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Market Concentration and Product Variety under Spatial Competition: Evidence from Retail Gasoline

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Abstract We show that for a spatially differentiated economy reduced product variety is the likely outcome of mergers except in cases where exit costs in relation to (outlet specific) fixed costs are high. Our empirical analysis of the Austrian retail gasoline market confirms that increases in concentration reduce product variety. Ignoring this product variety effect is likely to lead to an *under*estimate of market power in structural merger analysis.

Keywords spatial product differentiation · retail gasoline · mergers · concentration

JEL Classifications L11 · L13 · L90

1 Introduction

Mergers in spatially differentiated industries are likely to affect product variety. If potential entry matters, mergers may lead to an increase in product variety as shown by Berry and Waldfogel (2001). They find that the consolidation in radio broadcasting following the Telecommunication Act of 1996 led to an increase in product variety measured by the number of programming formats. However, examples such as mergers among retail banks show that mergers may also reduce the number of branches.[1]

We present theoretical examples for a spatially differentiated economy, which show that reduced product variety is a likely outcome of mergers if barriers to entry are high. This holds except in cases where exit costs are high in relation to (outlet

[1] After the merger of Bank Austria and Creditanstalt AG in Austria, 70 of the 470 bank branches of the combined firm were closed in 2002.

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specific) fixed costs. In the empirical analysis, we examine the effect of concentration on product variety in the Austrian retail gasoline market. This market is ideal for testing our hypothesis. First, it exhibits a number of the particular characteristics of a spatially differentiated industry.[2] Second, entry hardly matters, as Figure 1 shows. The number of stations is steadily decreasing over time, and de novo entry is nearly absent.

Third, there is considerable merger activity in the market as one can see, for instance, from the large change in the market share of the Majors[3] from 1993 to 1994 (see Figure 1). In that year OMV AG took over the independent discounter STROH, which operated about 100 stations. Finally, relocation costs are likely to be prohibitive, and exit costs are substantial (see Netz and Taylor, 2002).

These characteristics are not specific to Austria. For example, in Germany only 12,000 out of the currently 16,000 gasoline stations are viable in the long run according to industry lobbyists. The association of the Majors (*Mineralölwirtschafts-verband*) and the association of the independents (*Verband der Freien Tankstellen*) together applied on July 10th, 2001, at the German antitrust authority (*Bundeskartellamt*) for authorisation of the establishment of a structural crisis cartel (*Strukturkrisenkartell*). The goal of the cartel is to support the exit of unprofitable outlets by paying a kind of wreck premium. The payments are to be financed by a surcharge on the wholesale price for all stations. Since the antitrust authority opposes the proposal, mergers might be a device to at least partially avoid what the lobbyists call "structural adjustment via a price war."[4]

Our theoretical examples account for these special features, and our empirical analysis of the Austrian retail gasoline market confirms that increases in concentration reduce product variety (as measured by the number of stations per square kilometer). This relation depends on consumer density, and is always negative, except in areas with very low consumer density where no relation between concentration and station density is found. The ratio of exit to fixed costs is likely to be high in these sparsely populated regions, since fixed costs are lower due to lower real estate prices, while exit costs (particularly if they consist mainly of cleaning up costs) are independent of population density.

Our result that more concentrated markets display less product variety has implications for "structural" analyses in empirical industrial organization. Such studies combine assumptions on the pricing behavior of firms with a demand model, which identifies market conduct and thus market power.[5] They neglect a key feature of market power in differentiated markets, namely that a merger between formerly competing firms may change product variety. Compared to much of the theoretical

[2] See Pinkse et al. (2002).

[3] The six largest oil companies, OMV AG, BP Austria AG, Shell, Esso, Agip and ARAL, are called the Majors.

[4] The head of the *Bundeskartellamt* explicitly stated that the recent merger of two majors (BP and ARAL) will lead to closures of stations anyway. See FTD.DE, 25.7.2001, "Wettbewerbshüter gegen Tankstellenkartell." FAZ.net, 28.3.2001, "Immer weniger Tankstellen." Bundesverband Freier Tankstellen, 28.3.2001, "Aktuelles: Interview mit Herrn Müller: Markt für freie Tankstellen wird enger."

[5] See Baker and Bresnahan (1985), Nevo (2001), Ivaldi et al. (2002), Ivaldi and Verboven (2002), Genesove and Mullin (1998). For an early survey see Bresnahan (1989).

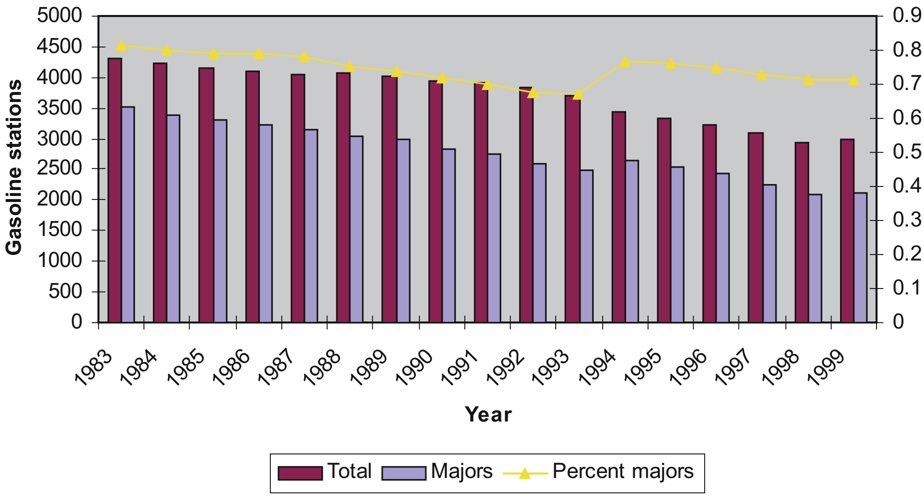

Figure 1 Number of gasoline stations in Austria.

literature (see, e.g., Pepall et al., 2002; Heywood et al., 2001) our paper explicitly accounts for closure of outlets and examines possible cost synergies in greater detail.

The next section presents our theoretical examples, Section 3 covers the empirical analysis, and Section 4 concludes.

2 Theoretical examples

Price competition is an important feature of the retail gasoline market. For example, Clemenz and Gugler (2006) find a significantly negative relation between average retail prices for EUROSUPER and station density in a district or at the zip code level. For more evidence on this issue, see also Borenstein and Shepard (1996) and Slade (1992). The easiest way to model both price competition and the spatial nature of competition is provided by the Salop-model of product differentiation. Since it is also the most often applied approach, we also consider a variant of the model of a circular city as developed by Salop (1979). Consumers are located uniformly on a circle with a perimeter equal to 1. Density and total population is normalized to 1. For a consumer whose location and most preferred variety is $\widehat{x}$, the (indirect) utility from consuming a good which is sold at a price p_i at location x_i is

$$U_{\widehat{x}} = a - t(x_i - \widehat{x})^2 - p_i.$$

The distance $(x_i - \widehat{x})$ is measured by the smallest arc length between x_i and $\widehat{x}$. Locations x_i and $\widehat{x}$ are measured by the clockwise arc length between noon and the respective location. The (common) reservation price a is assumed to be large so that all consumers will always buy a product. We choose the indices of the outlets in a way that outlet i is located to the left of outlet j, i.e., $x_i < x_j$, if $i < j$. The consumer α who is indifferent between buying at i and j is defined by the condition[6]

$$\alpha_{i,j} = \frac{p_j - p_i}{2t(x_j - x_i)} + \frac{x_j + x_i}{2}.^{6}$$

If prices are such that the market share of all outlets is positive, demand for outlet i equals $D_i = \alpha_{i,i-1} + \alpha_{i,i+1}$.

We analyse the effects of mergers and concentration in a framework in which—at most—three firms are active. We assume that each operates only one outlet. In the case of a merger of (at most) two of the three firms, the combined firm may either run one or two outlets. We allow explicitly for the exit of one outlet. With respect to locations we assume that outlets are located equidistantly in the three outlet case (i.e., at 0, 1/3, and 2/3).

2.1 Three single product firms

The profit function of firm i reads

$$\Pi_i = p_i D_i - f_i, \quad i = 1, 2, 3$$

where f_i denotes firm i's fixed costs. Marginal costs are normalized to zero. Straightforward calculations yield the symmetric equilibrium price $p = t/9$ and profits $\pi_i = t/27 - f_i$.

2.2 Merger: equilibrium with three outlets

The case of a merger between firms 1 and 2 that does not lead to outlet closure is depicted in Figure 2.

The combined firm's profit function reads

$$\Pi_m = p_1 D_1 + p_2 D_2 - f_1 - f_2$$

The combined firm's price, its total output q_m and its operating profit π_m, respectively, are as follows:

$$p_m = \frac{5t}{27}, \quad q_m = 5/9, \quad \pi_m = \frac{25t}{243}.$$

The respective values for the outsider are

$$p_o = \frac{4t}{27}, \quad q_o = 4/9, \quad \pi_o = \frac{16t}{243}.$$

The merger leads to higher prices as the merging firms internalize part of the business stealing implied by the quest for higher market share. Since the outsider responds to the price increase by increasing its own price by less than the combined firm, prices are unequal in equilibrium. The merging firms jointly gain $7t/243$ in total operating profits. That is, even without cost reducing synergies the merger is

[6] Note that we denote the consumer who is indifferent between the first firm and the nth firm, which is to the *right* of it, as $\alpha_{n,1}$.

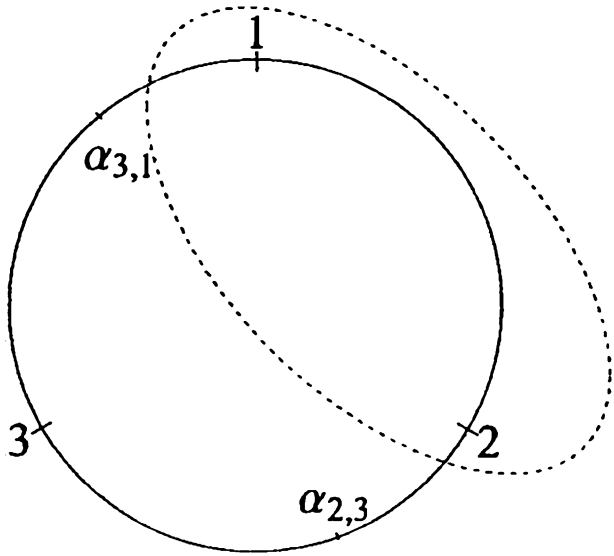

Figure 2 Circular model when firms *1* and *2* merge.

profitable. The profit gain of the outsider is also $7t/243$, twice the gain of a merging firm. The profit increase of the outsider is due to both the increase in prices and the increase of its market share. The latter point is obvious from Figure 2, the indifferent consumers ($\alpha_{2,3}$ and $\alpha_{3,1}$) are now located closer to the outlets of the combined firm compared to the case with three independent firms.

2.3 Merger: equilibrium with two outlets

If the merging firms decide to close one outlet, we can distinguish two cases: a scenario with costless relocation and one in which relocation is (prohibitively) costly. Since the principle of maximum product differentiation applies in our framework, in the first case the outlet of the merging firm would be located at a distance of 1/2 from the outsider. We obtain an equilibrium price of $t/4$ in this case. Operating profits are $t/8$.

Figure 3 shows the situation if relocation is not possible and outlet 2 is closed.

Now both firms charge a price of $2t/9$. The firms' profits are $t/9$. Although the firms share the market evenly ($\alpha_{1,3}$ and $\alpha_{3,1}$ are located half-way between the two competitors), price competition is tougher and profits are lower than in the case of (costless) relocation. This is due to the absence of maximum product differentiation as is apparent from Figure 3.

2.4 Merger: a combined firm with one or two outlets?

In order to determine the optimum number of outlets, we must be more specific about how (fixed) costs change in the case of a merger. The result is straightforward in the case of costless relocation (i.e., maximum product differentiation in the two outlet case). Operating profits are higher in the case of outlet closure by $t(1/8-25/243)=43t/1944$. Since the fixed costs of the merged entity should at least not be higher if it operates one rather than two outlets, closing one outlet is always

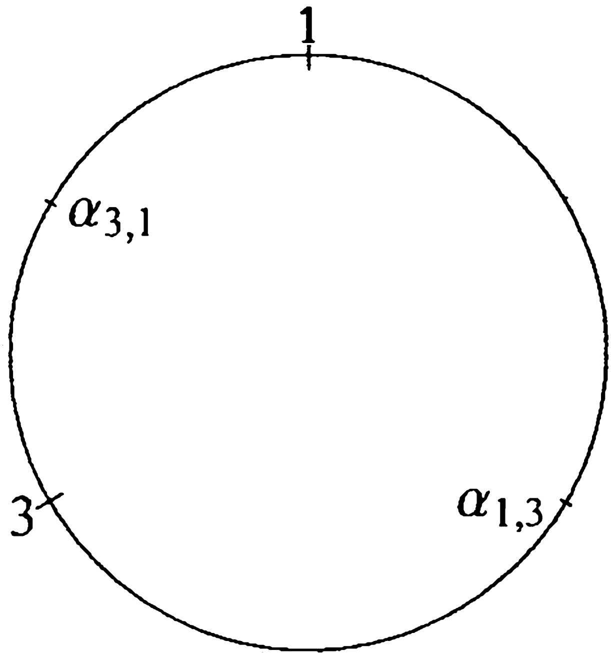

Figure 3 Circular model when the merging firm closes outlet 2 (no relocation).

profitable if relocation is costless. This result is an application of the result concerning non-optimality of multiple outlets in Martinez-Giralt and Neven (1988).

The result that operating profits of the merging firms are higher with one rather than two outlets holds also in the case without costless relocation. The difference in profits is $2t/243$. This value is much smaller than in the case of costless relocation, it amounts to less than 10% of the operating profits. To derive the optimum number of outlets in the case without costless relocation, we distinguish three cases.

1. All potential reductions in fixed costs are realized due to the merger per se, that is without closure of an outlet. Post-merger fixed costs are equal to f in this case if the merging firms operate two outlets.[7] Since closure of an outlet yields only the (small) gain in operating profits, the existence of small exit costs is sufficient to make two outlets the optimum choice.
2. Fixed costs do not change due to the merger unless an outlet is closed. In this case only exit costs which are greater than the fixed costs would leave the number of outlets unaffected.
3. Parts of the potential cost reductions are realized by the merger without closure of outlets. Suppose that a part of the fixed costs is outlet specific, while the remaining fixed costs are firm specific. The latter costs may be driven by factors such as advertising. In this case the decision on how many outlets to run depends crucially on the relation of outlet specific fixed costs to the exit costs, which are specific to the outlet as well.

[7] Pepall et al. (2002) also assume that cost structure.

Summing up the examples, we conclude that mergers are likely to lead to a reduced number of outlets unless exit costs are high in relation to (outlet specific) fixed costs.

3 The data and results

To substantiate this hypothesis we analyse the effects of market concentration on the density of gasoline stations in Austria. We assembled a comprehensive list of gasoline stations in Austria as of the beginning of 2001.[8] Unfortunately, there is no comprehensive list of stations available from a single source, therefore we had to construct a list from the sources *Statistik Austria* (Austrian Statistical Office), the *ÖAMTC* (an Austrian automobile club), and information provided by the petroleum companies (in the order of their market shares) OMV AG, BP Austria AG, SHELL, ESSO, AGIP and ARAL. Thus, we could localize 2,856 gasoline stations in Austria by address (zip code and address). Additionally, we know the name of the oil company operating the stations or whether the station is operated by an independent retailer. According to the *Fachverband der Mineralölindustrie* (Association of the Petroleum Industry in Austria), there were 2,957 operating gasoline stations in Austria as of the beginning of 2001, thus our list covers 96.6% of all gasoline stations in Austria.

A rather difficult problem is the delineation of local gasoline markets and the definition of 'regions'. Austria consists of nine federal states subdivided into 121 districts, which consist of roughly 2,400 municipalities (i.e., zip code level). We use the districts as relevant regions. This choice compromises on the market definition being too narrow (should we have based it on zip codes, etc.) or too wide (if we took federal states).

For each of the 121 districts, we calculate the density of gasoline stations S_k (=number of stations per square kilometer in district k), population density D_k (=number of inhabitants per square kilometer), the Herfindahl index HERF_k (=squared sum of market shares of all firms operating in district k), and the four-firm concentration measure $C4_k$ (=sum of market shares of four largest firms).

Several features of the data set are worth mentioning. First, our model of Section 2 assumes product differentiation, i.e., stations do not (perfectly) cluster in one location, since price competition would drive profits to zero. This is what we actually observe in the data. For example, in nearly 60% of the zip code areas with stations, there is only *one* station. Second, we use the number of gasoline stations rather than output or sales as the basis to calculate concentration figures. This has the advantage that our measures of concentration are less subject to the kind of endogeneity problems mentioned by Evans et al. (1993).[9] Finally, Table 1 presents summary statistics. On average, the patch of a service station is 31.4 km^2 ($=1/S$). The average *C4* is 65.4% and the average HERF is 16.8%, with a wide range from 6 to 100%. The table also presents summary statistics on retail prices of EUROSUPER averaged by district and net of all taxes in ATS per liter (a 20% sales tax and a gasoline quantity tax of 5.61 ATS/l). The dispersion of average prices across districts

[8] Thus we analyse a cross-section of markets as Berry and Waldfogel (2001).

[9] Concentration-price regressions suffer mainly from two sources of bias: first, concentration normally is a function of endogenous firm outputs or revenues. Second, performance feeds back into market structure, that is concentration causes price, but price also causes concentration. In this paper we look, however, at the concentration-density nexus, which should suffer much less from endogeneity.

Table 1 Summary statistics over 121 districts.

	Mean	Median	St. Dev.	Minimum	Maximum
km^2/station	31.39	29.04	26.87	0.30	113.28
Inhabitants/km^2	2,039.23	89.26	4,988.82	21.11	26,028.63
Herfindahl	16.77	14.05	12.54	5.87	100.00
C4	65.35	62.50	13.60	35.71	100.00
Average price of EUROSUPER net of taxes (ATS/l)	5.07	5.08	0.14	4.66	5.40

is quite high as can be seen from the range of a minimum of 4.66 ATS/l and a maximum of 5.4 ATS/l, and the standard deviation.

Table 2 presents the regression results. Specification 1 shows that population density (positively) and market concentration (negatively) affect station density. The coefficient on $\ln D_k$ of 0.84 ($t=49.01$) implies that for each percentage increase in the number of inhabitants per square kilometer the number of gasoline stations increases by around 0.8% per km^2. This conforms to predictions of models of spatial competition that the number of outlets increases less than proportional to consumer density, since the greater proximity of shops increases competition between them and thus reduces the equilibrium price. The negative and significant coefficient on $\ln HERF_k$ suggests that increases in concentration, e.g., via mergers, induce exit of stations. The adjusted R^2 is more than 95%.

Specification 2 includes an interaction term of $\ln D_k$ and $\ln HERF_k$. The negative and significant coefficient estimate on this interaction term implies that the negative (exit-inducing) effects of higher concentration increase with population density. We estimate that increases in concentration induce exit of stations in *all* districts except for the 10% districts with the lowest population density. Therefore, the largest exit-inducing effects of increasing concentration are witnessed in cities. This is consistent with fixed costs relative to exit costs being highest in cities, since high property prices in cities imply that outside opportunities for the station owner, e.g., alternative uses of the station area, are good.

Specification 3 replaces HERF with *C4*, with no change in (qualitative) results. On the contrary, the interaction term of $\ln D_k$ and $\ln C4_k$ affects station density even more negatively, consistent with *C4* being able to measure oligopolistic interaction.

Finally, specification 4 instruments the Herfindahl index as well as the interaction term with variables proxying for differential cost and demand conditions, and estimates by 2SLS. The instruments include nine federal state dummies, the overall number of cars as well as the number of cars per inhabitant in district k, the average income level in district k, and the area share of alps and wood in district k. These instruments strike us to be plausible determinants of market concentration, and yet are exogenous to station density for sure. Cost and demand conditions systematically affect concentration: For example, a larger market size or lower fixed costs lead to a less concentrated market structure in most models of IO. Also the regulatory environment varies across the nine federal states in Austria, which may affect market concentration.[10] The qualitative results are unaltered, however, using 2SLS, the interaction term is even more negative than in the corresponding OLS regression. Therefore, possible endogeneity of concentration does not drive our results.

[10] For example, environmental legislation differs across federal states, which affects fixed costs.

Table 2 Regression results.

Dependent variable: ln(stations/km^2)

Independent variables	OLS		OLS		OLS		2SLS	
	Coef	*t*-value	Coef	*t*-value	Coef	*t*-value	Coef	*t*-value
ln(Inhabitants/km^2)	0.835	49.01	1.174	13.08	1.840	6.10	1.580	7.59
ln(HERF)	−0.306	−3.79	0.426	2.07			1.081	1.76
ln(C4)					0.803	1.77		
ln(Inhabitants)×ln(HERF)			−0.118	−3.84			−0.253	−3.34
ln(Inhabitants)×ln(C4)					−0.237	−3.34		
Constant	−6.319	−30.95	−8.375	−14.72	−10.551	−5.55	−10.326	−6.31
No. obs.	121		121		121		121	
R^2-adjusted	0.957		0.962		0.960		0.954	

4 Conclusions

We find that more concentrated markets in spatially differentiated industries display less product variety. This negative effect of market concentration is present in nearly all markets except in very sparsely populated markets. This suggests that fixed entry and exit costs are key determinants of the effects of market concentration on product variety.

Our findings have important implications for empirical merger analysis. The structural analysis of the effects of mergers should account for changes in product variety. Using pre-merger outlet-specific data to estimate the elasticity of demand, and ignoring the possibility that outlets could be closed due to the merger, *under*estimates market power of the remaining outlets. Mergers are likely to have both, price and product variety effects.

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