Mergers and product variety under spatial competition: Evidence from retail gasoline

Georg Götz and Klaus Gugler

Department of Economics, University of Vienna, BWZ - Bruenner Str. 72, A-1210 Vienna, Austria, email: georg.goetz@univie.ac.at and klaus.gugler@univie.ac.at

January 2003

Abstract

This paper presents theoretical examples for a spatially differentiated economy, showing that reduced product variety is a 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 this reasoning. 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-Classification No.: 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 Waldvogel (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 except in cases where exit costs in relation to (outlet specific) fixed costs are high. In an empirical analysis, we examine the effect of mergers, and more generally, concentration on product variety in the Austrian retail gasoline market. This market exhibits a number of particular characteristics. First, entry hardly matters. As Figure 1 shows, the number of stations is steadily decreasing over time. De-novo entry is nearly absent.

Figure 1 about here

Second, 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[2] from 1993 to 1994 (see Figure 1). In that

---

[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.

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

year OMV AG took over the independent discounter STROH, which operated about 100 stations. Third, relocation costs are likely to be prohibitive, and exit costs are substantial (see Netz and Taylor, 2002).

Our theoretical examples account for these special features and our empirical analysis of the Austrian retail gasoline market confirms the theoretical results. Increases in concentration reduce product variety (as measured by the number of stations per sqkm). 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. In sparsely populated regions, fixed costs are likely to be lower due to lower real estate prices. Exit costs, on the other hand, particularly if they consist mainly of cleaning up costs, seem much more independent of population density.

Our paper provides a negative answer to the question whether mergers increase product variety. This result has important implications for the large number of recent empirical papers in "structural" industrial organization. Such studies combine assumptions on the pricing behavior of firms with a demand model, which identifies market conduct and thus market power. This sort of analysis is particularly important to address the effects of mergers on market outcome in the presence of product differentiation.[3] However, these studies 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 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.

---

[3] See Baker and Bresnahan (1985), Nevo (2000), Ivaldi et al. (2002), Ivaldi and Verboven (2002), Genesove and Mullin (1998). For an early survey see Bresnahan (1989).

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

2. Theoretical examples

Consider a variant of the traditional Salop (1979) model of a circular city. 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 $\hat{x}$, the (indirect) utility from consuming a good which is sold at a price p_i at location x_i is

$$U_{\hat{x}} = a - t\left(x_i - \hat{x}\right)^2 - p_i . \tag{1}$$

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 outlet 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

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

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. In the case of three firms we assume that each operates only one outlet. In the case of a merger of (at the most) two of the 3 firms, the merged 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). A merger does not change locations, but it may well change the number of outlets.

1.1 Three single product firms

The profit function of firm i reads

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

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 $\pi_i = t/27 - f_i$

1.2 Merger: equilibrium with three outlets

In the case of a merger without outlet closure the merged firm's price, its total output q_m and its operating profit π_m, respectively, are as follows:

$$p_m = \frac{5t}{27}, \; q_m = 5/9, \; \pi_m = \frac{25t}{243}. \tag{1.3}$$

The respective values for the outsider are

$$p_o = \frac{4t}{27}, \; q_o = 4/9, \; \pi_o = \frac{16t}{243}. \tag{1.4}$$

The merger leads to higher prices as the merging firm internalizes part of the business stealing implied by the quest for higher market share. The merging firms' gain $7t/243$ in total operating profits. That is, even without cost reducing synergies the merger is profitable. The profit gain of the outsider is also $7t/243$, twice the gain of a merging firm.

1.3 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 $t/8$.

Without relocation both outlets charge a price of $2t/9$. The firms' profits are $t/9$. Without maximum profit differentiation price competition is tougher and profits are lower.

1.4 Merger: 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 with only two outlets by $t(1/8 - 25/243) = 43t/1944$. Since fixed costs should at least not be higher in the one outlet case than with two outlets, closing one outlet is always 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).

In the case without costless relocation, operating profits are higher with one rather than two outlets. The difference in profits is $2t/243$. This value is much smaller than in the case of costless relocation, it amounts to less than ten percent 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.[4] It is obvious that 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. Part of the potential cost reductions are realized by the merger without closure of outlets. Suppose that a part of the fixed costs are outlet specific, while the remaining fixed costs are firm specific. The latter costs may be driven by factors such as advertising. In this

---

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

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.

Summing up the examples, we conclude that mergers are likely to lead to a reduced number of outlets unless the relation of exit costs to (outlet specific) fixed costs are high. Since mergers lead to more concentrated ownership of outlets, we obtain the hypothesis that more concentrated ownership of outlets is likely to yield a smaller number of outlets ceteris paribus. Again, a qualification applies for the case of exit costs which are high compared to the fixed costs.

3. The data and results

We assembled a comprehensive list of gasoline stations in Austria as of the beginning of 2001. 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. zipcode 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, population density D_k, the Herfindahl index $HERF_k$, and the four-firm concentration measure $C4_k$. 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).[5]

Table 1 about here

Table 1, Panel A, presents summary statistics. On average, the patch of a service station is 31.4 sqkm ($=1/S$). The average *C4* is 65.4% and the average *HERF* is 16.8%, with a wide range from 6 to 100%.

Panel B of Table 1 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 sqkm the number of gasoline stations increases by around 0.8 percent per sqkm. This conforms to predictions of models of spatial competition that the number of outlets increases less than proportional to consumer density, since the greater

---

[5] 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. Using the number of gasoline stations as the basis of our concentration measures should reduce the first bias.

proximity of shops 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 increases 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 better 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 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*. The qualitative results are unaltered, the interaction term is even more negative than in the OLS regression. Therefore, possible endogeneity of concentration does not drive our results.

4. Conclusions

We find that concentration, and therefore mergers in spatially differentiated industries may well decrease product variety. Therefore consumers' welfare is negatively affected by mergers through both price effects and reduced choice. Our findings also 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.

References

Berry, S. T. and J. Waldfogel, 2001, Do Mergers Increase Product Variety? Evidence From Radio Broadcasting, The Quarterly Journal of Economics 116, 1009-1025.

Baker, J. B. and T. F. Bresnahan, 1985, The Gains from Merger or Collusion in Product-Differentiated Industries, Journal of Industrial Economics 33(4), 427-444.

Bresnahan, T. F., 1989, Empirical studies of industries with market power, in R. Schmalensee and R. D. Willig (eds.) Handbook of Industrial Organization, Vol II, Elsevier Science Publishers B.V.

Evans,W. N., Froeb, L. M., Werden, G. J., 1993. Endogeneity in the Concentration-Price Relationship: Causes, Consequences, and Cures. Journal of Industrial Economics Vol. XLI, No. 4, 431-438.

Genesove, D. and W. P. Mullin, 1998, Testing static oligopoly models: conduct and cost in the sugar industry, 1890-1914, RAND Journal of Economics, Vol. 29, No. 2, 355-377.

Heywood, J.S., Monaco, K. and Rothschild, R., 2001, Spatial price discrimination and merger: the N-firm case. Southern Economic Journal 67, 672-684.

Ivaldi, M., G. McCullock and C. Linari, 2002, U.S. Railroad Mergers: A Structural Econometric Perspective, presented at the EARIE 2002 meeting in Madrid.

Ivaldi, M. and F. Verboven, 2002, Quantifying the Effects from Horizontal Mergers in European Competition Policy, CEPR WP No. 2697.

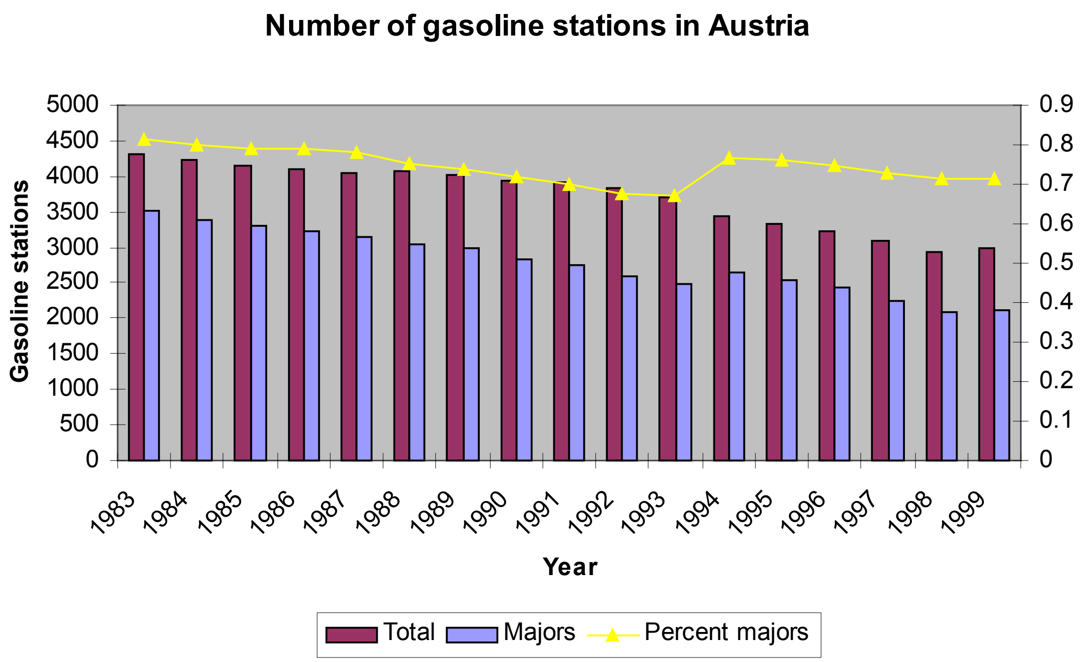
Martinez-Giralt, X., and D. Neven, 1988, Can price competition dominate market segmentation? Journal of Industrial Economics 36, 431-442.

Netz, J.S. and B.A. Taylor, 2002, Maximum or minimum product differentiation? Location patterns of retail outlets. Review of Economics and Statistics 84, 162-175.

Nevo, A., 2001, Measuring Market Power in the Ready-to-Eat Cereal Industry, Econometrica, 69(2), 307-342.

Pepall, L., Richards, D.J. and Norman, G., 2002, Industrial Organization: Contemporary Theory and Practice, 2e, South-Western, Mason, Ohio.

Figure 1



Number of gasoline stations in Austria
Gasoline stations
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
Year
Total
Majors
Percent majors

Table 1: Results

Panel A: Summary statistics over 121 districts

	Mean	Median	St. Dev.	Minimum	Maximum
km²/station	31.39	29.04	26.87	0.30	113.28
Inhabitants/km²	2039.23	89.26	4988.82	21.11	26028.63
Herfindahl	16.77	14.05	12.54	5.87	100.00
C4	65.35	62.50	13.60	35.71	100.00

Panel B: Regression results

Dependent variable: ln(stations/km²)

Independent variables:

	OLS		OLS		OLS		2SLS	
	Coef	t-value	Coef	t-value	Coef	t-value	Coef	t-value
ln(Inhabitants/km²)	0.835	49.01	1.174	13.08	1.840	6.10	1.580	7.59
ln(Herfindahl)	-0.306	-3.79	0.426	2.07			1.081	1.76
ln(C4)					0.803	1.77		
ln(Inhabitants)* ln(Herfindahl)			-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	