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Measuring Market Power in Gasoline Retailing:

A Market- or Station Phenomenon?

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Measuring Market Power in Gasoline Retailing:

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Abstract

Applying detailed consecutive daily micro data at the gasoline station level from Sweden we estimate a structural model to uncover the degree of competition in the gasoline retail market. We find that retailers do exercise market power, but despite the high upstream concentration, the market power is very limited on the downstream level. The degree of market power varies with both the distance to the nearest station and the local density of gasoline stations. A higher level of service tends to raise a seller's market power; self-service stations have close to no market power. Contractual form and brand identity also seem to matter. We find a clear result: local station characteristics significantly affect the degree of market power. Our results indicate that local differences in station characteristics can more than offset the average market power found for the whole market.

Keywords: Gasoline markets, market power, markup estimation, local market competition

JEL Codes: D22, L13, L25, L81

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"*…the stations' gross margins naturally vary over time and depend on the local competition pressure.*"

Swedish Competition Authority (2013, p.128)

1. Introduction

The same pattern is present in most countries: Gasoline markets are highly concentrated upstream, consisting of tight oligopolies, but often with a dispersed downstream retail market where the individual gasoline stations are operated through various vertical contract arrangements. One important question raised is whether upstream market concentration restricts the level of competition downstream. The market structure has motivated much attention from both regulators and researchers, where pricing strategies and competition are studied.[1] Local competition, brand identity and contractual arrangements are all factors that the literature has pointed to in the understanding of the competitive pressure in this market.

We study the competitive situation in the gasoline retail sector, scrutinizing in particular the impact of local market conditions and station characteristics on stations' competitive grounds. Specifically, in this paper we do the following. First, having access to detailed daily micro data at the station level, both on price and quantity, we estimate a structural model to uncover the degree of competition. Hence, we overcome one substantial limitation of previous studies, which, while endowed with rich price measures, often have to settle for aggregated quantity measures (see e.g. Noel, 2016 for a survey). In contrast, our volume and price data share the same frequency. Second, utilizing detailed knowledge on each station's (i) brand identity and contractual arrangements, (ii) station amenities and (iii) local competition factors, we extend the model to analyze how these factors impact the competition level. We are thus able to address a relatively large but yet non-conclusive empirical literature on how competition in gasoline retailing relates to local station characteristics. Whereas most of the previous literature typically focuses on either one or two of these factors, we look at all three issues in this paper.[2]

[1] For examples of government initiated studies, see for instance ACCC (2007) for the Australian market, the Irish CA (2003) for the Irish market and the Norwegian CA (2014) for the Norwegian market.

[2] Examples on *local competition* studies include Alderighi and Baudino (2015), Firgo et al. (2015), Hosken et al. (2008), Barron et al. (2004), Barron et al. (2007), Cooper and Jones (2007) and Clemenz and Gugler (2006). Examples on *station amenities* studies include Haucap et al. (2017), Hosken (2008) and Eckert and West (2005). Examples on *brand identity and contractual forms* studies include Verlinda (2008), Cooper and Jones (2007), Hastings (2004), and Slade (1987).

We analyze the Swedish market, which shares features with most concentrated national gasoline markets. At the upstream level, the market consists of four major companies having 99% of the market during the sample period. As in many other countries, antitrust concerns have been raised on several occasions. In 2005, the Swedish Market Court found the major oil companies guilty of illegal cooperation. They were sentenced for, among other things, coordinated rebate reductions, internal agreements not to compete for customers among themselves, and agreements on increasing the retail price (Swedish Market Court, 2005). As a result, the companies paid 112 million SEK in fines. Between 2007 and 2010, the market went through four major mergers, thereby increasing concentration further. Later, in 2012, due to worries on the potential lack of competition, the Swedish government required the Swedish Competition Authority (SCA) to initiate studies of the market structure in the industry.[3]

We estimate a structural model of demand and supply at the retail level using the method suggested by Bresnahan (1982) and Lau (1982). Endowed with a panel of daily quantity and price data at the station level for a whole consecutive year (2012), together with detailed information on the competitive situation, including distance to competitors, number of stations, ownership and contractual status, station amenities and demography on local markets, we provide estimates of the degree of market power. The richness of the data, consisting of daily price and quantity measures for 180 sample stations, allows us to introduce structure into the model. [4] For the majority of previous literature, detailed volume data have been unavailable (as far as we are aware, exceptions are Slade, 1987 and Wang, 2009), restricting research to mainly study reduced form models using aggregate data. Others have employed proxies of quantity (e.g., Lewis, 2011), which are exposed to measurement errors. The gasoline market is divided into several local markets due to geographical restrictions; applying aggregate data might lead to imprecise insights into the local competition conditions. As such, we are in a favorable position to study the problem at hand. We get around both limitations in terms of measurement errors and aggregation biases, and, combined with information on local market characteristics and station amenities, we establish a yet unexplored channel of insights into a highly explored market.

[3] As a result, the SCA initiated two studies of the competitive structure of the Swedish retail market, see Foros and Steen (2013) and Ganslandt and Rönnholm (2014).

[4] Our data originate from an analysis performed by Foros and Steen (2013) initiated by the SCA. To obtain sufficient micro information at the station level 180 stations were picked for the calendar year 2012. The data were collected by the NCA, and stations were chosen to be representative for the whole of the Swedish market. For instance, the analysis covered all companies for different regional areas in Sweden in terms of urban and regional status as well as various city sizes. In our sample the highway market is also included as a separate group.

Our demand estimates suggest an inelastic gasoline demand at the market level (significant negative elasticity of 0.72), which is in line with several other studies. The Bresnahan-Lau approach requires adding interaction terms between exogenous demand side variables and the retail price in the demand specification. Changes in these variables both shift and pivot the demand curve, hence the degree of market power is identified through these terms. Therefore, a critical requirement for this identification process to work empirically is that the exogenous demand variables chosen enter the demand equation in a well-behaved fashion. We use local income, local population and supply of public transportation in the region in these price interactions. They all come in significant, and produce reasonable and significant elasticities. The income elasticity suggests a normal good (elasticity=1.12) and an increased supply of public transportation reduces demand (elasticity=-0.44), suggesting substitutability, both elasticities also being significant. The interaction term with local population size is significant, and the elasticity suggests a marginal positive demand effect of 0.01, though not significant.

Using the information from the demand estimates we identify market power through the estimated supply relations. We find that retailers do exercise some (significant) market power in the Swedish market, but despite the high upstream concentration, the market power is very limited on the downstream level. This result is in line with what others have found using much more aggregated data (Houde, 2012; Manuszak, 2009).

Despite the very modest findings of market power, the competitive level varies significantly with local retail station characteristics. First, we estimate separate models where we control for the different characteristics in turn. When it comes to *local competition*, we show that the degree of market power varies with both the distance to the nearest gasoline station and with the local density of stations. A station with no competitors within a distance of 5 km or more, as compared to a station with the nearest competitor very close by (like 20 meters) has twice as high markup as the average station. High station density within a radius of 3 km also lowers market power. Gasoline station *amenities* are a potential source to differences in market power, as a higher level of service tends to raise a seller’s market power. In particular, we find that self-service stations have close to no market power. Finally, *contractual form and brand identity* seem to matter, too. However, we are not able to distinguish the effects fully in the sense that the only brand in our data which operates commissioned gasoline stations (and only such stations) also has a significantly higher markup than the other brands which predominantly have fully vertically integrated gasoline stations.

When controlling for all three characteristics (local competition, amenities and brand/contractual form) in the same models simultaneously, our results generally indicate higher market power. Further, we find similar effects for the three groups of retail station characteristics as we do when estimating them separately. Indeed, there is one clear result: local station characteristics significantly affect the degree of market power for the local gasoline station.

To illustrate our results, we construct estimates for two stations with different local competitive characteristics. We show that differences in local station characteristics, even within the scope of the variation in our sample, have a large effect on local market power. The magnitude in these local differences implies that in some local markets, the station will be able to extract market power. In other markets, local competition factors will remove this possibility.

Hence, we both establish the effects of local station characteristics on market power and show that these differences can more than offset the average market power found in the baseline model where we do not account directly for these effects on the estimated markup.

The rest of the paper proceeds as follows. In Section 2 we discuss the literature on measurement of market power and provide an overview of the most common sources of market power in gasoline retailing. Section 3 presents the structural Bresnahan-Lau model, while Section 4 decribes the data and the industry. Section 5 presents the empirical specification of the Bresnahan-Lau model. The results are discussed in Section 6. Finally, Section 7 concludes.

2. Literature review

2.1 Measuring market power in gasoline retailing

Previous literature suggests several factors that might impact local price competition in retail gasoline markets. These are mainly demographics, station amenities, contractual forms, and station location and density. The majority of empirical studies look at the retail price as a function of independent determinants and derive the potential effects on competition from these results. Data from several different countries, e.g. the US, Canada, Australia and European countries, are used. Our approach is to estimate the market power parameter directly by applying the oligopoly model by Bresnahan (1982) and Lau (1982). To the best of our knowledge, few papers estimate the degree of market power explicitly, and no study has yet used the Bresnahan-Lau method in examining gasoline retailing.[5]

[5] See Bresnahan (1989) for a discussion of this model. Several studies have applied this methodology in various disguises on several industries. For some of these see, for *consumer credit*: Toolsema (2002), for *banking*: Gruben

Further, as already emphasized, our price and quantity data are of daily frequency, at the station level and consecutive for a whole year, allowing us to obtain precise estimation of structural demand and supply models. Even though high-frequency price data are available in most retail markets, quantity data at the station level have so far been rare in the literature of gasoline retailing. As far as we are aware, the only exceptions are Slade (1987) and Wang (2009).

A few papers estimate structural models of supply and demand in order to evaluate the degree of market power. Slade (1987) estimates demand, cost and reaction functions at the station level for the sake of modeling a repeated game approach to competition between stations. Using data on daily price, volume and cost figures from stations in Vancouver, Canada, she finds that the actual outcome is less profitable than the cooperative solution while more profitable than the non-cooperative solution, suggesting that sellers in this market exercise some market power.

Houde (2012) considers stations close to the same commuter route as substitute stations as perceived by consumers. Estimating a model of spatial competition using bi-monthly station level data as well as data on road network structure for Quebec, Canada, he finds low markups and hence concludes that the degree of market power is low. With the use of monthly volume, price and station characteristics data from Hawaii, USA, Manuszak (2009) estimate a discrete choice model of demand and supply models for both the upstream- and the downstream market, and finds that the downstream market power is low.

In addition, many studies relate the degree of market power of retailers to how retail prices and margins respond to changes in input prices. For instance, Borenstein and Shepard (1996) examine price patterns that are consistent with models of tacit collusion and find that retail margins are higher when the wholesale price is anticipated to fall as predicted by these models. Further, Borenstein et al. (1997) and Deltas (2008) relate asymmetric response of retail prices to wholesale price changes to market power of retailers by estimating lag adjustment models.

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and McComb (2003), Shaffer (2002;1993) Suominen (1994), for *petroleum*: Considine (2001), for *cement*: Rosenbaum and Sukharomana (2001), for *cigarettes*: Delipalla and O'Donnel (2001), for *beef processing*: Muth and Wohlgenant (1999); for *salmon*: Steen and Salvanes (1999); for *sugar*: Genesove and Mullin (1998); for *advertising*: Jung and Seldon (1995), for *lumber*: Bernstein (1994), for *coconut oil*: Buschena and Perloff (1991) and for *electricity:* Puller (2007) and Graf and Wozabal (2013).

2.2 Sources of market power in gasoline retailing

Local competition

When it comes to local competition, studies have found ambiguous relations between station density and price. On the one hand, Barron et al. (2004), Barron and Waddel (2007) and Clemenz and Gugler (2006) show that higher station density tends to lower average prices, suggesting that a higher number of sellers raises local competition. This is in line with our findings, which propose that a seller's market power decreases in the number of neighbour stations. Similarly, Alderighi and Baudino (2015) suggest that stations' prices rely on neighbour stations' prices within around 1km. On the other hand, Hosken et al. (2008) find no relation. However, they show that price tends to increase with the distance to the closest station. Comparable results are found by Cooper and Jones (2007). We cannot directly relate our findings to these, as we do not examine the effect on price explicitly. Nonetheless, we show that a seller's market power parameter tends to increase with the distance to the closest competitor and decrease with station density. Firgo et al. (2015) suggest that sellers who have a central location in a market relative to their competitors in a market have a stronger influence on pricing decisions of competitors and on the equilibrium market price.

Station amenities

Regarding the impact of station amenities on prices and competition, previous studies provide mixed results. Eckert and West (2005) find that local market structure and station characteristics affect sellers' (uniform) price setting and suggest the presence of imperfect competition. Haucap et al. (2017) document that prices are positively related to station service levels. In contrast, Hosken et al. (2008) find no impact of station amenities.

Brand identity and contractual forms

Turning to the effect of contractual forms and brand identity, Eckert and West (2005) show that major brand stations with supplier control are more likely to set the market mode price, suggesting that the presence of vertically integrated major brand stations might increase incentives to tacitly collude. Cooper and Jones (2007) document that interbrand competition is more intensive than intrabrand competition. Hastings (2004) finds that the presence of independent retailers serves to decrease prices due to higher local price competition, while Verlinda (2008) finds that brand identity impacts how sellers respond to cost shocks, suggesting that asymmetric price responses may be explained by local market power.

3. The Bresnahan-Lau model

We make use of the Bresnahan-Lau model, after Bresnahan (1982) and Lau (1982). By simultaneous estimation of market demand and a cost relation, a parameter referring to the level of competition in the market is identifiable.

Market demand is described by the function

$$Q = D(P, Z; \alpha) + \epsilon \tag{1}$$

where Q is aggregate quantity, P is price, Z is a vector of exogenous demand side variables, α a vector of parameters which are to be estimated and ϵ the error term.

Under the assumption that sellers are profit maximizing, the structure of the supply side depends on whether sellers are price-takers or not. Under perfect competition, the first-order condition of the profit maximization problem leads to price equal to marginal cost $c(\cdot)$, which can be written as

$$P = c(Q, W; \beta) + \eta \tag{2}$$

where W is a vector of exogenous supply side variables, β a vector of supply side parameters and η the error term. However, if sellers are not price takers, perceived marginal revenue is set equal to marginal cost. The price relation is then[6]

$$P = c(Q, W; \beta) - \lambda h(Q, Z;\ \alpha) + \eta. \tag{3}$$

$h(\cdot)$ is defined as

$$h(\cdot) = \frac{\partial D^{-1}(Q, Z; \alpha)}{\partial Q} Q. \tag{4}$$

Hence, $P + h(\cdot)$ is industry marginal revenue while $P + \lambda h(\cdot)$ is the seller's perceived marginal revenue. λ can be interpreted as the industry average conjectural variation elasticity, where firm i's conjectural variation elasticity is (Dickson, 1981);

$$\lambda_i = \frac{\partial Q / Q}{\partial q_i / q_i} = \frac{\partial Q}{\partial q_i} \frac{q_i}{Q}. \tag{5}$$

That is, λ_i measures firm i's anticipated change in the output of all remaining firms following a change in its own output. Likewise, λ measures the industry's average level of competition

[6] Profit maximization at the industry level is (simplified by omitting vectors of explanatory variables and parameters) $Max_Q\ \Pi = QD^{-1}(Q) - C(Q)$, where $D^{-1}(Q)$ is the inverse demand function and $C(Q)$ the cost function. Solving for P from the first-order condition yields $P = (\partial C(Q)/\partial Q) - (\partial D^{-1}(Q)/\partial Q)Q$. The average fraction of a firm's industry profits is λ, hence $P = (\partial C(Q)/\partial Q) - \lambda(\partial D^{-1}(Q)/\partial Q)Q$, which is equivalent to Eq. (3) where $c(\cdot) = \partial C(Q)/\partial Q$ and $h(\cdot) = (\partial D^{-1}(Q)/\partial Q)Q$.

and lies in the range [0,1] if it is to be given meaningful economic translation. $\lambda = 0$ thus implies perfect competition, $\lambda = 1$ implies a perfect cartel, while intermediate values refer to various sorts of oligopoly regimes.

Bresnahan (1982) and Lau (1982) show that by interacting exogenous demand side variables Z with P in the demand specification, changes in these variables both shift and pivot the demand curve such that λ can be econometrically identified. Formally, assuming that both the demand function and the marginal cost function are linear, the latter of which is given by $c(\cdot) = \beta_0 + \beta_1 Q + \beta_2 W$, the simultaneous equation system consisting of the demand and supply relation is[7]

$$Q = \alpha_0 + \alpha_1 P + \alpha_2 Z + \alpha_3 PZ + \epsilon \tag{6}$$

$$P = \beta_0 - \lambda \left[\frac{Q}{\alpha_1 + \alpha_3 Z} \right] + \beta_1 Q + \beta_2 W + \eta. \tag{7}$$

By first estimating Eq. (6) of the equation system, α_1 and α_3 can be treated as known parameters. In Eq. (7), there are two included endogenous variables, Q and $Q^* = Q/(\alpha_1 + \alpha_3 Z)$, and two excluded exogenous variables, Z and PZ. The term $\alpha_3 Z$ allows separation between Q and $Q^* = Q/(\alpha_1 + \alpha_3 Z)$ and hence identification of λ. If PZ is omitted in Eq. (6), $Q^* = Q/\alpha_1$. Then, we would have two structural parameters λ and β_1, but only one estimate based on the coefficient of Q. The supply relation is still identified, but we would not know whether we have to do with the case of $P = c(\cdot)$ or $MR = c(\cdot)$. Hence, inclusion of the interaction term PZ is crucial for identification of the level of competition in the market.

The Bresnahan-Lau model along with other conjectural variation (CV) models received critique in the late nineties for being atheoretical, in particular from Corts (1999). His argument is that inference regarding the extent of market power cannot be made without specifying underlying behavior. More specifically, he argues that the mapping between equilibrium variation and the equilibrium value of the elasticity-adjusted price cost margin is not valid, unless average and marginal responses of margins to demand shifters are the same. However, at the same time Genesove and Mullin (1998) assessed actual, as opposed to potential, bias in CV models as predicted by Corts, using data on observed costs and margins in the sugar refining industry. The sugar refining industry's very simple fixed coefficient technology serves as an

[7] Note that the inverse demand function is $D^{-1}(Q) = (Q - \alpha_0 - \alpha_2 Z)/(\alpha_1 + \alpha_3 Z)$. Hence, $h(\cdot) = Q(\partial D^{-1}(Q, Z; \alpha)/\partial Q) = Q(1/(\alpha_1 + \alpha_3 Z))$. Marginal revenues are $MR = (\partial(Q \times P)/\partial Q) = P + h(\cdot) = P + Q/(\alpha_1 + \alpha_3 Z)$. If there is monopoly pricing, the equilibrium condition is $c(\cdot) = MR$, and solving for P we obtain $P = \beta_0 - (Q/(\alpha_1 + \alpha_3 Z)) + \beta_1 Q + \beta_2 W$. It follows that the econometric specification for supply is $P = \beta_0 - \lambda(Q/(\alpha_1 + \alpha_3 Z)) + \beta_1 Q + \beta_2 W + \eta$ (or, alternatively, $P = \beta_0 + \lambda(-Q/(\alpha_1 + \alpha_3 Z)) + \beta_1 Q + \beta_2 W + \eta$).

objective benchmark to the estimated models. They find that estimated and actual cost margins are quite close, and the potential bias as suggested by Corts very small, if even existing, which they argue favors the atheoretical CV model. They directly address Corts' argument (p.369): "*The proper test of a methodology is not the correctness of its assumptions, however, but its success or failure in doing what it is meant to do. So while acknowledging the failure of an assumption to hold, we examine how well the methodology does in reproducing the full-information estimates of conduct and cost*". In a very recent study discussing among other things the CV models, Aquirregabiria and Slade (2017) also conclude accordingly. The Bresnahan-Lau and Genesove- Mullin conduct approach is thus still valid as an empirical way of measuring market power. It was recently applied in an empirical study of pass-through, where Weyl and Fabinger (2013) postulate a model where the elasticity-adjusted Lerner index is set equal to a conduct parameter in the fashion of Bresnahan (1989) and Genesove and Mullin (1998).

4. Overview of industry and data

4.1 Industry characteristics

During the sample period, there are four major companies in the Swedish market; Statoil Fuel & Retail AB (operating the brands Statoil and Jet), St1 Energy AB (operating the brands St1 and Shell), OK-Q8 AB and Preem AB.[8] These four companies run 2 416 of 2 716 retail stations (Ganslandt and Rönnholm, 2014). Statoil Fuel & Retail AB has a market share in volume of gasoline of 34.9%, St1 Energy AB of 22.6%, OK-Q8 of 27.9% and Preem AB of 14.2% (SPBI, 2013). In total, the four majors have a market share of over 99%, and the Herfindahl index of the industry is 2 173, suggesting that the market is concentrated.[9] The majority of retail stations are vertically integrated in the sense that the upstream company owns the stations and is responsible for running them. The rest of the stations are either commissioned agent stations, franchise stations or dealer owned stations.[10]

[8] Of these brands, Jet and St1 only operate self-serviced retail stations.
[9] Typically, the other stations are small. As opposed to the 99.6% market share in volumes, the four firms have more than ten percentage points fewer stations (89%).
[10] In gasoline retailing, the most common contract types are (i) company-owned contracts, which correspond to full vertical integration, (ii) franchising contracts which assign some control to the upstream firm, and (iii) open-dealer contracts at the other end, corresponding to full vertical separation (Shepard, 1993).

Market power is a highly relevant issue in this industry, hence assessing the degree of competition in the market is important. This is underlined both by the vast existing general literature on the topic, and, more specifically, by a high focus on the part of the regulators on competition challenges in the Swedish gasoline market. In 2005 the Swedish Market Court found the major oil companies were found of illegal cooperation during the year 1999. They were penalized for, among other things, coordinated rebate reductions in order to sort customers into different groups, internal agreements not to compete for customers among themselves, and agreements on increasing the retail price (Swedish Market Court, 2005). Common for these actions was their potential to soften competition. In total, the companies paid 112 million SEK in fines.[11] At that time, there were six major companies operating; OK-Q8 (market share 26.20%), Statoil (24.0%), Shell (16.70%), Hydro (11.9%), Preem (10.90%) and Jet (8.3%) (Foros and Steen, 2013). This corresponds to a Herfindahl index of 1 874, which is lower than the 2012 level. The growth in concentration is mainly due to four major mergers taking place between 2007 and 2010.[12] This also led to steadily increasing gross margins over the period by around 30%.[13] Later, in 2012, and partly due to this development and worries about the potential lack of competition, the SCA was required by the government to initiate studies of the market structure in this market.[14]

4.2 Data

The data period is 1 January 2012 to 31 December 2012 and the sample consists of 180 stations. Sample stations are from four different geographical regions. These are «larger cities» (Stockholm, Gothenburg and Malmo, the respective first, second, and third largest cities in Sweden), «smaller cities» (cities with population of between 33 000 and 80 000), «E6 highway»[15] and «rural areas» (population below 10 000). Regions can be subdivided into counties and municipalities.[16] An overview of station and municipality distribution for the sample is provided in Table 1.

[11] In 2005, one US dollar was worth between 6.8 and 7.6 SEK.

[12] In 2007, Statoil acquired Norsk Hydro, in 2008 Statoil acquired Jet from Conoco Phillips, in 2009 St1 acquired 158 automat stations from Statoil, and in 2010 St1 bought Shell (Ganslandt and Rönnholm, 2014).

[13] See report by the Swedish Competition Authorities (2013), in particular Figure 3.11, p 123.

[14] As a result, the Swedish CA initiated two studies of the competitive structure of the Swedish gasoline retail market, see Foros and Steen (2013) and Ganslandt and Rönnholm (2014).

[15] E6 is a part of the international E-road network. We consider it a separate geographical region as customers who frequent stations along the highway mostly are busy highway commuters. Further, it is likely that demand around highways is more variable in relation to weekends and holidays.

[16] Sweden is divided into 21 counties and 290 municipalities. Some counties are represented in several of the geographical regions because the E6 highway is located near several larger and smaller cities. Our sample consists of observations from 14 distinct counties.

Table 1: Station and municipality distribution across geographical regions.

Region	Number of stations	Number of municipalities
Larger cities	81	8
Smaller cities	32	6
E6 highway	26	9
Rural areas	41	28
Total	180	51

Information on station characteristics and facilities includes the distance to the nearest, second nearest and third nearest competitor, as well as which company a station belongs to. These data are obtained from the firms through the SCA. From the information on distance to the nearest competitors, we compute the number of stations within three km from each seller, which we use as a measure of station density. Further, a carwash indicator and a self-service indicator are obtained from the petroleum companies' websites.[17]

Table 2: Overview of data definition and sources.

Data definition	Variable name	Level	Frequency	Source
95 octane gasoline retail price per liter	*P*	Station	Daily	SCA
Volume in liters sold of 95 octane gasoline	*Q*	Station	Daily	SCA
Rotterdam wholesale price per liter (Platts)	Wholesale price	Industry	Daily	SCA
Brand	Brand	Station	Yearly	SCA
Distance to nearest competitor in kilometers	Distance to competitor	Station	Yearly	SCA
Number of stations within 3 km radius	Station density	Station	Yearly	SCA
Average disposable income in 1000 SEK	*Y*	Municipality	Yearly	Statistics Sweden
Population number in 1000	Population	Municipality	Quarterly	Regional Facts
Supply of public transportation in 1000 kilometers per capita	Public transportation	County	Yearly	STA

We assemble data on demographics from 'Regional Facts', data on average disposable income[18] from Statistics Sweden, and data on public transportation[19] from the Swedish

[17] Some facility information is accessed in 2017. Hence, we implicitly assume that these facilities are the same in 2017 as in 2012.
[18]Disposable income is measured as the sum of all tax deductible and non-tax deductible income subtracted taxes and other negative transfers.
[19] The supply of public transportation measured in kilometers is the sum of kilometers driven by buses, trains, trams and lightrails.

Transport Analysis (STA) based on the stations' location, using their addresses. These data are either at the municipality or the county level and are either quarterly or yearly data. A complete overview of data and sources as presented in Table 2.

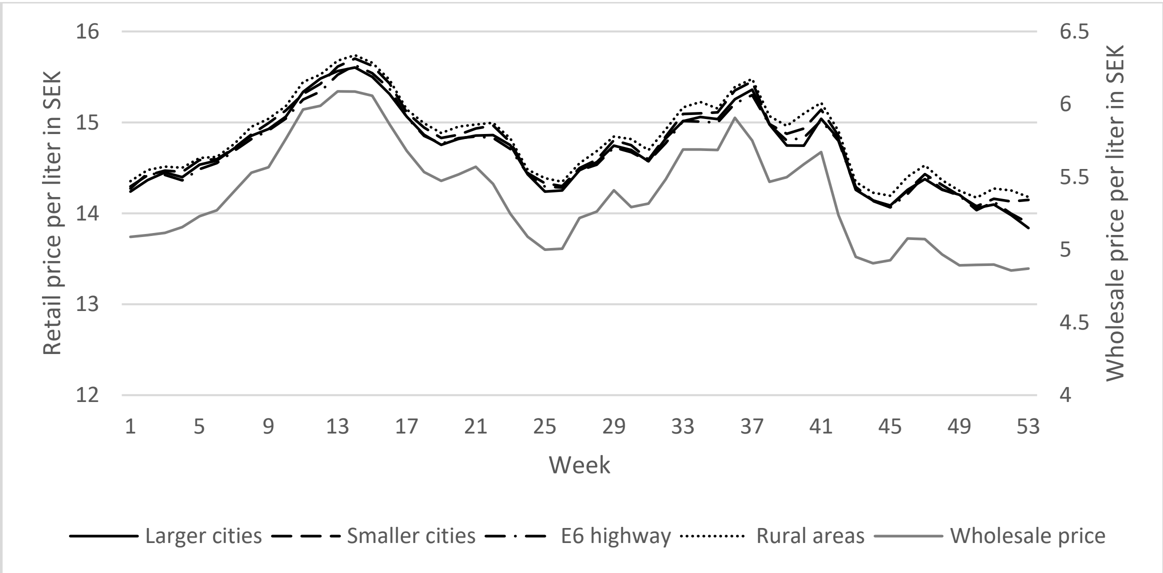

Figure 1: Average weekly retail price for each geographical region (left axis) and wholesale price (right axis). Sample period is 1 January 2012 to 31 December 2012.

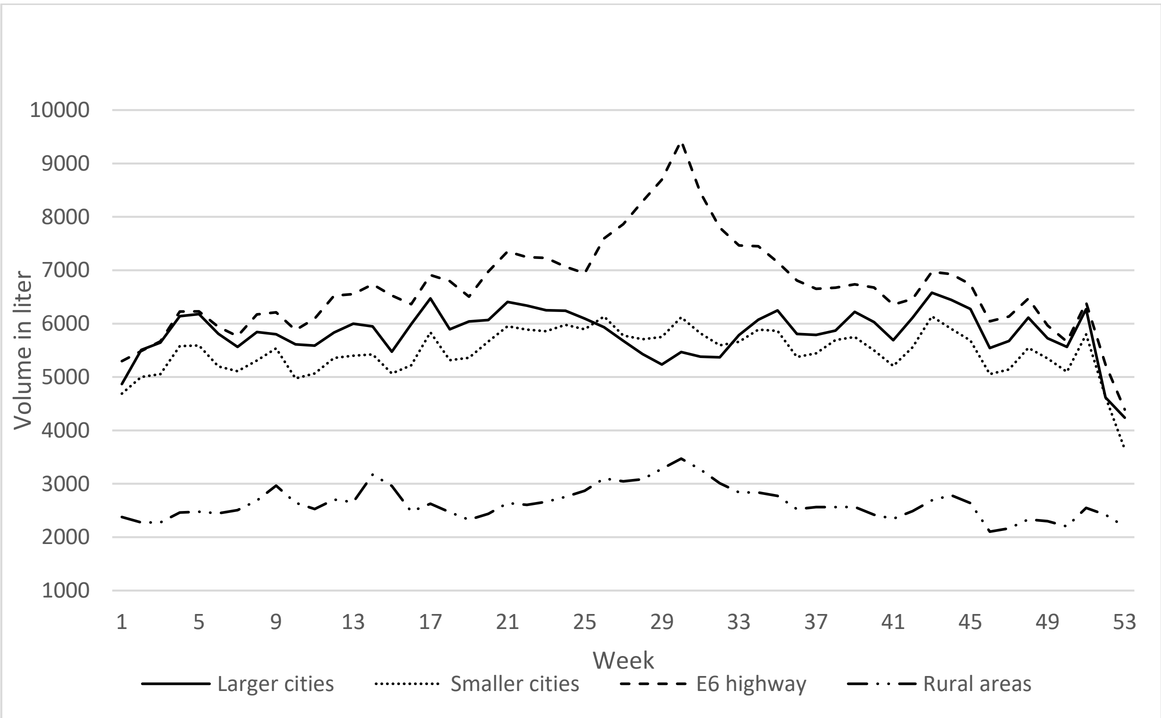

Figure 2: Average weekly quantity sold at the station level in different geographical regions. Sample period is 1 January 2012 to 31 December 2012.

Figure 1 depicts the retail price averaged over stations within each geographical region. Prices across regions are quite similar, but, rural areas have slightly higher prices than other regions in most parts of the sample period. Prices are highest during the spring and autumn months, and fluctuations seem to follow those observed in the wholesale price. On the other hand, as shown in Figure 2, the average quantity sold for stations varies more across regions as compared to prices. Average quantity sold per station is highest in the cities and the E6 highway, while lowest in rural areas. Volumes resemble the population in these areas, as more inhabitants naturally lead to higher consumption of fuel. The E6 highway is one of the main commuting highways in Sweden, which explains the high average volume sold in this region. Further, the summer holiday season stands out for the E6 highway with an upward peak in the volume sold in the summer months (July and August) due to increased traffic. Descriptive statistics of the main variables are presented in Table 3.

Table 3: Statistical properties of main variables (number of stations *n*=180).

Variable name	Mean	St.dev.	Min	Max
P	14.755	0.473	13.300	15.950
Q	5190.336	3775.662	11.000	29833.630
Wholesale price	5.394	0.358	4.800	6.151
Y	384.522	58.941	295.700	616.700
Public transportation	81.407	18.257	31.707	114.630
Population	244.058	277.776	3.196	881.235
Number of stations	49.951	33.322	4	122
Distance to competitor	1.819	3.731	0.020	30
Station density	2.396	1.416	0	4
Carwash	0.307	0.461	0	1
Self-service	0.364	0.481	0	1
Vertically integrated	0.761	0.426	0	1
Commissioned agent	0.205	0.403	0	1
Franchise	0.011	0.106	0	1
Independent	0.023	0.149	0	1

5. Empirical specification of the Bresnahan Lau model

The first equation in our simultaneous equation system is the demand function

$$Q_{it} = \alpha_0 + \alpha_1 P_{it} + \boldsymbol{z}'\boldsymbol{\alpha}_{\boldsymbol{z}} + P_{it}\boldsymbol{z}'\boldsymbol{\alpha}_{\boldsymbol{Pz}} + \boldsymbol{x}'\boldsymbol{\alpha}_{\boldsymbol{x}} + \epsilon_{it}, \tag{8}$$

where i indexes station and t indexes day of the week. Q_{it} is the daily volume sold in liters and P_{it} is the price per liter at station i at time t. $\boldsymbol{z}$ is a $K \times 1$ column vector of exogenous variables consisting of average disposable income, average disposable income squared and the population in the municipality. Furthermore, the number of 1000 kilometers driven by public transportation per capita is included in the $\boldsymbol{z}$. By including an income variable, we take the income effect into account, while inclusion of a public transportation measure allows for a substitution effect. The size of the population obviously impacts the quantity demanded as it serves as a measure market size and is hence a potential determinant of fuel consumption. In the theory section we showed that the inclusion of interactions between variables in $\boldsymbol{z}$ and P_{it} are crucial for the identification of the supply side equation. Thus, there are four interaction terms included in our demand model.

We also include additional exogenous variables which do not interact with P_{it} in the $K \times 1$ column vector $\boldsymbol{x}$, consisting of the number of stations in the regional county, distance to the nearest competitor and a dummy for whether station i is self-serviced or not. In addition, $\boldsymbol{x}$ includes a full set of day-of-the-week dummy variables using Monday as baseline, a full set of month dummy variables using January as baseline, and a full set of region dummy variables (Foros and Steen, 2013). We include three regional dummy variables, one for smaller cities, one for rural areas and one for E6 highway stations. The larger cities serve as reference category. A complete overview of variable definitions, data source, granularity and frequency is presented in Section 4. Finally, ϵ_{it} is the idiosyncratic error term representing unobserved factors which have an impact on the quantity demanded on each station.

The supply specification is

$$P_{it} = \beta_0 + \lambda Q_{it}^* + \beta_1 Q_{it} + \boldsymbol{w}'\boldsymbol{\beta}_{\boldsymbol{w}} + \eta_{it}, \tag{9}$$

where $Q_{it}^* = -Q_{it}/(\alpha_1 + \boldsymbol{z}'\boldsymbol{\alpha}_{\boldsymbol{Pz}})$. $\boldsymbol{w}$ is a $K \times 1$ column vector of exogenous supply side variables consisting of the daily wholesale price, a dummy for whether station i offers carwash or not, a dummy for whether station i is self-serviced or not, a full set of month dummy variables, a full set of region dummy variables, contractual form dummies and a full set of brand dummy variables.[20] η_{it} is the idiosyncratic error term which represents unobserved differences in sellers' marginal costs while Q_{it} is the actual quantity sold at station i on day t.[21]

A fundamental endogeneity problem arises as quantity demanded affects the price sellers set, while price setting also affects the quantity demanded by consumers. Hence, the two variables of interest are simultaneously determined within the model, causing P_{it} to be correlated with ϵ_{it} in Eq. (8) and, likewise, Q_{it} to be correlated with η_{it} in Eq. (9). To correct

[20] The variables included in $\boldsymbol{w}$ have an impact on a seller's marginal costs. Consequently, by using P_{it} as the left hand side variable we can estimate the supply relation without knowing marginal costs.

[21] In order to estimate the equations and impose market clearing, we assume that prices clear the market, allowing us to treat Q_{it} as the equilibrium quantity. We believe this is a reasonable assumption to make since the Swedish retail market is not under governmental regulation neither at the demand, nor the supply side during the sample period.

for the biases, we apply two stage least squares (2SLS). We use the wholesale price as an instrumental variable for P_{it} in the demand equation. In the supply relation, the variables included in $\boldsymbol{z}$ are used as instrumental variables for Q_{it}.

We use the wholesale price as an instrument for P_{it} because the wholesale price is the main input cost for gasoline and is hence a valid instrument.[22] Further, there is no obvious direct relationship between the cost of input factors and the quantity demanded in the retail market, implying that the wholesale price is uncorrelated with ϵ_{it}. This instrument thus generates exogenous variation related to P_{it} which we can take advantage of when estimating the impact of the retail price on quantity demanded. Q_{it} is instrumented by the $\boldsymbol{z}$ variables; namely the average disposable income, the average disposable income squared, the size of the local population and the regional supply of public transportation. These variables are all good candidates as they directly influence gasoline consumption through a positive income or negative substitution effect, and through the fact that an increase in the population increases the demand for cars and fuel. However, they have no clear partial effect on the retail price or factors determining sellers' marginal costs, therefore being uncorrelated with η_{it}.

Data differ in various dimensions. The main variables *Q* and *P* vary from day to day and between stations. *Wholesale price* varies from day to day. Station characteristics are fixed over time, but have significant variation across stations. The remaining independent variables vary across either municipality or county, but are fixed over time.[23] In order to use all within and between variation across different dimensions, we use pooled OLS as an estimation method (Baltagi and Griffin, 1983). First, we estimate Eq. (8) using two-stage least squares in order to find the best linear combination of instrumental variables. Next, we use the estimated parameters from Eq. (8) to calculate Q^*. Finally, we estimate Eq. (9), again using two-stage least squares.

[22] Swedish oil companies are price takers in the European gasoline market. The correlation between the instrument and the endogenous variable is as high as 0.881.
[23] One exception is *population*, which is quarterly numbers.

6. Empirical results

6.1 Market power in the Swedish retail gasoline market

Demand

Results for the demand equation (8) together with elasticities are presented in Table 4.[24] Due to the interaction terms, parameter values and corresponding signs give little direct intuition. As such, elasticities are a better measure in order to gain intuition.

The average price elasticity is estimated to be -0.72 and is significant, implying that gasoline demand is downward sloping and inelastic to responses in fuel price. The income elasticity is positive, significant and slightly larger than one (1.11), meaning that gasoline is a normal good.[25] Results are within the range of elasticities found in other demand studies.[26] Further, as ε_Y is higher than ε_P, holding all other factors fixed, the demand for gasoline will increase for proportional increases in income and price.

The elasticity of public transportation proposes that better access to public transportation lowers the gasoline demand with a negative significant elasticity of -0.44. Hence, public transportation is a substitute for car travel, although not a perfect one. The population elasticity is marginally positive, though not significant. Being careful in interpreting a low insignificant number, this still suggests that the number of licensed drivers rises with population, which in turn increases the gasoline consumption. Contrary to expectations, although elasticities are small, the effect of the *number of stations* is positive, while the effect of the *distance to competitor* is negative. Larger markets typically have more stations, which suggests higher market demand. Likewise, in a dense market, the distance to the closest competitor is lower than in less dense markets, where the distance between outlets is larger. This we attribute to our control for market size, which is defined at the regional level, and thus very likely too wide to fully account for all cross-market differences. The local market effects instead turn out through our elasticities for distance to competitors and number of stations.

[24] Consider the simplified demand equation; $Q = \alpha_0 + \alpha_1 P + \alpha_z Z + \alpha_{PZ} PZ$. Then, the elasticity of Z is given by $\epsilon_Z = (\alpha_Z + \alpha_{PZ} P)(Z/Q)$, where we use sample means of P, Z and Q.

[25] When testing the hypothesis H_0: ε_Y=1, we reject the hypothesis at the 1% level. Thus, the income elasticity is significantly higher than 1.

[26] See e.g. the survey by Basso and Oum (2007), as well as Johansson and Schipper (1997) and Baltagi and Griffin (1983) for OECD-countries and Yatchew and No (2001) for Canada.

Table 4: 2SLS estimation results of Eq. (8) and corresponding elasticities.

Variable	Coefficient
P	127,819.8***
	(16,169.0)
Y	8,796.3***
	(1,086.4)
Y^2	-10.024***
	(1.243)
Public transportation	742.88***
	(154.71)
Population	-119.53***
	(16.368)
Number of stations	10.114***
	(0.761)
Distance to competitor	-70.268***
	(3.382)
Self-service	2,185.6***
	(33.97)
P × Y	-594.20***
	(73.642)
P × Y^2	0.678***
	(0.084)
P × Public Transportation	-52.219***
	(10.518)
P × Total number of stations	8.110***
	(1.103)
Constant	-1888145.9***
	(238,490.8)
ε_P	-0.719**
	(0.245)
ε_Y	1.117***
	(.0425)
$\varepsilon_{\text{Public transportation}}$	-0.442***
	(0.022)
$\varepsilon_{\text{Population}}$	0.007
	(0.007)
$\varepsilon_{\text{Number of stations}}$	0.097***
	(0.007)
$\varepsilon_{\text{Distance}}$	-0.025***
	(0.001)
Observations	64,497
R-squared	0.112
Day of the week dummies	YES
Month dummies	YES
Region dummies	YES

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors of elasticities are calculated using the delta method. Sample period is 1 January 2012 to 31 December 2012.

Focusing on the interaction terms, we see that coefficients are strongly significant, which is important in order to identify the coefficient of *Q** in the supply equations. In total, the demand function behaves well and proposes plausible predictions.

Supply

Turning to the supply relation, baseline estimation results of Eq. (9) are presented in Table 5. All variables come in significantly and with anticipated signs. The marginal effects are difficult to interpret directly and we have therefore provided elasticities in the table as well. Marginal costs are increasing in *Q*, but only marginally (elasticity=0.002).

Table 5: 2SLS estimation results of Eq. (9) and corresponding elasticities.

Variables	Coefficients
Q	0.000006***
	(0.000001)
Wholesale price	1.066***
	(0.005)
Q*	0.005***
	(0.0003)
Carwash	0.075***
	(0.003)
Self-service	-0.095***
	(0.023)
Constant	8.982***
	(0.037)
ε_{Q}	0.002***
	(0.0004)
$\varepsilon_{\text{Wholesale price}}$	0.389***
	(0.002)
$\varepsilon_{\text{Carwash}}$	0.002***
	(0.00006)
$\varepsilon_{\text{Selfservice}}$	-0.002***
	(0.0006)
Observations	60,888
R-squared	0.843
Month dummies	YES
Region dummies	YES
Brand dummies	YES
Contractual form dummies	YES

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors of elasticities are calculated using the delta method. Sample period is 1 January 2012 to 31 December 2012.

Increases in the wholesale price also raises costs (elasticity=0.39), but due to the high data frequency and only one year of data we do not find full pass-through. The station amenity variables both influence costs; self-service reduces costs (elasticity=-0.002), whereas car-wash facilities increase costs (elasticity=0.002).[27]

Scrutinizing the markup parameter, the model predicts λ to be significant and larger than zero, but very low. An estimate of 0.005 suggests that Swedish gasoline retailing is not a pure competition market. This is in line with several other studies that find that despite high upstream concentration, the retail level does experience competition, e.g., Houde (2012), Manuszak (2009) and Slade (1987). This suggests that even though the market is highly concentrated as there are few brands present in the Swedish market, there is sufficient competition between sellers at the retail level.[28]

However, in the baseline model we do not identify to which extent potential effects on the firms' markup level depend on station characteristics. The literature points in particular to three groups of station characteristics that might influence the level of market power locally; (i) local competition level, (ii) station amenities and (iii) brand identity and contract forms. We will look at these groups in turn below.

6.2 Sources of local market power

Local competition

To analyze the effects of local competition, we estimate modified supply relations (Eq. (9)) where we interact Q^* with variables that measure local competition. The variables are alternative measures of closeness to competitors. The first is *distance to competitor*, and the second is *station density*. Results are presented in Table 6. [29]

Both models perform in the same manner as our baseline model. The new interaction terms both suggest that local competition level influences market power. The larger the distance to the nearest competitor, the higher is the market power. Likewise, the more stations within the close vicinity, the less market power is attainable for the stations.

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[27] The instruments perform well in both models. The 1st stage adjusted R^2 of Eq. (8) and (9) are 0.999 and 0.689 for the demand function and the supply relation, respectively.

[28] According to Corts (1999), the CV models perform poorly only when the estimated market power as measured by λ is large (Genesove and Mullin, 1998). We find only a very modest level of market power.

[29] There are fewer observations used in the estimation of the models in Table 6 because information about distance to the nearest sellers is missing for some stations. We do not replace missing values in order to avoid smoothing effects. However, results are qualitatively the same when replacing missing values with the mean value for each distance variable in each county.

Table 6: 2SLS estimation results of Eq. (9) with inclusion of interactions between Q* and local competition measures.

	Distance to competitor	Station density
Q	0.000005***	0.000007***
	(0.000001)	(0.000001)
Wholesale price	1.062***	1.063***
	(0.006)	(0.006)
Q*	0.005***	0.008***
	(0.0002)	(0.0004)
Q*×Distance to competitor	0.001***	
	(0.0005)	
Q*×Station density		-0.001***
		(0.0001)
Carwash	0.086***	0.085***
	(0.003)	(0.003)
Self-service	-0.066***	-0.062***
	(0.023)	(0.023)
Constant	8.967***	8.951***
	(0.037)	(0.037)
Q* + Q*×Distance to competitor	0.005***	
	(0.0003)	
Q* + Q*×Station density		0.007***
		(0.0003)
ε_{Q}	0.002***	0.003***
	(0.0004)	(0.0004)
$\varepsilon_{\text{Wholesale price}}$	0.388***	0.389***
	(0.002)	(0.002)
$\varepsilon_{\text{Carwash}}$	0.002***	0.002***
	(0.00007)	(0.00006)
$\varepsilon_{\text{Selfservice}}$	-0.002***	-0.002***
	(0.0006)	(0.0006)
Observations	58,345	58,345
R-squared	0.843	0.843
Month dummies	YES	YES
Region dummies	YES	YES
Brand dummies	YES	YES
Contractual form dummies	YES	YES

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors of elasticities are calculated using the delta method. Sample period is 1 January 2012 to 31 December 2012.

Taking a closer look at the coefficients, we can get an idea of how sizeable the effect of local competition is. The *distance to competitor* coefficient is 0.001 and the interpretation is as follows: If the distance to the nearest rival of seller *i* increases by one km, seller *i*'s markup increases with 0.001. Hence, the total effect of *Q** for a station with a distance of one km to its closest rival is 0.005 + 0.001 = 0.006, and the effect is significant. Thus, this coefficient scales the markup according to the distance to the closest competitor. The average station in our sample is located 1.82 km from its closest competitor. The distance variable has, however, a rather high variation, and varies from 0.02 to 30 km across all stations in the sample. This implies for instance, that if we compare a station with no competitors closer than 5 km to a station with a next-door neighbour station, the baseline markup parameter from Table 5 is doubled. Obviously, though one should be careful with the interpretation when we are far away from the mean value, rural stations are typically a long distances away from their neighbours, and they will have substantially more market power than those who have close competitors.

This suggests that the longer the distance between outlets, the higher market power each seller will have because the fuel they offer is more horizontally differentiated from the consumers' point of view. Intuitively, a la Hotelling (1929), the further the distance to the closest competitor, the more consumers are in seller *i*'s "backyard" and hence regard seller *i* as the most preferred seller, other things equal.

In column (B), we interact Q^* with *station density*. The baseline estimate of λ is now 0.008, and slightly higher compared to the benchmark; however it is still small, but positive and significant. The interaction-term coefficient is negative, implying that if seller *i* faces an additional outlet within its neighbourhood (3 km radius), its market power decreases to 0.008 + (-0.001) = 0.007. One possible explanation to this is that the higher the station density, the more stations are within each consumer's reach and so each seller's good has more substitutes. Other things equal, increasing spatial competition thus reduces each seller's market power. However, the *station density* variable has less variation than the *distance to competitor* variable, with a minimum of zero, a maximum of 4, and an average of 2.4. This implies that the maximum scope for this variable (4×-0.001) is lower than for the *distance to competitor* variable. This gives some support to the findings of Hosken et al. (2008), namely that nearness to the closest competitor is more important than density.

In total, results indicate that raising the density of stations or lowering distance between sellers have a detrimental effect on each seller's markup and hence a positive effect on local competition. These findings are in line with those of Barron et al. (2004), Barron et al. (2007) and Clemenz and Gugler (2006).

Station Amenities

We move on to examine station amenities. From Table 1 we see that for our price and quantity observations, 31% of our sample have carwash amenities, 36% are self-service stations and 33% are full service stations without carwash. We want to examine to which extent these differences in service level affect market power. Using the full service stations without carwash amenities as reference category, we interact *Q** with *carwash* and *self-service* and estimate the supply relation (Eq. (9)). We present the results in Table 7.

Table 7: 2SLS estimation results of Eq. (9) with inclusion of interactions between Q* and station amenities.

	Station amenities
Q	0.000003**
	(0.000001)
Wholesale price	1.065***
	(0.005)
Q*	0.011***
	(0.001)
Q*×Carwash	-0.001
	(0.001)
Q*×Self-service	-0.010***
	(0.001)
Carwash	0.067***
	(0.003)
Selfservice	-0.088***
	(0.023)
Constant	8.991***
	(0.029)
Q* + Q*×Carwash	0.01***
	(0.0003)
Q* + Q*×Selfservice	0.0006**
	(0.0003)
ε_{Q}	0.001**
	(0.0004)
$\varepsilon_{\text{Wholesale price}}$	0.389***
	(0.002)
$\varepsilon_{\text{Carwash}}$	0.001***
	(0.00007)
$\varepsilon_{\text{Selfservice}}$	-0.003***
	(0.0006)
Observations	60,888
R-squared	0.846
Month dummies	YES
Region dummies	YES
Brand dummies	YES
Contractual form dummies	YES

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors of elasticities are calculated using the delta method. Sample period is 1 January 2012 to 31 December 2012.

Again, we find signs, parameter magnitudes and significance as in our baseline model. The explanation power is marginally increased. Full service stations with no carwash have a markup (λ) of 0.011. Our results imply that there is no significant difference in markup for the full service stations with *carwash*. These have the same markup as the full service stations without carwash. On the other hand, the *self-service* stations have a significantly lower markup than the others. The interaction term between Q* and *selfservice* is significant and sizeable, suggesting that self-service stations have close to no markup. The estimate is still positive and significant at a 5%-level, but as low as 0.0006.

This suggests that market power increases with station service level. One explanation is that a seller might be able to charge a markup that covers more than the actual cost of providing service to customers. Our findings have some similarities to the results of Haucap et al. (2017), who show that carwash facilities affect retail prices positively, while stations without store facilities, tend to have lower prices.[30]

Our results are also in line with Eckert and West (2005) who find that station characteristics affect sellers' price setting, this as opposed to Hosken et al. (2008) who do not find any impact of station amenities on market power.

Brand identity and contractual forms

Several studies have argued that brand identity and contractual forms affect the stations' performance. In Table 8 we allow λ to vary with brand identity. Again, parameters, significance and elasticities are similar to those of our baseline model, and the explanation power is marginally increased.

Preem has a higher λ than the other brands (0.012), followed by OK-Q8 (0.01), Shell (0.009), Statoil (0.009), St1 (0.003), and lastly, Jet (-0.0005). All estimates except that of Jet are highly significant. This latter result is in line with the finding that self-service stations do not have any markup: Jet stations are all self-service stations. Related to this result, it is interesting to note that the other self-service brand, St1, has only one third of the markup as compared to the others, but here the positive markup estimate is significant. One possible explanation is that St1 and Shell have a common owner, and, as such, some of Shell's brand name effect potentially carries over to St1. Statoil has owned the Jet stations since 2008, but Jet has a very long prior history of being the low-price market challenger, suggesting that it is harder for Jet than St1 to increase its prices in 2012.

[30] If we only include the carwash interaction, we find some evidence of higher market power for the carwash stations.

Table 8: 2SLS estimation results of Eq. (9) with inclusion of interactions between Q* and brand identity dummies.

	Brand identity
Q	0.000006***
	(0.000001)
Wholesale price	1.066***
	(0.005)
Q*	0.009***
	(0.0003)
Q*×Preem	0.004***
	(0.001)
Q*×Okq8	0.001**
	(0.0005)
Q*×Shell	0.001
	(0.001)
Q*×Jet	-0.009***
	(0.0004)
Q*×St1	-0.006***
	(0.001)
Carwash	0.060***
	(0.003)
Self-service	-0.091***
	(0.023)
Constant	8.972***
	(0.029)
Q* + Q*×Preem	0.012***
	(0.0005)
Q* + Q*×Okq8	0.01***
	(0.0004)
Q* + Q*×Shell	0.009***
	(0.0009)
Q* + Q*×Jet	-0.0005
	(0.0003)
Q* + Q*×St1	0.003***
	(0.0005)
ε_{Q}	0.002***
	(0.0004)
$\varepsilon_{\text{Wholesale price}}$	0.389
	(0.002)
$\varepsilon_{\text{Carwash}}$	0.001***
	(0.00007)
$\varepsilon_{\text{Selfservice}}$	-0.002***
	(0.0006)
Observations	60,888
R-squared	0.845
Month dummies	YES
Region dummies	YES
Brand dummies	YES
Contractual form dummies	YES

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors of elasticities are calculated using the delta method. Sample period is 1 January 2012 to 31 December 2012.

The finding of higher Preem margins is at first glance surprising all the time they have less than half the market share (14%) of both Statoil/Jet (35%) and OK-O8 (28%). However, Preem has a similar market share in terms of the number of stations as OK-Q8 and Statoil/Jet and has a significantly higher market share for diesel.[31] In our sample, Preem is also different in terms of which type of retail stations are represented. Even though commissioned stations are common in all the companies running full-service stations (Swedish Competition Authorities, 2013), in our sample, Preem only operates commissioned agent stations. The other five brands' stations are all typically fully vertically integrated outlets.[32] Thus, a potential explanation for the higher Preem markup is the contractual form they have chosen. Unfortunately, we are not able to distinguish between the brand identity effect and the contractual form effect since no other brands are using commissioned agent contracts in our sample. It is, however, not unreasonable to attribute some of this Preem-effect to the contractual form given their smaller market share.

Combining local competition, station amenities and brand identity

We learned above that three characteristics stand out. First, local competition, both measured by closeness to the next gasoline station and by the local density of stations, matters to the amount of market power extracted by the gasoline stations. Second, station amenities are important, especially whether the station is fully serviced or not. Third, we saw that Preem stands out, experiencing significant higher markups than the others, which might be due to their different contact structure in our sample, operating only commissioned agent stations.

Now we combine these three characteristics, local competition, station amenities and controlling for Preem, in the same models. Since local competition is controlled for in two different fashions (refer Table 6), In Table 9 we estimate two supply relations, one where we interact Q^* with *distance to the closest competitor* and the other two characteristics, the other interacting Q^* with *station density* and these other two characteristics.

As before, the models have similar predictions as the baseline model when it comes to magnitudes for cost parameters and elasticities. The models also have higher explanatory power than the baseline model in Table 5.

[31] OK-Q8, Preem and Statoil/Jet had between 600 and 700 stations in 2012. They also sold around a third of the diesel in Sweden in 2012 (Swedish Competition Authorities, 2013).

[32] We have 38 Preem stations in our sample, making up 21% of the sample. The remaining 142 stations are run by the other five brands, whereof as many as 136 are fully vertically integrated (96%). In our sample we only see 2 franchised and 4 independent stations, out of which 6 are OK-Q8 brands.

Table 9: 2SLS estimation results of Eq. (9) combining local competition, station amenities and brand identity/contractual form.

	Distance to competitor	Station density
Q	0.000005***	0.000008***
	(0.000001)	(0.000001)
Wholesale price	1.062***	1.062***
	(0.005)	(0.005)
Q*	0.009***	0.017***
	(0.0003)	(0.0005)
Q*×Distance to competitor	0.0004***	
	(0.0001)	
Q*×Station density		-0.002***
		(0.0001)
Q*×Self-service	-0.009***	-0.011***
	(0.0003)	(0.0004)
Q*×Preem&Commisioned	0.003***	0.003***
	(0.001)	(0.001)
Carwash	0.072***	0.070***
	(0.003)	(0.003)
Selfservice	-0.067***	-0.057**
	(0.023)	(0.023)
Constant	8.995***	8.982***
	(0.030)	(0.030)
Q* + Q*×Distance to competitor	0.009***	
	(0.0003)	
Q* + Q*×Station density		0.014***
		(0.0004)
Q* + Q*×Selfservice	0.00001	0.006***
	(0.0003)	(0.0004)
Q* + Q*×Commisioned	0.012***	0.02***
	(0.0005)	(0.0006)
ε_{Q}	0.002***	0.003***
	(0.0004)	(0.0004)
$\varepsilon_{\text{Wholesale price}}$	0.388***	0.388***
	(0.002)	(0.002)
$\varepsilon_{\text{Carwash}}$	0.002***	0.002***
	0.00007	(0.00008)
$\varepsilon_{\text{Selfservice}}$	-0.002***	-0.002***
	(0.0006)	(0.0006)
Observations	58,345	58,345
R-squared	0.846	0.846
Month dummies	YES	YES
Region dummies	YES	YES
Brand dummies	YES	YES
Contractual form dummies	YES	YES

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Standard errors of elasticities are calculated using the delta method. Sample period is 1 January 2012 to 31 December 2012.

All the interactions between Q^* and the station characteristics are significant in both models, and Q^* is even more precisely estimated than in the baseline model. In sum, both the models in Table 9 perform better than the baseline model, suggesting that we can estimate the markup more precisely when we also account for the different sources of market power.

The baseline estimate of Q^* in the *station density* model is higher in this combined model than in all the other models. Also, the *distance to the closest competitor* model suggests a high baseline estimate of Q^*. When looking at the marginal effects of the characteristics measured through the interactions with Q^*, these have the same signs as above.

Looking at local competition effects, the effect of *distance to closest* competitor effect is still significant, but smaller in magnitude than what we found in Table 6. The model with *station density* suggests a higher negative marginal effect. However, given the variance in these two continuous characteristics (distance and density), the potential influence on market power is still highest from *distance to the closest* competitor.[33] The station amenity measured through the self-service interaction exactly cancels the baseline effect in the model with *distance to the closest competitor*, whereas in the *station density* model we find some significant market power also for self-service stations. The effect of being a Preem and commissioned agent-run station is still significant and positive, and the marginal difference between these commissioned agent-run stations and the other brands' fully vertically integrated stations is increased as compared to Table 8.

We find a clear result: local station characteristics significantly affect the degree of market power for the local gasoline station. To illustrate our results, we construct estimates for two stations with different characteristics. First, from our *distance to the closest competitor* model: Compare a Preem-owned commissioned agent operated full-service station with average distance to its competitor (1.82 km), with one of the other brands' self-service stations, typically vertically integrated, competing with a next door neighbour. The "Preem station" has an estimated markup (λ) of 0.013, the "other station" has no markup (estimated $\lambda = 0.000008$).[34] Second, from our *station density* model: Compare a Preem-owned commissioned agent operated full-service station with an average density of stations (2.4) within a vicinity of three kms, to another brand's vertically integrated self-service station that has four stations within

[33] Remember that the variance in the *distance to competitor* is 0.02 to 30 km whereas the *station density* variable only varies between 0 and 4 stations.

[34] Estimated λ for the "Preem station" from the *distance to competitor* model: Baseline (0.009) + Distance to competitor (0.0004 × 1.82) + Self-service (-0.009 × 0) + Preem&Commissioned (0.003 × 1) = 0.0127. Estimated λ for "the other station": Baseline (0.009) + Distance to competitor (0.0004 × 0.02) + Self-service (-0.009 × 1) + Preem&commissioned (0.003 × 0) = 0.000008.

three kms. The “Preem station” has an estimated markup (λ) of 0.015, the “other station” has a marginally negative markup (estimated λ = -0.002).[35] In sum, though we should be careful when comparing small numbers, local station characteristics influence market power to such an extent that in some local markets, a station will be able to extract market power, whereas in others the competition will remove this possibility.

7. Concluding remarks

Endowed with detailed consecutive daily micro data at the gasoline station level from Sweden on both prices and quantities we estimate a structural model to uncover the degree of competition in the retail market. We apply a Bresnahan-Lau (1988) model utilizing detailed knowledge on each station’s (i) brand identity and contractual arrangements, (ii) station amenities and (iii) local competition factors. We analyze how all these three factors impact on the competition level.

The paper addresses a relatively large but still non-conclusive empirical literature on how competition in gasoline retailing relates to local station characteristics. Micro data at the station level on both quantity and price have typically been hard to obtain, restricting previous research to mainly study aggregate data and reduced form models. Our approach is thus different from the majority of previous literature, both due to the richness of our data, and because we can combine several local station characteristics within the same model.

Our demand estimates suggest an inelastic gasoline demand, which is in line with other studies of gasoline markets. The Bresnahan-Lau approach requires adding interaction terms between exogenous demand side variables and the retail price in the demand specification. We use local income, local population and supply of public transportation in the region in these price interactions. They all come in significant, and produce reasonable and significant elasticities. The income elasticity suggests a normal good, and an increased supply of public transportation reduces demand, suggesting substitutability, both elasticities also being significant. The interaction term with local population size is significant, and the elasticity proposes a marginal positive demand effect, though not significant.

[35] Estimated λ for the “Preem station” from the *density* model: Baseline (0.017) + Station density (-0.002 × 2.4) + Self-service(-0.011 × 0) + Preem&commissioned (0.003 × 1) = 0.0152. Estimated λ for “the other station”: Baseline (0.017) + Station density (-0.002 × 4) + Self-service (-0.011 × 1) + Preem&commissioned (0.003 × 0) = -0.002.

Using the information from the demand estimates, we identify market power through our estimated supply relations. We find that retailers do exercise some market power in the Swedish market on average, but despite the high upstream concentration also in Sweden (C4=99%), the market power is very limited on the downstream level.

Despite the very modest findings of market power, the competitive level varies significantly with local retail station characteristics such as the degree of local competition, station amenities and brand identity/contractual form. We show that the degree of market power varies with both the distance to the nearest station and the local density of gasoline stations. A higher level of service tends to raise a seller's market power, in particular we find that self-service stations have close to no market power. Finally, contractual form and brand identity are also found to matter, but we are not able to distinguish the effects fully in the sense that the only brand in our sample (Preem) that operates commissioned gasoline stations (and only such stations) also have a significantly higher markup than the other brands that predominantly have fully vertically integrated stations.

Swedish Competition Authorities stated in 2013 (p.128) "*…the stations' gross margins naturally vary over time and depend on the local competition pressure.*". We find a clear result reflecting this observation: local station characteristics significantly affect the degree of market power for the local gasoline stations. We show that differences in local station characteristics, even within the scope of the variation in our sample, have a large effect on local market power. The results show that the magnitude of these local differences implies that in some local markets, a station will be able to extract market power, in other markets the local competition factors will remove this possibility.

Hence, not only do we establish the effects of differences and importance in local station characteristics on market power, our results also indicate that local differences in station characteristics can more than offset the average market power found in our baseline models.

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