Spatial Price Competition in the Austrian Retail Gasoline Market:
The Influence of Unbranded Stations on Competition and Prices

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I. Introduction

The price of gasoline increased considerably in the last couple of years in Austria. Between October 1999 and November 2004 the price of diesel rose by roughly 25 per cent. As prices reach new peaks, competition and pricing strategies in the retail gasoline market receive considerable attention in the media and cause concerns among drivers´ associations and political actors. It is argued that too little competition leads to higher net prices compared to neighbouring countries. An increase in the number of unbranded gas stations is widely seen as a proper solution for this lack of competition[1]. This should decrease prices as unbranded stations are cheaper on average, which sharpens price competition and forces branded stations to lower its prices as well. This is basically in line with the empirical literature that deals with the retail gasoline sector that also emphasizes the positive effect of unbranded stations on competition (see e.g. Hastings 2004 or Netz and Taylor 2002).

But is this a result that we would expect? It is possible that at least some consumers see branded gasoline superior compared to gasoline sold at unbranded stations. If that is the case, one would expect that a larger share of unbranded gas stations will lead to less competition among branded stations (the high quality segment) and higher prices among them. Competition does not only depend on the pure number of competitors, but also on their composition, namely on the share of competitors that are considered close substitutes. I will use the term "composition effect" to describe the change in prices of other stations if one station changes from unbranded to branded (or vice versa) if the price charged by the switching station is not altered. But as independent stations usually charge lower prices, they are more aggressive competitors (Netz and Taylor 2002 p. 165), which should cause other stations to lower their prices as well. I will refer to this as "competition effect".

Besides quality differences between branded and unbranded stations, gasoline is a spatially differentiated good. As it is plausible to assume that not all gas stations are symmetric substitutes à la Chamberlin[2] and that close competitors have a greater influence on the pricing

[1] See, among others, "Kanzler soll Sprit zu EU-Thema machen" (2005) or "Tankstellenlage bestimmt Spritpreis" (2005). Further details on the Austrian gasoline market can be found in a study for the Ministry of Economics and Labour by Benigni and Prinz (2005) that also supports the idea of constructing unbranded gas stations in regions where the prices are relatively high (p. 236).

[2] See, among others, Anderson et. al. (1992) for more details.

decision of a specific firm, a spatial lag model is used to analyze this market. It will be shown that both the composition and the competition effect exist. It is crucial to decompose the overall price effect, as the influence of unbranded stations on branded ones does not only depend on the size of these effects, but also on specific spatial patterns. The competition effect is larger on average, which supports the results of Hastings (2004) and Netz and Taylor (2002) that unbranded stations sharpen price competition in general. But as the size of both effects depends on spatial patterns, it will be shown that there exist unbranded stations that, transformed to branded stations, causes other stations to lower their prices, although the price charged at the switching station will increase.

In section II reaction or best reply functions are derived from a fairly general model of price competition and it is shown how the parameters as well as spatial characteristics influence pricing decisions of firms. Section III gives a description of the data and a statistical overview and specifies spatial competition. The model is constructed in a way to test for both the composition and the competition effect separately. The results are presented and discussed in section IV. Section V concludes.

II. A Model of Price Competition

In modelling price competition I follow Pinkse et. al. (2002) as well as Pinkse et. al. (2004). I assume that there are n sellers of a differentiated product. The products, $q = (q_1, ..., q_n)^T$, are sold at prices $p = (p_1, \ldots, p_n)^T$. Each product is associated with one characteristic y_i, which can be easily expanded to a vector of characteristics. I use a normalized quadratic utility function that leads to the reaction or best response function p_i:

$$p_i = R_i(p_{-i}) = \frac{1}{-2b_{ii}^1}\left(a_i - b_{ii}^1\gamma^T c_i + \sum_{j\neq i} b_{ij}^1 p_j + \sum_j b_{ij}^2 y_j\right)$$

whereas $i = 1,\ldots, n$, $j = 1,\ldots, n$, $p_{-i} = (p_1,\ldots, p_{i-1}, p_{i+1}, \ldots., p_n)$ and $\gamma^T c_i$ are firm i´s marginal costs that are a linear function of cost factors. This equation shows that the intercept of the reaction function depends on the product characteristic y_i and on the cost factors $\gamma^T c_i$ of the firm.

As it is not possible to estimate all parameters from a single cross section of n firms, I have to put some structure on the model. The slopes of the reaction function, $\frac{-b_{ij}^1}{2b_{ii}^1}$, are proportional to the diversion ratios[3]. It seems plausible that this ratio depends somehow on the Euclidean distance between i and j[4], and that it decreases the farther i and j lie apart. I will also assume that if the distance between two observations is farther away of each other than a critical distance, the direct increase in demand of firm j due to an increase in the price charged by firm i will be very small and can be ignored without losing too much information. The spatial information will be stored in a spatial weights matrix W, which will be row-standardized. As w_{ij} depends on the distance between i and j as well as on the number of and the distance to other direct competitors of i, w_{ij} can be interpreted as the station j´s share of total competition for station i. As I will allow just for one estimator ρ to estimate the influence of other stations´ prices on a specific station, the influence of the price of station j on the price of station i depends just on the share of competition of firm j for firm i, but not on other characteristics of either station i or station j. As the influence of the site characteristics, y_j, $j \neq i$, on the price of firm i, $\frac{-b_{ij}^2}{2b_{ii}^1}$, will also depend on the distance similar to $\frac{-b_{ij}^1}{2b_{ii}^1}$, the same matrix W is used to estimate the influence of the characteristics of rivaling stations on the price charged by a specific station i. But as the share of branded and unbranded stations might have a different influence on the level of prices charged by firm i, depending whether this specific station is branded or unbranded, one estimator for all $\frac{-b_{ij}^2}{2b_{ii}^1}$ will be too restrictive, and so the geographical information depending on this site characteristic (branded or unbranded) will be stored in different matrices W^h, and different coefficients will be allowed. Therefore, the model can be written as:

$$p = R(p) = A + X\beta + WY\gamma + \sum_{h=1}^{H} W^h Z \delta^h + \rho W p$$

where A is a vector of intercepts that can be included in X to get

$$p = R(p) = X\beta + WY\gamma + \sum_{h=1}^{H} W^h Z \delta^h + \rho W p$$

X will include site and therefore product characteristics as well as cost variables. Matrix Z summarizes those site characteristics, where depending on some characteristics of observation i and observation j different coefficients are possible, where for those variables summarized in

[3] The diversion ratio from product i to j is the share among all lost consumers by firm i due to an increase of p_i that switches to firm j.
[4] Although it is more intuitive to assume that this ratio depends on the driving distance, on the driving time and on traffic patterns, I think the Euclidean distance is a good proxy for these variables.

matrix Y no different coefficients will be allowed. Wp is the spatially weighted average price charged by all direct competitors.

The overall price effect of unbranded stations on other stations will be determined by the parameters β, δ and ρ, and by the specific spatial patterns of competition. Just knowing the parameters is not enough to evaluate whether an unbranded gas station has a positive impact on price competition and a negative influence on the overall price level. Just consider a simple example: In the relevant market there are only three competitors that lie on a straight road, as illustrated below:

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No. 1      No. 2                        No.3
  x----------o-------------------------o
     1 km              4 km
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where the branded station is marked by x and the unbranded stations are marked by o. In this simple model the price of firm i just depends on a few characteristics and so the reaction function of firm i can be described as:

$$p_i = \beta_0 + \beta_1 x_i + \beta_2 x_i \sum_{j \neq i} w_{ij}(1 - x_j) + \rho \sum_{j \neq i} w_{ij} p_j$$

where x_i is a dummy variable for branded gas stations (which is one if the station is branded and zero otherwise), $\sum_{j \neq i} w_{ij}(1 - x_j)$ is the spatially weighted average of unbranded stations among competitors (which is only relevant for branded stations) and $\sum_{j \neq i} w_{ij} p_j$ is the spatially weighted average of rivals´ prices. The spatial weights w_{ij} are the inverse distance of two observations and the rows of Matrix W are normalized to one. The above equation can be rewritten in a reduced form using matrix notation:

$$p = (I - \rho W)^{-1} X \beta$$

I will further assume that one of the unbranded stations becomes a branded station and I will consider two different sets of parameters:

Table 1: Sets of Parameters

	β_0	β_1	β_2	ρ
1st set	2	0.4	0.8	0.8
2nd set	2	0.4	0.2	0.8

A value of 0.8 for ρ means, that if the other two stations increase their prices by one, the station in question will increase its price by 0.8. The reaction functions of all firms have an intercept β_0. This intercept will be higher for branded stations (by β_1), and it will be increased further, if there is little competition in the high quality segment, as indicated by β_2. If station number two or station number three becomes a branded station, it can be expected that this specific station will increase its price by β_1 plus a share of β_2, depending on the strength of competition among branded stations. The other branded station will face tougher competition in its segment and will therefore lower its price due to the composition effect. These initial price changes will have consequences for all stations, as indicated by $(I- \rho W)^{-1}$. The price changes of all three stations are summarized in table 2:

Table 2: Expected Change in Prices

	1st case		2nd case	
Switching station	No. 2	No. 3	No. 2	No. 3
Change in prices at the switching station	↑ (+0.18)	↑ (+1.05)	↑ (+0.80)	↑ (+0.72)
Average change in prices at the other two stations	↓ (-0.34)	↑ (+0.25)	↑ (+0.47)	↑ (+0.26)
Average change in prices at all three stations	↓ (-0.17)	↑ (+0.52)	↑ (+0.58)	↑ (+0.41)

For the second set of parameters, if either station number two or three from becomes a branded station causes all prices to rise. For the first set of variables the switching station will increases its price, but the reaction of the two other firms will depend on whether station two or station three is the switching firm. This is not a surprising result. As station one is an important competitor of station two and vice verse, the initial price increase of station two is not very high if it becomes a branded station, as it is disciplined by tough competition in the high quality segment. Station number one on the other hand will initially lower its price quite a bit, as the spatially weighted share of branded competitors increases from zero to over eighty percent as station two switches. In total the composition effect outweighs the competition effect and the prices of the two competitors of station two will decrease. The price decrease of these stations will be even large enough to more than compensate the price increase of station number two.

It can be concluded that the overall price effect when an unbranded station becomes a branded one depends not only on the parameters, but also on the concrete spatial patterns of competition, and that knowing the parameters is not enough to evaluate the effect of a single unbranded station on the prices charged by its competitors.

III Data and Empirical Specification

For the estimation two different data sets are used. One is a comprehensive survey that contains information about site characteristics of all gas stations of Lower Austria, including information about location, brand, traffic speed, traffic builder, if it is self service, if there is a convenience store or a garage and if credit or fuel cards are accepted, among others. The second data set used contains price data of a sample of 60 percent of October 1999. Table 3 gives a short summary of the market shares of different brands and their average prices.

Table 3: Statistical Overview on Market Shares and Average Prices

Brand	Number of Stations	Market Share	Average Price	Standard Deviation
Agip	34	8.52%	9.46	0.204
Aral	16	4.01%	9.44	0.251
Avanti	24	6.02%	9.38	0.242
Avia	19	4.76%	9.56	0.230
BP	63	15.79%	9.48	0.236
Esso	25	6.27%	9.49	0.205
Jet	8	2.01%	9.47	0.070
OMV	72	18.05%	9.48	0.199
Shell	45	11.28%	9.57	0.159
Stroh	29	7.27%	9.45	0.154
Unbranded	64	16.04%	9.24	0.315
all Stations	399	100.00%	9.45	0.245

In defining the retail market used in the regression I follow Netz and Taylor (2002 p. 164) and define the relevant market by drawing a circle around every observation. All stations within a radius of 15 kilometres compete directly with each other.[5] The information about spatial competition between two stations is stored in the spatial weights matrix W. To get the i-th row of W I consider all stations that are located 15 km or less away from station i and take the reciprocal value of the Euclidean distance, as one can assume that the closer the stations are, the more intense competition is among them. Finally, all rows are standardized to one. So w_{ij} measures the spatially weighted share of competition that station j has for station i and ranges from zero (station j is more than 15 km away from i) to one (j is the only direct competitor).

To analyze the impact of the share (among total competition) of branded gas stations of the same brand (1), of a different brand (2) and the share of unbranded stations (3) on branded gas stations, indices for the different shares in competition have to be derived. As there are no

[5] In this point I deviate from other empirical papers, that use on mile (Hastings p. 321) or one-half of a mile, one mile and two miles (Netz p. 167) as the relevant market. I choose 15 km because the area under consideration has a smaller population density and to ensure that every station has at least one competitor. As the distance is somewhat arbitrary, the regression is also estimated using critical distances of 20 and 25 kilometres. As the results do not change significantly, these results are printed in the Appendix.

chains of unbranded gas stations with a significant market share in Austria and as possible different effects of branded or unbranded stations on branded ones is not the question under consideration, no different indices for unbranded stations are calculated. I split the matrix W in four matrices W^i, i e {1, 2, 3, 4} of the same dimension, whereas $\sum_{i=1}^{4} W^i = W$.

$$W^1 : w_{ij}^1 = \begin{cases} w_{ij} & \text{if i and j are branded stations of the same brand} \\ 0 & \text{otherwhise} \end{cases}$$

$$W^2 : w_{ij}^2 = \begin{cases} w_{ij} & \text{if i and j are branded stations of a different brand} \\ 0 & \text{otherwise} \end{cases}$$

$$W^3 : w_{ij}^3 = \begin{cases} w_{ij} & \text{if i is a branded and j is an unbranded station} \\ 0 & \text{otherwise} \end{cases}$$

$$W^4 : w_{ij}^4 = \begin{cases} w_{ij} & \text{if i is an unbranded station} \\ 0 & \text{otherwise} \end{cases}$$

I calculate $e^i = W^i e$ for all i=1, 2, 3, 4, whereas e is a unit vector of dimension n, to get four indices:

e^1 … the share among total competition of branded gas stations of the same brand for a branded gas station

e^2 … the share among total competition of branded gas stations of different brands for a branded gas station

e^3 … the share among total competition of unbranded gas stations for a branded gas station

e^4 … the share among total competition of branded and unbranded gas stations for an unbranded gas station (which equals to one for unbranded stations)

As it is plausible that not only the structure of competitors, but also their pure number influence price competition, the spatially weighted number of competitors (e_5) within the 15 kilometres market border is included into the model

$$p = X\beta + WY\gamma + \delta_1 e_1 + \delta_3 e_3 + \delta_5 e_5 + \rho Wp$$

which can be rewritten in a reduced form

$$p = (I - \rho W)^{-1} (X\beta + WY\gamma + \delta_1 e_1 + \delta_3 e_3 + \delta_5 e_5)$$

As spatial price competition is assumed, a spatially weighted average of prices of the relevant competitors (Wp) is included into the model. As e_1, e_2 and e_3 are zero for unbranded stations and sum up to one for branded ones, and as e_4 is zero for branded stations and one for unbranded ones, e_2 and e_4 are dropped due to multi-collinearity reasons.
As the OLS estimators will be biased and inconsistent in the presence of a spatially lagged dependent variable, maximum likelihood estimation is used.[6]

IV Results and Interpretation

IV a The Whole Market

The results of the estimation are summarized in table 4. All Variables marked with "Mis" characterize missing values. ρ is quite large (0.71) and highly significant and can be interpreted that a station will increase its price by 0.71 Austrian Schillings (ATS) if all other stations in the spatially relevant market increase their price by 1 ATS. The dummy variables for all brands are positive and highly significant, except for the dummy for Avanti that is just significant at a 5 per cent level. Other significant results: Stations that sell only diesel are 0.66 ATS cheaper than other stations, although there are just two observations in the sample that sell only diesel. Stations that are open for 24 hours are 0.08 ATS more expensive and stations that are located next to a highway (speed over 100 km/h) are 0.33 ATS more expensive, ceteris paribus. One maybe surprising result that is significant at the 5 per cent level is that a larger share among total competition of stations which are located at a highway leads to lower prices (W*Speed over 100). A plausible explanation for this might be that car drivers using the highway do not consider stations off the highway as close substitutes to stations at the highway. As a consequence the price effect of the stations next to the highway to the station off the highway might be overestimated by ρ and adjusted by this variable. It is somewhat counterintuitive that the spatially weighted number of competitors (e_5) does not have a significant influence on prices, but as this model lacks of demand side variables, the number competitors will probably be correlated with overall demand that offsets the positive effect on competition.

[6] See Anselin (1988) for further details on the properties of ordinary least squares and maximum likelihood in the presence of spatial autocorrelation.

The most interesting result is probably, if we control for the negative price effect of unbranded stations on competitors prices, that more unbranded stations (at the expense of branded stations of a different brand than the station in question) lead to lower competition and to higher prices charged by branded stations. If all direct competitors of a branded station are unbranded stations instead of branded stations of a different brand, prices will increase on average by 0.07 ATS (e_3). Although this result has the expected sign and therefore supports the hypothesis that for a branded station other branded stations are closer substitutes than unbranded ones, it is not significantly different from zero. If all competitors are of the same brand than the station under consideration, prices are expected to be 0.14 ATS higher compared to a branded station that is just surrounded by branded stations of different brands. This result is significant at the 10 per cent level.

Table 4: Results of the Maximum Likelihood Estimation

Variable	Coefficient	z-value	Significance	Variable	Coefficient	z-value	Significance
Constant	2.5604	7.62	***	Speed 40-60	0.0038	0.12	-
Agip	0.1458	3.90	***	Speed 61-80	-0.0087	-0.23	-
Aral	0.2041	4.56	***	Speed 81-100	0.0921	1.55	-
Avanti	0.0919	2.33	**	**Speed over 100**	0.3325	4.44	***
Avia	0.1833	4.63	***	Nodal Point	0.0410	0.87	-
BP	0.1807	5.49	***	Catering facility	0.0911	1.66	*
Esso	0.1956	5.07	***	Shopping Center	-0.0164	-0.49	-
Jet	0.1788	3.08	***	Motorway Feeder	0.0202	0.43	-
OMV	0.1687	4.96	***	Attendant Service	0.0249	1.08	-
Shell	0.2231	6.49	***	Biodiesel	0.0049	0.13	-
Stroh	0.1212	3.59	***	Mis Biodiesel	0.0166	1.01	-
Only Diesel	-0.6584	-6.53	***	Mis Garage	0.1728	1.78	*
Garage	-0.0286	-1.72	*	Mis Payment	0.0610	0.89	-
24 h open	0.0785	2.23	**	Mis Building Date	-0.0057	-0.12	-
Credit Card	0.0379	1.18	-	Mis Size	0.0252	0.48	-
Fuel Card	-0.0157	-0.60	-	Mis Service	0.0259	0.53	-
Diesel only Card	-0.0133	-0.65	-	W*Garage	0.0341	1.23	-
ATM	-0.0411	-0.70	-	W*24 h open	0.0009	0.01	-
Built before 89	-0.0274	-0.83	-	**W*Speed over 100**	-0.3990	-1.90	**
Built before _99	-0.0680	-2.28	**	$\mathbf{e_1}$	0.1374	1.78	*
Built since 2000	-0.0078	-0.24	-	$\mathbf{e_3}$	0.0736	1.41	-
No shop	-0.0110	-0.45	-	$\mathbf{e_5}$	1.6826	1.44	-
Plot size till 800m²	0.0446	1.86	*				
Plot size till 2.000m²	0.0596	2.90	***	$\boldsymbol{\rho}$	0.7055	20.37	***

When an unbranded station switches to a branded one (whether it is bought by another branded station or the owner simply changes her strategy does not matter), a couple of things are expected to happen: The price at this specific station will increase, as indicated by the dummy variables for the different brand. The price increase will be even higher, the higher the share of branded stations of the same brand and the higher the share of unbranded stations is among total competition. This will induce the prices of rivaling stations to increase due to weaker price competition, indicated by ρ (competition effect). But for close competitors, not only their spatially weighted price will be altered, also their shares of competitors change. Especially when the station in question switches to a different brand, price competition will be sharper as there are more competitors in the high quality segment, and prices are expected to fall (composition effect). The composition effect will induce rivaling branded stations to increase prices by 0.064 ATS, when the station in question switches to the same brand, or to lower prices by 0.074 ATS, when the station switches to a different brand.

Although the composition effect is not significant, I will use the estimated coefficient for further investigations. Although the dummy variables for all brands are higher than e_3, it is not that easy to figure out whether the competition effect outweighs the composition effect in every case. In a next step I will assume that all unbranded stations are bought by a single brand. As all the other characteristics do not change, the aggregation of competition and composition effect can be estimated. The results of the simulation depending on the take over company are presented in table 5. The price increases are highest at the stations that are taken over, as expected. The average increase in prices at stations of the take over company is higher than at the other branded stations.[7] This does not come as a surprise, as the composition effect on stations of other brands is positive, which causes prices to fall, and negative to stations of the same brand. The price level among all stations as well as among all branded stations[8] is expected to rise. The aggregate effect on prices depends positively on the coefficient of the dummy variables and on the market share of the take over company.

It seems plausible to conclude that the competition effect outweighs the composition effect. This is basically in line with the results of Netz and Taylor (2002) and Hastings (2004).

Table 5: Expected Results of Taking Over All Stations

Company that takes over the unbranded stations	Total change in prices among all stations (aggregated)	Average change in prices among all stations	Average change in prices among stations of the take over company	Average change in prices among branded stations other than the take over company	Average change in prices among the taken over (former unbranded) stations
Agip	26.804	0.067	0.045	0.026	0.274
Aral	35.904	0.090	0.071	0.037	0.357
Avanti	16.024	0.040	0.040	0.010	0.189

7 Jet is the only brand where this is not true, but as there are only eight Jet stations in the sample, this result might depend on the spatial characteristics of these small number of stations and should not cause too much of a concern.

8 The term "branded stations” refers to stations that were branded even before the take over.

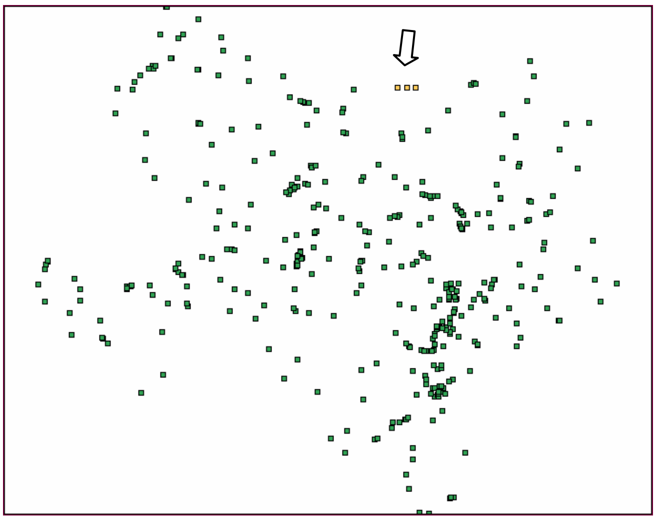
Avia	31.507	0.079	0.062	0.031	0.321
BP	37.602	0.094	0.069	0.039	0.355
Esso	35.103	0.088	0.052	0.037	0.347
Jet	29.579	0.074	0.027	0.029	0.309
OMV	35.197	0.088	0.064	0.034	0.338
Shell	43.247	0.108	0.082	0.047	0.407
Stroh	20.488	0.051	0.032	0.016	0.228

IV.b A Single Gas Station

As unbranded stations are not concentrated in ownership, it is highly unrealistic that all of them are bought at once. The more interesting question is, whether we can conclude that if a branded station buys an unbranded one, we always expect prices charged by other stations to rise. Unfortunately, this cannot by derived from the results stated above, as competition patterns are quite difficult in spatial models

Let us take a look at two examples from the data. In figure 1 we can see the 399 of roughly 750 gas stations in Lower Austria where I have data on prices. The middle position of the three yellow dots is the unbranded station under consideration. The only two direct competitors in its relevant market are two branded stations (BP and Aral), that are also marked with yellow.

Figure 1: Gasoline Stations in Lower Austria (Example 1)



If the station is transformed into a branded station (other than BP or Aral) prices are expected to rise at that specific station. Nevertheless, the price increase will be quite low, as competition in the high quality segment is sharp as all its competitors are branded stations. As this station is highly relevant for its direct competitors (the spatially weighted share in competition is more than 50 per cent for both stations), the competition effect is expected to be quite considerable. The expected results of the transformation of the unbranded station (depending on the brand it is changed to) on own prices and on the prices of competitors are presented in table 6.

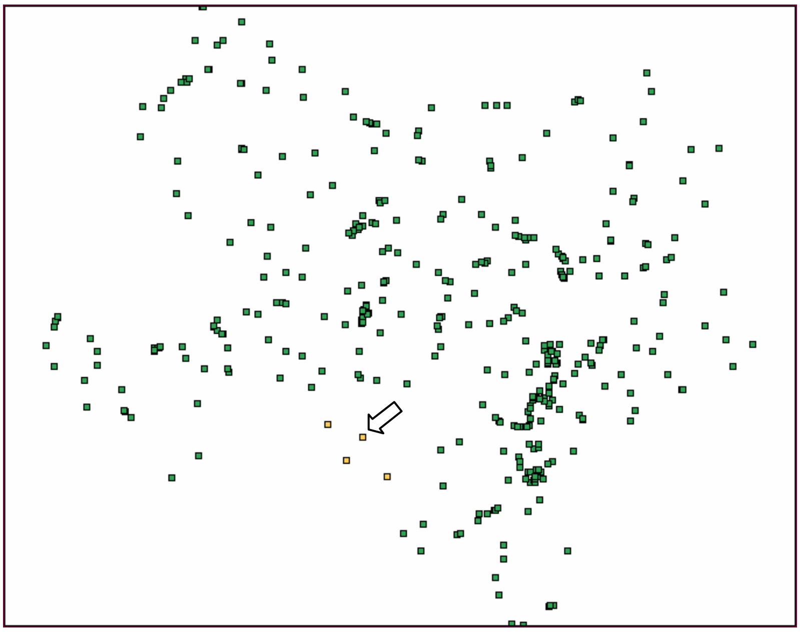
Table 6: Expected Results of Taking Over a Specific Gasoline Station (Example 1)

The unbranded station switches to	Total change in price at the station that is taken over	Total change in price at the BP station next to it	Total change in price at the Aral station next to it	Total change in prices among all (aggregated) (excluding the switching station)	Total change in prices among all branded stations (aggregated) (excluding the switching station)
Agip	0.168	0.030	0.032	0.075	0.071
Aral	0.311	0.177	0.121	0.367	0.340
Avanti	**0.085**	**-0.009**	**-0.009**	**-0.022**	**-0.021**
Avia	0.225	0.057	0.060	0.143	0.135
BP	0.268	0.092	0.163	0.306	0.292
Esso	0.244	0.066	0.070	0.166	0.156
Jet	0.218	0.054	0.057	0.135	0.127
OMV	0.202	0.047	0.049	0.117	0.110
Shell	0.285	0.086	0.091	0.216	0.203
Stroh	0.130	0.012	0.013	0.031	0.029

In every case the price of the transformed station will increase, depending on the brand it switches to. Overall the price increase is relative low. The price increase will be highest if the station is taken over by Aral or by BP, due to its negative composition effect on one of its direct competitors, or by Shell, which is the most expensive brand. The most interesting thing is that there is indeed one brand (Agip), where composition effect dominates the competition effect, and if the former unbranded station becomes an Agip station, the prices at the two neighbouring stations are expected to fall. As the change in prices or in site characteristics affects direct competitors strongest, the aggregated reduction of prices of all stations can be expected to be just slightly larger than the reduction in prices at the two direct competitors. Nevertheless, the reduction in prices of stations other than the switching one is not strong enough to compensate for the price increase of the switching station and the overall price level can be expected to increase, although slightly.

Let us take a look at another example. Among the four yellow dots in figure 2, the one that lies farthest in the north east is the unbranded station under consideration. The other three yellow points are its direct competitors, which are also unbranded stations.

Figure 2: Gasoline Stations in Lower Austria (Example 2)



If the station under consideration becomes a branded station, it will increase its price considerably, as it does not face direct competition with other branded stations. As a consequence, the competition effect will be very large. As this station is not a direct competitor for any other branded station (and the behavior of unbranded stations is independent whether its competitors are branded or not), there will be no composition effect at all. The expected results of transforming the station in question into a branded one are summarized in table 7.

Table 7: Expected Results of Taking Over a Specific Gasoline Station (Example 2)

The unbranded station switches to	Total change in price at the station that is taken over	Total change in price at the closest competitor	Total change in price at the 2nd closest competitor	Total change in price at the 3rd closest competitor	Total change in prices among all (aggregated) (excluding the switching station)	Total change in prices among all branded stations (aggregated) (excluding the switching station)
Agip	0.312	0.144	0.093	0.159	0.424	0.017
Aral	0.395	0.182	0.118	0.202	0.536	0.022
Avanti	0.235	0.109	0.070	0.120	0.320	0.013
Avia	0.365	0.169	0.109	0.187	0.496	0.020
BP	0.362	0.167	0.108	0.185	0.491	0.020
Esso	0.383	0.177	0.114	0.196	0.520	0.021
Jet	0.359	0.166	0.107	0.183	0.488	0.020
OMV	0.345	0.159	0.103	0.176	0.468	0.019
Shell	0.422	0.195	0.126	0.216	0.573	0.023
Stroh	0.277	0.128	0.083	0.142	0.376	0.015

Indeed, the price increase of the specific station is relative high (especially compared to the other example). As there is no composition effect on the competitors, their prices will increase by a considerable amount, although at a smaller extent than the switching station. The only price increase that is quite small is that of other branded station, which is due to the fact that no branded station is close to the station in question.

It can be concluded that the effect of an unbranded station on the prices of other (branded or unbranded) stations does not only depend on the estimated parameters, but also on the concrete spatial patterns of price competition. If a station switches from unbranded to branded, the reaction of its direct competitors can vary significantly, and it is even possible, that these competitors lower its price, as shown in the first example.

V. Conclusions

This study investigates the effects of unbranded gas stations on the prices charged by branded and unbranded competitors. It is shown that both the composition and the competition effect have the expected sign, although the first one is not significant. This supports the existing literature that unbranded stations have a negative effect on prices charged by branded ones. Nevertheless, I find some support for the hypotheses that diesel sold at gas stations is a differentiated good, not only in a spatial, but also in a quality perspective, and that branded stations are seen as closer substitutes than branded and unbranded ones. It is further shown that both effects and so the contribution of unbranded stations to sharpen price competition (also among branded stations) depends heavily on the concrete spatial competition patterns and has to be estimated on a case by case basis.

The model can be generalized to describe the effect that a low quality segment has on prices charged by the premium quality segment in a spatially differentiated market. This paper sheds new light on the pricing behavior at markets that are characterized by monopolistic price competition with products that are differentiated in a spatial and in a nonspatial perspective.

Appendix

Table 8: Results of ML-estimation when the critical distance is 20 kilometres

Variable	Coefficient	z-value	Significance	Variable	Coefficient	z-value	Significance
Constant	1.9328	5.33	***	Speed 40-60	0.0054	0.16	-
Agip	0.1456	3.78	***	Speed 61-80	-0.0055	-0.15	-
Aral	0.2029	4.44	***	Speed 81-100	0.0914	1.52	-
Avanti	0.0984	2.44	**	**Speed over 100**	0.3363	4.44	***
Avia	0.1775	4.38	***	Nodal Point	0.0518	1.09	-
BP	0.1776	5.11	***	Catering facility	0.0767	1.38	-
Esso	0.1928	4.87	***	Shopping Center	-0.0164	-0.48	-
Jet	0.1812	3.08	***	Motorway Feeder	0.0190	0.4	-
OMV	0.1698	4.7	***	Attendant Service	0.0240	1.03	-
Shell	0.2213	6.23	***	Biodiesel	-0.0001	0	-
Stroh	0.1235	3.57	***	Mis Biodiesel	0.0142	0.86	-
Only Diesel	-0.6580	-6.45	***	Mis Garage	0.1852	1.89	*
Garage	-0.0276	-1.64	*	Mis Payment	0.0397	0.57	-
24 h open	0.0889	2.49	**	Mis Building Date	0.0095	0.19	-
Credit Card	0.0276	0.85	-	Mis Size	0.0092	0.17	-
Fuel Card	-0.0222	-0.83	-	Mis Service	0.0320	0.64	-
Diesel only Card	-0.0073	-0.35	-	W*Garage	0.0272	0.89	-
ATM	-0.0287	-0.49	-	W*24 h open	-0.0265	-0.32	-
Built before 89	-0.0244	-0.73	-	**W*Speed over 100**	-0.3921	-1.39	-
Built before _99	-0.0629	-2.09	**	$\mathbf{e_1}$	0.1259	1.24	-
Built since 2000	-0.0045	-0.14	-	$\mathbf{e_3}$	0.0974	1.56	-
No shop	-0.0080	-0.32	-	$\mathbf{e_5}$	1.6855	1.39	-
Plot size till 800m²	0.0494	2.03	*				
Plot size till 2.000m²	0.0627	3.02	***	$\boldsymbol{\rho}$	0.7723	20.64	***

Table 9: Results of ML-estimation when the critical distance is 25 kilometres

Variable	Coefficient	z-value	Significance	Variable	Coefficient	z-value	Significance
Constant	1.5012	3.93	***	Speed 40-60	0.0046	0.14	-
Agip	0.1502	3.80	***	Speed 61-80	-0.0094	-0.25	-
Aral	0.2037	4.39	***	Speed 81-100	0.0931	1.53	-
Avanti	0.0965	2.34	**	**Speed over 100**	0.3466	4.53	***
Avia	0.1814	4.40	***	Nodal Point	0.0616	1.28	-
BP	0.1835	5.04	***	Catering facility	0.0651	1.16	-
Esso	0.1947	4.79	***	Shopping Center	-0.0178	-0.52	-
Jet	0.1802	3.03	***	Motorway Feeder	0.0210	0.43	-
OMV	0.1711	4.53	***	Attendant Service	0.0214	0.91	-
Shell	0.2215	6.04	***	Biodiesel	0.0000	0.00	-
Stroh	0.1348	3.79	***	Mis Biodiesel	0.0142	0.85	-
Only Diesel	-0.6617	-6.40	***	Mis Garage	0.1755	1.76	*
Garage	-0.0312	-1.83	*	Mis Payment	0.0363	0.52	-
24 h open	0.0932	2.58	***	Mis Building Date	0.0047	0.09	-
Credit card	0.0296	0.91	-	Mis Size	0.0078	0.14	-
Fuel Card	-0.0224	-0.83	-	Mis Service	0.0292	0.57	-
Diesel only Card	-0.0074	-0.35	-	W*Garage	0.0318	0.95	-
ATM	-0.0329	-0.55	-	W*24 h open	-0.0191	-0.20	-

Built before 89	-0.0350	-1.03	-	**W*Speed over 100**	-0.3109	-0.95	**-**
Built before _99	-0.0712	-2.34	**	**e_1**	0.1296	1.09	**-**
Built since 2000	-0.0081	-0.24	-	**e_3**	0.0544	0.75	**-**
No shop	-0.0086	-0.34	-	**e_5**	1.6808	1.36	**-**
Plot size till 800m²	0.0473	1.92	*				
Plot size till 2.000m²	0.0629	2.99	***	**ρ**	0.8184	20.72	*******

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