^{th} nearest	22.782	17.910	46.794	21.506	1.043	259.743
Distance to the 5^{th} nearest	28.685	23.065	56.487	26.496	1.416	321.509
Distance to the 6^{th} nearest	32.937	27.002	64.125	29.106	2.018	324.923
Distance to the 7^{th} nearest	36.457	29.527	71.961	31.016	2.752	324.931
Distance to the 8^{th} nearest	39.836	32.266	77.327	33.140	3.300	328.339
Distance to the 9^{th} nearest	43.363	35.336	88.602	35.482	4.085	330.602
Distance to the 10^{th} nearest	46.130	37.852	95.835	36.648	4.985	331.479

located in their own municipality. Nearly 7.9% drive environmentally friendly cars. There is considerable variation in the distances car owners travel for inspection service: the average car owner travels 9.3 km but one-half of the car owners travel no more than 5.2 km. Figure 1 shows the whole distribution of travel distances to the chosen stations, it indicates that the majority of car owners chose a station within a reasonable distance from their home.

On the service providers' side, the average station charges SEK 450, is 1,584 days old,[11] and provides 47.8 hours of services per week on weekdays. There are a total of 90 state owned stations. The sales volume varies considerably between stations, with the average station conducting 797 car inspections per month. The fraction of cars that pass inspection (pass rate) varies. The mean pass rate is 74.1%. The average station has its nearest competitor at a distance of 10.2 km, whereas each station has two competitors on average within 13.2 km and three competitors within 15.9 km. We also see that there are 3.7 service providers in the average station's geographic market.

Lastly, to get a sense of whether car owners bypass their nearest station, Figure 2 presents the percentage of car owners who chose their nearest, second nearest and so on station for inspection services. We see that around 53.9% chose a station bypassing their nearest one, which indicates that various

[11] I use December 21, 2010 as the entry date of those stations that were owned by the monopoly company and were later partly sold or transferred to private firms. These stations obviously were in the market before December 21, 2010, However, after the deregulation of the market, the previous monopoly company was reorganized and obtained a new license as of December 21, 2010.

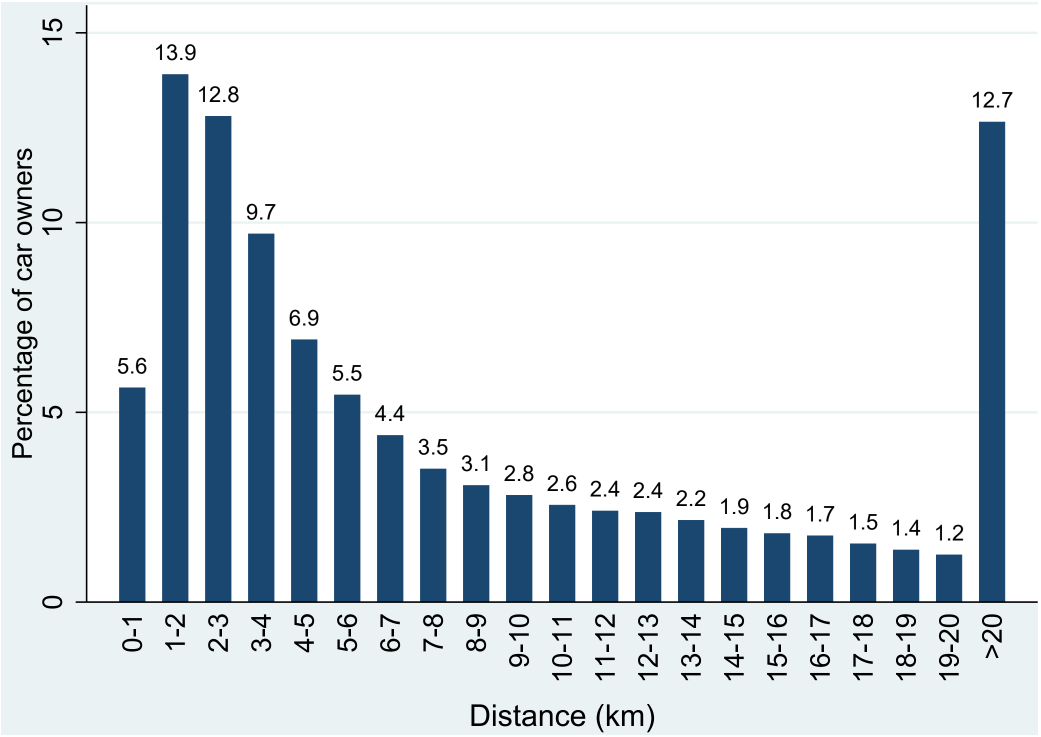

Figure 1: Distribution of distances to chosen station

station characteristics other than just location also affect car owners' choices of station. Table 2 presents the distribution of distances from the car owner's home to nearby stations. The first row shows that the distance to the nearest station for the average car owner is 6.6 km. One-half of the car owners in the sample have access to a station within 3.1 km, and 90% can find a station located within 16.4 km of where they live.[12]

3.2 Choice Sets

To define the set of alternatives that are available to each car owner, I rely on the travel distances to the actual chosen stations. Figure 2 shows that the vast majority (80.3%) chose a station from the three nearest stations

[12]The rest of the rows of Table 2 contain the distances to the second nearest, third nearest and so on station for car owners in our sample. For example, according to row three the average car owner has access to two stations within 13 km, one-half of the sample have access to two stations within 7.7 km and 90% have access to two stations within 30.5 km.

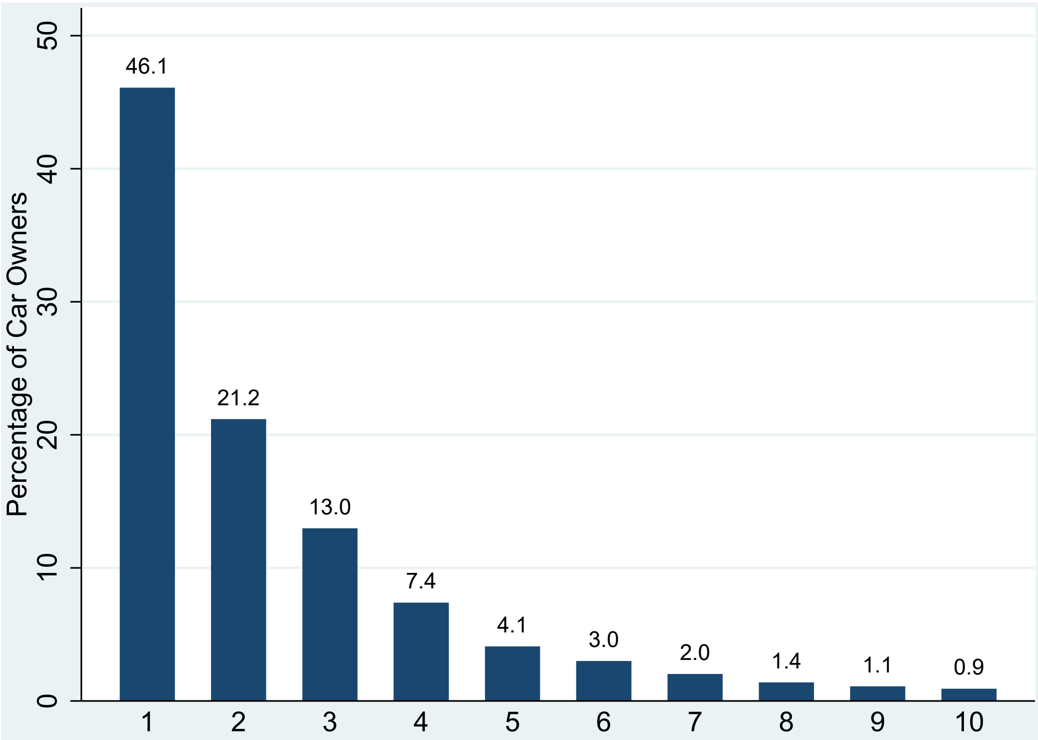

Figure 2: Percentage of car owners who went to their *Nth* nearest station

to where they live. In this study, I construct car owner specific choice sets consisting of the 10 stations nearest to the owner's home.[13] As a robustness check, I will subject the main results to different ways of defining the choice sets, specifying choice sets as consisting of stations up to the nearest 11, 13 stations, and down to the nearest 8, 6, 4 and 3 stations.

4 Empirical Approach

I estimate a conditional logit random utility model of a car owner's choice of station. The model is derived based on the assumption that car owners choose a station that maximizes their utility. Assuming a linear utility function and

[13]This excludes 26,736 car owners from the main analysis since they chose a station outside of their 10 nearest stations. When I carry out a robustness check, the choice set is defined as up to the 13 nearest stations from each car owner's home. As a result, 15,756 individuals out of the 26,736 will be included in the analysis, since they chose their station from the 11th, 12th and 13th nearest ones to their homes.

denoting car owner i's choice set of stations by C_i , the utility of car owner i from choosing station $j \in C_i$ is given by

$$U_{ij} = D_{ij}\alpha_1 + D_{ij}^2\alpha_2 + \boldsymbol{x}_j'\boldsymbol{\beta} + \epsilon_{ij} = V_{ij} + \epsilon_{ij}, \tag{1}$$

where $\boldsymbol{x}_j = (x_{1j}, ..., x_{Kj})$ is a vector of K observed characteristics of station j, and D_{ij} denotes the distance from car owner i's home to station j. Here, $\alpha_1, \alpha_2, \boldsymbol{\beta}$ are parameters to be estimated, and ϵ_{ij} is a random error term representing unobservable factors that affect i's valuation of station j. Under the assumption that the random errors of the utility function, ϵ_{ij}, are independently and identically distributed with type-1 extreme value distribution, McFadden (1974) shows that the probability that car owner i chooses alternative $j \in C_i$ is

$$P_{ij} = \frac{exp(V_{ij})}{\sum_{l \in C_i} exp(V_{il})} \tag{2}$$

This model assumes homogeneous preferences for station characteristics across individuals. I capture preference heterogeneity in two ways. First, by reestimating my model for a number of separate samples: by gender, by car age, and by car type. Second, by estimating a model that allows for observable heterogeneity in preferences. In the latter case, I introduce heterogeneity into the model by interacting observable station characteristics and distance with the car owners' characteristics. The utility that car owner i derives from choosing station $j \in C_i$ is now given by

$$U_{ij} = D_{ij}\omega_1 + D_{ij}^2\omega_2 + \boldsymbol{x}_j'\boldsymbol{\rho} + \sum_{\mathrm{k}=1}^{K} D_{ij}Z_{i\mathrm{k}}\phi_{\mathrm{k}} + \sum_{\mathrm{k}=1}^{K} D_{ij}^2 Z_{i\mathrm{k}}\theta_{\mathrm{k}} + \sum_{\mathrm{k}=1}^{K} Z_{i\mathrm{k}}\boldsymbol{x}_j'\boldsymbol{\lambda}_{\mathrm{k}} + \xi_{ij} \tag{3}$$

where $\boldsymbol{x}_j$ is a vector of observed characteristics of station j, D_{ij} denotes the distance from car owner i's home to station j, $(Z_{i\text{k}}, \text{k} = 1, ..., K)$ denote the car owner's characteristics (gender, age of the car and whether the owner drives an environmentally friendly car), and ξ_{ij} are unobserved random error terms. The fourth, fifth and sixth terms in equation 3 represent interactions between distance and car owner characteristics, squared distance and car owner characteristics and, car owner and station characteristics, respectively. Hence, the vectors of coefficients $\boldsymbol{\rho}$, $(\boldsymbol{\lambda}_{\text{k}}$, $\text{k} = 1, ..., K)$, and parameters ω_1, ω_2, $(\phi_{\text{k}}$, $\text{k} = 1,.... , K)$ and $(\theta_{\text{k}}$, $\text{k} = 1,.... , K)$ will be estimated.

In this model, I am only able to capture differences in preferences according to observed characteristics of the car owners. However, heterogeneity in preferences can also arise from unobservable characteristics (Hole, 2008). To allow for unobservable heterogeneity in preferences for station characteristics, I estimate mixed logit model. The mixed logit model is the most flexible discrete choice model and can approximate any random utility model (Hensher and Greene, 2003; Train, 2003). The model produces a flexible substitution pattern since it does not have the property of Independence of Irrelevant Alternatives (IIA), which is the result of the assumption of the standard logit model that the error terms are independently and identically distributed (IID) (Hensher and Greene, 2003; Train, 2003). The mixed model accommodates heterogeneity by allowing the estimates of the model to vary with the individual. The utility associated with car owner *i's* choosing j is now represented by

$$U_{ij} = \boldsymbol{x}'_{ij}\boldsymbol{\beta}_i + \mu_{ij} \tag{4}$$

where $\boldsymbol{\beta}_i$ is a vector of individual-specific coefficients, $\boldsymbol{x}_{ij}$ is a vector of observable station characteristics including distance from i's home to station j and μ_{ij} is IID according to extreme value type-1 distribution. Denoting the density of $\boldsymbol{\beta}_i$ by $f(\boldsymbol{\beta}\backslash\boldsymbol{\theta})$, the unconditional choice probability that car owner i chooses alternative $j \in C_i$ is

$$P_{ij}(\boldsymbol{\theta}) = \int_{\boldsymbol{\beta_i}} \frac{exp(\boldsymbol{x}'_{ij}\boldsymbol{\beta}_i)}{\sum_{l\in C_i} exp(\boldsymbol{x}'_{il}\boldsymbol{\beta}_i)} f(\boldsymbol{\beta}\backslash\boldsymbol{\theta})d\boldsymbol{\beta} \tag{5}$$

which is the integral of the standard logit probability integrated over all possible values of $\boldsymbol{\beta_i}$, weighted by the density of $\boldsymbol{\beta_i}$. The probability is a function of $\boldsymbol{\theta}$, which represents the parameters of the density of $\boldsymbol{\beta}$. Unlike the conditional logit model, the probability equation of the mixed logit model in equation 5 does not have a closed form solution. As a result, the integral is approximated through simulation (Hensher and Greene, 2003; Train, 2003). The researcher needs to specify the appropriate density for $\boldsymbol{\beta_i}$, draw a value from the density and calculate the integrand of equation 5. These steps are repeated several times and the average gives simulated choice probability. I specify normal and log-normal distributions for the coefficients of the station attributes and estimate the model with maximum simulated likelihood using 200 Halton draws.[14]

4.1 Elasticities, Willingness to Pay and Willingness to Travel

Since the utility function is only unique up to a positive linear transformation, the estimated coefficients convey information only about the sign of the marginal utility of the station attributes and the sign of the effect of the attributes on demand. The marginal rate of substitution between two attributes is invariant to the scale of utility and provides quantitative information about car owners' valuations of attributes, which can be compared between different samples of individuals. I calculate the willingness to pay (WTP) and the willingness to travel (WTT) for one unit improvement in station attributes. The WTT is derived from the ratio of the coefficient on a specific attribute to the marginal utility of distance.[15] In the same way, the WTP is derived from the ratio of the coefficient on a specific attribute

[14] As the number of draws increases, the simulated probability becomes less biased (Train, 2003) but increases the computational burden. For example, both Gutacker et al. (2016) and Santos et al. (2017) used 50 Halton draws to estimate mixed logit model.

[15] The quadratic form of distance is evaluated at the mean distance to the chosen stations.

to the marginal utility of income (i.e., the estimated price coefficient). The delta method is used to estimate the standard errors of the WTT and WTP estimates (Hole, 2007).

I also compute the elasticity of demand a station faces with respect to price and opening hours. The expected number of car owners choosing station j is $\hat{n}_j = \sum_{i \in S_j} \hat{P}_{ij}$, where S_j is the set of car owners whose choice sets include station j and $\hat{p}_{ij}$ is the probability that individual i chooses station j. Following Santos et al. (2017), the elasticity of demand of station j with respect to own price and opening hours is

$$\epsilon_j^x = \frac{\partial \hat{n}_j}{\partial x_j} \frac{x_j}{\hat{n}_j} = \sum_{i \in S_j} \hat{\beta}_x \hat{p}_{ij}(1 - \hat{p}_{ij}) \frac{x_j}{\sum_{i \in S_j} \hat{p}_{ij}} \tag{6}$$

where $\hat{\beta}_x$ is the estimates of the coefficient of attribute x. The distribution of (6) across all stations for both price and opening hours is presented.

I am also interested in the number of additional cars a station would obtain by lowering price by one krona and increasing opening hours per week by one hour. The estimated change in the number of car owners choosing station j resulting from changing price and opening hours by one unit is

$$\frac{\partial \hat{n}_j}{\partial x_j} = \sum_{i \in S_j} \hat{\beta}_x \hat{p}_{ij}(1 - \hat{p}_{ij}) \tag{7}$$

The distribution of (7) across all stations for both price and opening hours is presented.

5 Results

Table 3 presents the results from two model specifications. Model 1 shows results for my baseline specification with distance in its quadratic form, price, service opening hours, station size, number of competitors and station age. Furthermore, the model includes indicators for drop-in service, whether the station is located within the car owner's municipality and whether the station is owned by the state. The first columns of Tables 4, respectively, 5, present the estimates of WTP, respectively, WTT, based on the baseline model.

These parameter estimates of the baseline model are all highly significant. The distance coefficients suggest that car owners care about distance to a station. The positive coefficient on the quadratic term of distance implies that the disutility from distance declines with distance. As shown in the first column of Table 4, consumers are willing to pay SEK 41 to avoid travelling one additional kilometer. The results also show that car owners prefer stations that offer lower prices and longer opening hours. They also prefer stations that provide drop-in services and that are large in size. They value a station with drop-in service nearly SEK 43 more than a station without drop-in service.

As expected, the model estimates also indicate that stations facing large number of competitors are less likely to be chosen. After controlling for observed station characteristics, I also find that car owners prefer state-owned stations over privately owned stations, reflecting that either there are unobserved characteristics of state owned stations that have a positive effect on consumer choice or consumers attach value to the name of the incumbent state owned company.[16] The WTP estimate indicates that consumers value purchasing the service from state owned stations nearly SEK 34 more than purchasing the service from privately owned stations. The positive coefficient on the dummy for home municipality station shows that consumers prefer stations located in their home municipality to stations located in a neighboring municipality.

5.1 Is There Preference Heterogeneity?

I examine observable heterogeneity in preferences in two ways. First, I augment the baseline specification by including interaction terms between car owners and stations' characteristics. Second, I reestimate the baseline model for different samples: by owner gender, by car age and by whether the owner

[16]Hortacsu et al. (2017) also find sizable incumbent brand effect in retail choice market for residential electric power in a market setting where the quality of power consumers obtain is independent of retailers.

Table 3: Choice of Stations: Estimates of Marginal utilities

	Model 1		Model 2	
Variable	Coeff.	SE	Coeff.	SE
Distance	−0.14261***	(0.000486)	−0.15459***	(0.001129)
Distance squared	0.00045***	(0.000005)	0.00050***	(0.000013)
Price	−0.00324***	(0.000047)	−0.00371***	(0.000118)
Opening hours	0.01257***	(0.000281)	0.00848***	(0.000705)
Station size	0.00051***	(0.000002)	0.00051***	(0.000006)
Pass rate	0.01701***	(0.000348)	0.01784***	(0.000859)
No. of competitors	−0.04377***	(0.000898)	−0.01810***	(0.002238)
Station age	0.00036***	(0.000003)	0.00035***	(0.000007)
Drop-in service	0.13790***	(0.006086)	0.28937***	(0.015083)
Municipality	0.94359***	(0.004822)	0.96367***	(0.011703)
State owned	0.10936***	(0.004104)	0.29620***	(0.010279)
Interaction with Green Car				
X Distance			−0.01850***	(0.001823)
X Distance squared			0.00012***	(0.000011)
X Price			0.00000	(0.000180)
X Opening hours			0.00089	(0.001010)
X Station size			−0.00003***	(0.000009)
X Pass rate			−0.00329**	(0.001290)
X No. of competitors			0.00719**	(0.003265)
X Station age			0.00002**	(0.000010)
X Drop-in service			0.00609	(0.022109)
X Municipality			−0.06437***	(0.017482)
X State owned			0.09276***	(0.015138)
Interaction with Female				
X Distance			−0.00803***	(0.001020)
X Distance squared			0.00004***	(0.000010)
X Price			0.00101***	(0.000101)
X Opening hours			−0.00070	(0.000598)
X Station size			0.00003***	(0.000005)
X Pass rate			0.00135*	(0.000737)
X No. of competitors			−0.00982***	(0.001905)
X Station age			0.00005***	(0.000006)
X Drop-in service			0.02765**	(0.012836)
X Municipality			0.06914***	(0.010168)
X State owned			0.06768***	(0.008690)
Interaction with Age of Car				
X Distance			0.00000***	(0.000000)
X Distance squared			−0.00000***	(0.000000)
X Price			0.00000	(0.000000)
X Opening hours			0.00000***	(0.000000)
X Station size			−0.00000	(0.000000)
X Pass rate			−0.00000	(0.000000)
X No. of competitors			−0.00001***	(0.000000)
X Station age			−0.00000**	(0.000000)
X Drop-in service			−0.00004***	(0.000003)
X Municipality			−0.00001***	(0.000002)
X State owned			−0.00005***	(0.000002)
BIC	2,298,900		2,295,400	
AIC	2,298,746		2,294,796	
Pseudo R^2	0.459		0.460	
No. of observations	9,228,560		9,228,560	
No. of car owners	922,856		922,856	
No. of stations	452		452	

Notes: Conditional logit models of station choice. Robust standard errors are presented in parentheses. AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion. *** indicates significance at 1% level and ** significance at 5% level.

Table 4: Willingness to Pay (WTP)

Variable	Baseline	Green	Non-green	Male	Female	Car age below median	Car age above median
Distance (km)	41.47	46.75	41.06	36.85	54.18	41.48	41.43
Opening hours	3.88	3.69	3.89	3.58	4.65	3.38	4.38
Pass rate (%)	5.26	4.36	5.33	4.62	6.95	5.47	5.01
Station age (days)	0.11	0.12	0.11	0.1	0.15	0.11	0.11
Drop-in service	42.61	56.08	41.45	35.38	62.12	57.49	24.93
Municipality	291.6	270.3	292.71	257.13	383.79	279.88	299.36
State owned	33.79	75.8	29.95	23.54	61.84	60.26	3.11

Notes: The table presents the amount of extra money (SEK) car owners would be willing to pay for one unit improvement in station characteristics. Improvement on distance corresponds to a decrease in distance. WTP is the ratio of a coefficient on a specific station characteristic to the coefficient on price. The corresponding standard errors on the WTP estimates are computed using Delta method (*nlcom*) and presented in the appendix. The WTP for visiting government stations for car owners with above-median car age is significant at 11% level, otherwise all WTP estimates are significant at 1% level.

Table 5: Willingness to Travel (WTT)

Variable	Baseline	Green	Non-green	Male	Female	Car age below median	Car age above median
Price (kr)	24.1	21.4	24.4	27.1	18.5	24.2	24.1
Opening hours	93.7	79	94.6	97.2	85.9	81.4	105.8
Pass rate (%)	126.8	93.2	129.8	125.4	128.4	131.8	120.8
Station age (days)	2.7	2.5	2.7	2.6	2.8	2.6	2.8
Drop-in service	1027.6	1199.5	1009.4	960	1146.7	1385.3	600.6
Municipality	7031.3	5781.4	7128.8	6977.6	7084.1	6753.6	7220
State owned	814.9	1621.2	729.4	638.7	1141.5	1451.1	74.1

Notes: The table presents the number of extra meters car owners would be willing to travel for one unit improvement in station characteristics. Improvement on price corresponds to a decrease in price. WTT is the ratio of a coefficient on a specific station characteristic to the coefficient on distance. The quadratic form of distance is evaluated at the mean distance to the chosen stations. The corresponding standard errors on the WTT estimates are computed using Delta method (*nlcom*) and presented in the appendix. All WTT estimates are significant at 1% level.

drives environmentally friendly car. I present the results for six different groups in Table 13 in the Appendix. Columns 2-7 of Tables 4 and 5 present WTP and WTT estimates respectively for each group of individuals.

Model 2 in Table 3 presents the results from the specification in (3), which includes interaction terms between observed car owner characteristics (gender, age of the car and whether the owner drives environmentally friendly car) and station characteristics. The negative coefficient on the interaction term between the dummy for environmentally friendly car owners and distance indicates that environmentally friendly car owners put more value on proximity than owners of conventional cars. Based on WTP estimates, "green" car owners are willing to pay nearly SEK 6 more than conventional car owners to avoid traveling one kilometer. I also find that "green" car owners value drop-in service and state-owned stations more than other car owners.

When we see preference differences across gender, female car owners put greater value on proximity, drop-in service, home municipality stations and state owned stations more than their male counterparts. Females are willing to pay SEK 54 while their male counterpart pay SEK 37 to avoid traveling one additional kilometer. Females are also willing to pay SEK 27 for drop-in service, SEK 127 for home municipality stations and SEK 38 for state-owned stations more than male car owners. Finally, car owners who drive relatively new cars put higher value on drop-in service and state owned stations, but put lower value on home municipality stations than car owners who drive relatively old cars.

5.2 Mixed Logit Model

To allow for unobserved heterogeneity in preferences, I estimate a mixed logit model where model parameters are allowed to vary across individuals. Due to computational constraint, I estimate the mixed logit model using station choices made by a random sample of 200,000 car owners (which is more than 20% of the baseline dataset). An important issue in specifying mixed logit model is determining which station characteristics should have random coefficients and what distribution they should follow (Hensher and Greene, 2003; Hole, 2008). I estimate two alternative specifications. In the first specification, all parameters of the model are assumed to be distributed according to normal distribution. In the second specification, the coefficients on station age, indicators for home municipality stations and state owned stations will have normal distribution and the coefficients on distance will have log-normal distribution.[17] The coefficients on price, opening hours, sta-

[17] A log-normally distributed variable takes only positive values. Specifying the coefficient on distance to have log-normal distribution ensures all car owners to have the same (positive) sign on the coefficient of distance. Since I expect negative coefficient on distance, I multiply the distance variable by minus one before estimation and the actual coefficient

Table 6: Choice of Stations: Mixed Logit Model Estimates of Marginal Utilities

		Model 1		Model 2	
Variable	Parameter	Value	SE	Value	SE
Distance	Mean of coeff.	-0.208748***	(0.001649)	-1.572265***	(0.007634)
	S.D. of coeff.	0.079352***	(0.001564)	0.713426***	(0.011359)
Distance squared	Mean of coeff.	0.000232***	(0.000019)	-8.639130***	(0.055158)
	S.D. of coeff.	0.000001	(0.000006)	-0.001832	(0.043826)
Price	Mean of coeff.	-0.004770***	(0.000122)	-0.005139***	(0.000127)
	S.D. of coeff.	-0.000042	(0.000322)		
Opening hours	Mean of coeff.	0.014996***	(0.000700)	0.015628***	(0.000730)
	S.D. of coeff.	-0.000522	(0.000384)		
Station size	Mean of coeff.	0.000524***	(0.000006)	0.000537***	(0.000006)
	S.D. of coeff.	-0.000007	(0.000004)		
Pass rate	Mean of coeff.	0.018062***	(0.000899)	0.018588***	(0.000921)
	S.D. of coeff.	-0.003688	(0.004364)		
No. of competitors	Mean of coeff.	-0.012647***	(0.002320)	-0.010485***	(0.002392)
	S.D. of coeff.	-0.000971	(0.001816)		
Station age	Mean of coeff.	0.000656***	(0.000011)	0.000705***	(0.000012)
	S.D. of coeff.	-0.000975***	(0.000018)	0.001046***	(0.000018)
Drop-in service	Mean of coeff.	0.142597***	(0.016013)	0.169562***	(0.016428)
	S.D. of coeff.	0.052880	(0.038584)		
Municipality	Mean of coeff.	1.077941***	(0.016623)	1.064846***	(0.016657)
	S.D. of coeff.	-1.438582***	(0.036503)	1.317297***	(0.037303)
State owned	Mean of coeff.	0.011561	(0.012952)	-0.023239*	(0.012909)
	S.D. of coeff.	-0.850281***	(0.045355)	1.066314***	(0.034419)
No. of car owners		200,000		200,000	
No. of stations		452		452	
No. of observations		2,000,000		2,000,000	
BIC		492,496		490,859	
AIC		492,221		490,659	

Notes: Mixed logit models of station choice. In model 1, all coefficients are normally distributed. In model 2, coefficients of distance and squared distance are log-normally distributed; the coefficients on stage age, municipality and state owned are normally distributed; the coefficients on price, opening hours, station size, number of competitors and drop-in service are fixed. Robust standard errors are presented in parentheses. AIC = Akaike Information Criterion; BIC = Bayesian Information Criterion. *** indicates significance at 1% level and * significance at 10% level.

Table 7: Point Estimates of Log-Normal Coefficients

Variable	Median	Mean	S.D.
Distance	−0.207574	−0.296546	−0.302560
Distance squared	0.000177	0.000177	−0.000008

tion size, pass rate, number of competitors and indicator for drop-in service are assumed to be fixed.[18]

Model 1 in Table 6 presents the results from the first specification where all coefficients are normally distributed. The estimated mean coefficients are statistically significant and similar in sign to the conditional logit model results. Car owners prefer stations located closer to their homes and that offer lower prices. Car owners also prefer stations that provide longer opening hours, drop-in service and that are large in size. They also prefer stations located in their home municipality to stations located in neighboring municipalities. The coefficient on the indicator for state-owned stations is insignificant but has positive sign.

The standard deviation of the distance coefficient is significant, suggesting that the effect of distance differs across individuals. The estimated standard deviations of the coefficients on station age, indicators for home municipality stations and state ownership are significant, which implies that valuation of these characteristics differs across individuals. All the other coefficients have insignificant standard deviations indicating that values attached to these characteristics do not vary across individuals.

Consider now the results from the second specification where the coefficients are considered to be fixed, normally and log-normally distributed. Model 2 in Table 6 presents the results. The parameter estimates of the model are statistically significant and not different in sign to the results of the conditional logit models except for state ownership indicator. The estimated standard deviations of the coefficients on distance, station age, indicators for home municipality stations and stations owned by the state reveal the existence of preference heterogeneity across individuals. The mean coefficients on distance, price and indicator for home municipality stations are larger than those from the baseline model.

The estimates of log-normally distributed parameters on distance and

becomes the negative of the exponential of the estimated coefficient.

[18]Fixed coefficient specification follows partly from the results of the first mixed logit specification, in which the estimated standard deviations of the coefficients on these variables are insignificant suggesting no differences across individuals in valuation of these station characteristics.

Table 8: Effect Sizes of Price

Variable	Mean	S.D.	25th percentile	Median	75th percentile	90th percentile
Elasticity of demand	−0.91	0.38	−1.21	−1.02	−0.59	−0.33
Demand change	3.74	2.91	1.87	3.08	4.75	7.22
% Demand change	0.20	0.086	0.13	0.23	0.27	0.29

Notes: Elasticity of demand: percentage change in demand resulting from one percent increase in price. Demand change: number of additional customers a station will gain from lowering price by one krona. % Demand change: the percentage change in demand resulting from lowering price by one krona.

Table 9: Effect Sizes of Opening Hours

Variable	Mean	S.D.	25th percentile	Median	75th percentile	90th percentile
Elasticity of demand	0.37	0.16	0.24	0.440	0.50	0.54
Demand change	14.55	11.31	7.30	11.98	18.46	28.06
% Demand change	0.79	0.33	0.50	0.90	1.08	1.15

Notes: Elasticity of demand: percentage change in demand resulting from one percent increase in opening hours. Demand change: number of additional customers a station will gain resulting from one hour increase per week in opening hours. % Demand change: the percentage change in demand resulting from one hour increase in opening hours.

squared distance in Table 6 are the means (m_k) and standard deviations (sd_k) of the natural logarithm of the coefficients. Train (2003) shows that the point estimates for the median, mean and standard deviations of the corresponding original coefficients are given by $exp(m_k)$, $exp(m_k + sd_k^2/2)$ and $exp(m_k + sd_k^2/2)\sqrt{exp(sd_k^2) - 1}$ respectively.[19] The results are presented in Table 7. The negative coefficient on distance indicates that car owners dislike to travel. The estimated standard deviation of the distance coefficient is significant, implying that sensitivity to distance differs across individuals.

The results from the model specification that allow for observed heterogeneity in (3) and unobserved heterogeneity in (4) are generally similar in signs and statistical significance to the results obtained from the baseline specification in (1). I therefore continue considering the baseline model specification as a reasonable representation of the car owners' choice behavior.

[19] Note that since I multiplied the distance variable by negative one initially, the estimates in Table 7 are obtained after being multiplied by negative one to take that into account.

5.3 The Effect of Price and Opening Hours on Demand

Using the estimates from the baseline choice model of Table 3, I illustrate the effect of price and opening hours on demand. Tables 8 and 9 present the estimated effect of price and opening hours on demand respectively. The first rows of Tables 8 and 9 provide the elasticity of demand with respect to own price and opening hours respectively. The responsiveness to changes in price and opening hours differs across stations. The mean (median) demand elasticity with respect to price is -0.91 (-1.02) and with respect to opening hours is 0.37 (0.44). The second and third rows of Tables 8 and 9 present the number of additional customers a station will gain and the percentage change in demand respectively resulting from a reduction by one krona in the price and an increase by one hour in the opening hours per week. Reducing the price by one krona is expected to increase the number of inspected cars at a station on average by four, which is 0.20% of the predicted demand at the current price levels. Increasing opening hours by one hour per week is estimated to increase the number of inspected cars at a station on average by fifteen, which is 0.79% of the predicted demand at the current opening hours levels.

There is a variation across stations in the estimated effects on demand of changes in own-price and opening hours. The expected increase in the number of customers from a one krona reduction in price varies from seven(at the 90th percentile) to two (at the 25th percentile). The percentage change in demand from a one krona reduction in price varies from 0.29% (at the 90th percentile) to 0.13% (at the 25th percentile). Similarly, the expected increases in the number of customers from a one hour increase in opening hours per week are 28 (at the 90th percentile) and seven (at the 25th percentile). The corresponding percentage changes in demand from a one hour increase in opening hours are 1.15 at the 90th percentile and 0.5 at the 25th percentile.

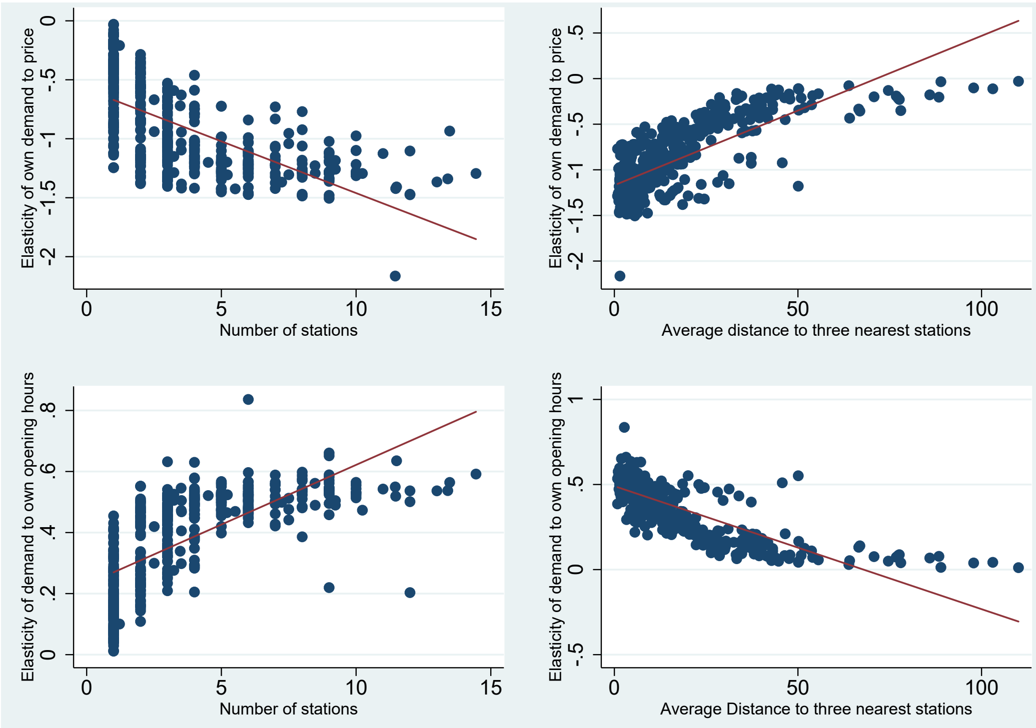

Figure 3: Elasticity of Demand by Degree of Competition. *Notes: These figures plot Price and opening hours elasticity of demand against the degree of competition a station faces (measured using both the number of stations in a given market and average distance to three nearest stations). Solid lines show best linear fit as follows: Top left (Intercept = -0.58 (SE = 0.022), slope = -0.08 (SE = 0.004),* R^2 *= 0.42); Top right (Intercept = -1.16 (SE = 0.015), slope = 0.02 (SE = 0.000),* R^2 *= 0.59); Bottom left (Intercept = 0.23 (SE = 0.009), slope = 0.04 (SE = 0 .001),* R^2 *= 0.46); Bottom right (Intercept = 0.49 (SE = 0.006), slope = -0.01 (SE = 0.000),* R^2 *= 0.64).*

5.4 Demand Elasticity and Competition

The first rows of Tables 8 and 9 present the distribution of demand elasticities. The tables show that there is heterogeneity in the effects of price and opening hours across stations. The estimated elasticities with respect to price and opening hours are -0.33 and 0.54, respectively at the 90th percentile. At the 25th percentile, the demand elasticities with respect to price and opening hours are -1.21 and 0.24 respectively.

I also examine how much does the degree of competition a station faces explain the variation between stations in the elasticity of demand. Figure 3

Table 10: Correlation Matrix: Demand Elasticity and Competition Measures

Variable	(1)	(2)	(3)	(4)	(5)	(6)
(1)Price elasticity	1					
(2)OH elasticity	−0.9226	1				
(3) No. of competitors	−0.6456	0.6797	1			
(4)Distance to nearest	0.7349	−0.7758	−0.4959	1		
(5)Avg. distance to 2 nearest	0.7683	−0.8056	−0.5547	0.9526	1	
(6)Avg. distance to 3 nearest	0.7684	−0.7998	−0.5781	0.9145	0.9885	1

Notes: Price elasticity: elasticity of demand with respect to price. OH elasticity: elasticity of demand with respect to opening hours. No. of competitors: number of competitors a station faces within its geographic market. Distance to nearest: distance to the nearest competitor. Avg. distance to 2 nearest: average distance to two nearest competitors. Avg. distance to 3 nearest: average distance to three nearest competitors.

shows the linear relation between demand elasticities and competition, measured by the number of competitors in a geographic market and distance to nearby competitors. Stations in more competitive areas face larger price and opening hours elasticities than stations in less competitive areas. The degree of competition a station faces, measured by the number of service providers within a station's geographic market, explains 42% of the variation in price elasticity of demand and 46% of the variation in demand elasticity with respect to opening hours. Similarly, about 59% of the variation in price elasticity of demand and 64% of the variation in opening hours elasticity of demand are explained by the degree of competition a station faces, here measured by the average distance to the three nearest competitors. The correlation coefficients between the estimated demand elasticities and my competition measures are presented in Table 10. There is a high level of correlation between the demand elasticities and the measures of competition, once again suggesting that stations in highly competitive areas (shorter distance to nearby competitors or a larger number of nearby competitors) face higher demand elasticities than those operating in less competitive areas.

5.5 Welfare Gain from Improved Geographical Accessibility

An important goal of the deregulation was to improve geographical accessibility of the inspection stations to the vehicle owners. In this section, I will quantify the welfare gain to consumers from the improvement in spatial accessibility following the deregulation. Before the elimination of the monopoly,

Table 11: Distribution of Distances to the Nearest Station

	Distance to the nearest station (Pre-deregulation, July 2010)	Distance to the nearest station (Post- deregulation, April 2017)
Mean	8.97	6.55
Median	5.34	3.12
P75	13.17	9.16
P90	21.12	16.40
Std. dev.	8.88	7.97
No. of Stations	194	452
No. of Observations	922,856	922,856

Table 12: The Effect on Consumer Surplus of Improvement in Spatial Accessibility (SEK)

	Average consumer	Median consumer
Consumer surplus	99.51	101.95

a total of 194 state owned stations were providing inspection services. After the deregulation and subsequent entrance of private firms, the number of stations increased substantially. As of April 2017, there were a total of 452 fixed stations providing services throughout the country. This has improved the car owners' proximity to the stations. Table 11 provides the distributions of distances from the locations of 922,856 car owners' homes to the locations of their nearest stations before and after the removal of the monopoly. The first column of the table shows that during the pre-deregulation period, the distance to the nearest station for the average car owner was 8.97 km. The last column of the table shows that the average car owner's distance to a nearest station decreased to 6.55 km as of April 2017. This means that the removal of the monopoly and subsequent new entries decreased the distance to the nearest station for the average car owner by 2.42 km compared to the pre-deregulation period.

Using two methods, I will quantify the welfare gain to consumers from improved spatial accessibility. This welfare analysis does not take into considerations any supply-side adjustments by the stations to the changes in travel distances. Previous findings show that car owners are willing to pay SEK 41.47 to avoid traveling one additional kilometer. The first method uses this information. Assuming that the average car owner now travels 2.42 km less distance than in the monopoly period, the consumer surplus to the average car owner increases by SEK 100.36 (= 2.42 x 41.47). In the second method, I will analyze the change in consumer welfare using the measure of compensating variation. The change in consumer surplus for individual i is given by $\Delta E(CS)_i = \frac{1}{-\alpha}\left[\ln(\sum_{j\in C_i}\exp(V_{ij}^{STQ})) - \ln(\sum_{j\in C_i}\exp(V_{ij}^{CTF}))\right]$ (Small and Harvey, 1981), where α is the coefficient on price that converts utils into monetary value, CTF represents counterfactual and STQ represents status quo. Under the status quo, I will use the distance to all stations as of April, 2017. The counterfactual uses the distances consumers would have traveled if there had been no deregulation and no new entrants. That means, had there been no deregulation and new entrants, distance to the nearest station for the average consumer would have increased by 2.42 km compared to the status quo. I will incorporate this to the model by increasing the distance from the location of each car owner to all stations in the choice set by 2.42 km. As indicated in Table 12, the estimates show that because of the deregulation and eventual improvement in spatial accessibility, consumer surplus to the average consumer increased by SEK 99.51. Both methods give almost equal size of the effect on consumer welfare of the improvement in geographical accessibility.

6 Robustness Checks Using Specification of the Choice Set

In the main analyses, individual-specific choice set was defined as consisting of the ten nearest stations to each car owner's home. Only 26,736 individuals (2.8% of the final sample) who chose a station outside of their ten nearest stations were excluded from the final sample by specifying the choice set in this way. To explore the possible impact on my parameter estimates of the specification of the choice set, I subject the results to a number of robustness checks by varying the definition of the choice set. These sensitivity analyses include estimating models in which the number of stations included in the individual's choice set varies, starting with the 13 nearest stations, and being successively reduced to 11, 8, 6, 4, and 3 (nearest) stations. Table 16 in the Appendix presents the results, which show that my main results are robust to alternative specifications of the choice sets.

7 Conclusion

This paper estimates the demand for car inspection services in the Swedish motor vehicle inspection market so as to investigate consumer preferences for station characteristics, and to evaluate the effect on consumer welfare of eliminating the state monopoly on inspection services. Using individual-level data, conditional and mixed logit demand models are estimated to understand consumer behavior in choosing an inspection station, as well as its implication for demand and competition. As with other spatially differentiated markets, the findings show that distance is an important determinant of station choice. Consumers also prefer stations that offer lower prices and longer opening hours. The demand response to price and opening hours differs between stations: where stations in highly competitive markets face higher elasticities of demand.

I also quantified the welfare gain for consumers attributable to the improvement in spatial accessibility to stations following the removal of the state monopoly on inspection services. The improvement in consumer proximity to inspection stations leads to a substantial welfare gain to consumers. The results of my paper show the importance of taking into account various improvements in product and service characteristics other than just price, in analyzing the welfare effects of market changes.

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8 Appendix

Table 13: Comparison of Station Choice Models by Gender, Age of Car, and Whether the Owner Drives a “Green” Car

Variable	All	green	non-green	male	female	age of car below median	age of car above median
Distance	-0.14261***	-0.16472***	-0.14109***	-0.13981***	-0.14860***	-0.15035***	-0.13617***
	(0.000486)	(0.001728)	(0.000506)	(0.000599)	(0.000837)	(0.000715)	(0.000669)
Distance squared	0.00045***	0.00058***	0.00044***	0.00044***	0.00048***	0.00048***	0.00042***
	(0.000005)	(0.000009)	(0.000005)	(0.000006)	(0.000008)	(0.000007)	(0.000007)
Price	-0.00324***	-0.00329***	-0.00324***	-0.00357***	-0.00258***	-0.00341***	-0.00310***
	(0.000047)	(0.000171)	(0.000049)	(0.000058)	(0.000082)	(0.000067)	(0.000067)
Opening hours	0.01257***	0.01215***	0.01257***	0.01280***	0.01199***	0.01150***	0.01357***
	(0.000281)	(0.000950)	(0.000294)	(0.000344)	(0.000489)	(0.000400)	(0.000397)
Station size	0.00051***	0.00048***	0.00051***	0.00050***	0.00053***	0.00050***	0.00051***
	(0.000002)	(0.000008)	(0.000003)	(0.000003)	(0.000004)	(0.000003)	(0.000003)
Pass rate	0.01701***	0.01435***	0.01724***	0.01651***	0.01793***	0.01862***	0.01550***
	(0.000348)	(0.001222)	(0.000364)	(0.000429)	(0.000597)	(0.000488)	(0.000499)
No. of competitors	-0.04377***	-0.03177***	-0.04490***	-0.04065***	-0.04955***	-0.03602***	-0.05239***
	(0.000898)	(0.003087)	(0.000939)	(0.001105)	(0.001546)	(0.001240)	(0.001306)
Station age	0.00036***	0.00039***	0.00036***	0.00034***	0.00039***	0.00036***	0.00036***
	(0.000003)	(0.000010)	(0.000003)	(0.000003)	(0.000005)	(0.000004)	(0.000004)
Drop-in service	0.13790***	0.18459***	0.13410***	0.12638***	0.16020***	0.19585***	0.07720***
	(0.006086)	(0.020897)	(0.006362)	(0.007501)	(0.010418)	(0.008472)	(0.008748)
Municipality	0.94359***	0.88969***	0.94704***	0.91856***	0.98970***	0.95344***	0.92721***
	(0.004822)	(0.016526)	(0.005036)	(0.005935)	(0.008281)	(0.006722)	(0.006919)
State owned	0.10936***	0.24948***	0.09690***	0.08409***	0.15948***	0.20530***	0.00962
	(0.004104)	(0.014312)	(0.004285)	(0.005045)	(0.007065)	(0.005762)	(0.005855)
BIC	2298900	185430	2113108	1528174	769480	1160847	1136563
AIC	2298746	185304	2112955	1528024	769337	1160700	1136416
Pseudo R^2	0.459	0.448	0.460	0.450	0.478	0.453	0.466
No. of obs.	9,228,560	729,250	8,499,310	6,030,730	3,197,830	4,608,190	4,620,370
No. of car owners	922,856	72,925	849,931	603,073	319,783	460,819	462,037
No. of stations	452	452	452	452	452	452	452

Notes: Conditional logit models of station choice. Robust standard errors are presented in parentheses. *** indicates significance at 1% level.

Table 14: Standard Errors for Willingness to Pay Estimates

Variable	Baseline	Green	Non-green	Male	Female	Car age below median	Car age above median
Distance	0.6084	2.4342	0.6274	0.5998	1.7335	0.8197	0.8979
Opening hours	0.1024	0.3408	0.1071	0.111	0.2376	0.1334	0.1567
Pass rate	0.1287	0.4159	0.1351	0.138	0.3113	0.1731	0.19
Station age (days)	0.0016	0.006	0.0016	0.0015	0.0047	0.0021	0.0024
Drop-in service	2.0686	7.3614	2.1539	2.2574	4.7692	2.8801	2.9552
Municipality	4.5461	15.0422	4.7505	4.5084	12.7764	5.8914	6.8874
State owned	1.4039	6.1255	1.4408	1.4959	3.5383	2.1511	1.898

Notes: Standard errors calculated using the Delta method.

Table 15: Standard Errors for Willingness to Travel Estimates

Variable	Baseline	Green	Non-green	Male	Female	Car age below median	Car age above median
Price (kr)	0.00035	0.00111	0.00037	0.00044	0.00059	0.00048	0.00052
Opening hours	0.00212	0.00624	0.00224	0.00264	0.00353	0.00285	0.00313
Pass rate	0.00261	0.00795	0.00275	0.00328	0.00429	0.00346	0.00391
Station age (days)	0.00002	0.00007	0.00002	0.00003	0.00004	0.00003	0.00003
Drop-in service	0.04551	0.1364	0.04805	0.05717	0.07485	0.06028	0.06833
Municipality	0.05315	0.15216	0.05624	0.06635	0.0885	0.0707	0.07922
State owned	0.03074	0.09497	0.03239	0.03845	0.05103	0.04136	0.04567

Notes: Standard errors calculated using the Delta method.

Table 16: Choice Models with Different Nth Nearest Stations Used to Define Choice Sets

Variable	Baseline	13 nearest	11 nearest	8 nearest	6 nearest	4 nearest	3 nearest
Distance	-0.14261***	-0.14306***	-0.14321***	-0.14125***	-0.13929***	-0.14316***	-0.14162***
	(0.000486)	(0.000458)	(0.000476)	(0.000548)	(0.000722)	(0.000824)	(0.000833)
Distance squared	0.00045***	0.00043***	0.00045***	0.00045***	0.00045***	0.00055***	0.00062***
	(0.000005)	(0.000004)	(0.000005)	(0.000007)	(0.000011)	(0.000014)	(0.000012)
Price	-0.00324***	-0.00328***	-0.00326***	-0.00320***	-0.00308***	-0.00270***	-0.00245***
	(0.000047)	(0.000046)	(0.000047)	(0.000048)	(0.000050)	(0.000056)	(0.000062)
Opening hours	0.01257***	0.01275***	0.01234***	0.01360***	0.01440***	0.01578***	0.01723***
	(0.000281)	(0.000274)	(0.000278)	(0.000295)	(0.000310)	(0.000346)	(0.000422)
Station size	0.00051***	0.00049***	0.00050***	0.00052***	0.00053***	0.00053***	0.00054***
	(0.000002)	(0.000002)	(0.000002)	(0.000003)	(0.000003)	(0.000003)	(0.000004)
Pass rate	0.01701***	0.01858***	0.01813***	0.01508***	0.01355***	0.01498***	0.01386***
	(0.000348)	(0.000339)	(0.000344)	(0.000360)	(0.000381)	(0.000421)	(0.000467)
No. of competitors	-0.04377***	-0.04274***	-0.04393***	-0.04460***	-0.04679***	-0.04394***	-0.03887***
	(0.000898)	(0.000821)	(0.000867)	(0.000973)	(0.001091)	(0.001297)	(0.001514)
Station age	0.00036***	0.00037***	0.00036***	0.00035***	0.00034***	0.00032***	0.00029***
	(0.000003)	(0.000003)	(0.000003)	(0.000003)	(0.000003)	(0.000003)	(0.000003)
Drop-in service	0.13790***	0.14476***	0.13974***	0.11739***	0.10310***	0.07906***	0.07222***
	(0.006086)	(0.006025)	(0.006066)	(0.006190)	(0.006365)	(0.006841)	(0.007526)
Municipality	0.94359***	0.96417***	0.94905***	0.92567***	0.89966***	0.83690***	0.83148***
	(0.004822)	(0.004790)	(0.004800)	(0.004906)	(0.005152)	(0.005553)	(0.006126)
State owned	0.10936***	0.11527***	0.10969***	0.10397***	0.09515***	0.07764***	0.09181***
	(0.004104)	(0.004029)	(0.004074)	(0.004219)	(0.004387)	(0.004834)	(0.005331)
BIC	2,298,900	2,481,455	2,368,185	2,117,154	1,854,308	1,420,130	1,058,059
AIC	2,298,746	2,481,297	2,368,030	2,117,003	1,854,160	1,419,987	1,057,920
Pseudo R^2	0.459	0.485	0.469	0.437	0.408	0.366	0.349
No. of obs.	9,228,560	12,201,956	10,219,594	7,236,392	5,239,854	3,232,364	2,220,252
No. of car owners	922,856	938,612	929,054	904,549	873,309	808,091	740,084
No. of stations	452	452	452	452	452	452	452

Notes: Conditional logit models of station choice. Individual specific choice sets are defined as the set of the Nth nearest stations to the car owner. The baseline model is estimated based on the set of 10 nearest stations for each individual. Robust standard errors are presented in parentheses. *** indicates significance at 1% level and ** significance at 5% level.