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by

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Impact of Cross-Border Competition on the German Retail Gasoline Market – German-Polish Border

Mats P. Kahl*

Abstract: Competition on the German gasoline market is of interest for economists, competition authorities and the general public alike. In this paper, I analyse how constantly lower gasoline prices in Poland affect the prices set in the German border region. More precisely, I estimate the impact of one additional kilometre of distance to the nearest Polish competitor on the price charged by German gasoline stations. The analysis is based on a complete dataset of German gasoline prices and an accurate assessment of distances. Fitting random effects models for German gasoline prices while controlling for various station characteristics, I find no evidence suggesting that German gasoline stations enter into price competition with their Polish opponents. The analysis of gasoline station infrastructure in the German border region reveals increasingly sparse gasoline station density when approaching the Polish border, along with an increasing share of premium brands. On the one hand, I find evidence suggesting that price competition between German and Polish gasoline stations is dominated by the enormous tax differences that presumably exceed profit margins by far; on the other hand, I reveal the consequences on the market structure that are caused by German gasoline stations anticipating this permanent difference in taxes when deciding upon where to locate their gasoline stations.

Keywords: gasoline market, cross-border competition, market transparency

JEL classification: L13, L41, L92

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1 Introduction

Price competition and spatial competition are two aspects lying at the centre of industrial organization. Competition on the market for gasoline retailing is characterised by two important conditions: the fact that goods are homogeneous (Haucap *et al.*, 2015, p. 16) without notable product differentiation and the fact that the market is spatially limited, *exempli gratia* residents of Hamburg would not fuel their vehicles in Prague just because it is cheaper there. Moreover, the German gasoline market is characterised by tremendous price transparency, resulting from lately introduced requirements of German competition authorities.

In regulated markets, tax changes or tax differences may affect prices enormously. Constantly lower gasoline prices in Poland result from permanently lower taxes, in contrast to higher prices in the German high-tax environment. If one assumes price competition á la Bertrand (Kreps and Scheinkman, 1983, p. 326) and increases the number of competitors infinitely, the resulting price converges towards the marginal cost. Thus, the underlying causal assumption prevails that a higher degree of local competition has a negative effect on the price.

In this paper, I compare pricing behaviour of German gasoline stations at the border to Poland to pricing behaviour further inland and I analyse the retailing infrastructure in the German border region. Complete data on virtually all price changes of all German gasoline stations in the border region are available and enter the analysis covering a three quarter period, from January to September 2019. In particular, the impact of distance to the nearest Polish competitor on the price charged by German gasoline stations in the border region is estimated. Surprisingly, I find no economically relevant effect. In fact, the distance to Polish competitors does not affect the prices set by German stations in the border region.

In addition to the price analysis, I assume that gasoline retailers in Germany include the permanent competition disadvantage near Polish competitors into their decision where to locate their gasoline stations. Therefore, I focus on long-run aspects, such as station density and brand composition along the border to Poland. The analysis of gasoline station infrastructure reveals considerable differences between the German border region and the German interior. Gasoline station density gets increasingly sparse when approaching the Polish border, along with an increasing share of premium brands.

To shed light on different aspects of competition between retailers as well as on the implications for the consumers, researchers conducted various regression analyses, including increasingly accurate measures of spatial competition. However, the impact of cross-border competition in the European single market remains poorly investigated. This study ties on to the literature on local competition in gasoline retailing, by stressing this point in the extreme setting at the Polish border. The research question is: what is the effect of "closeness to Poland" on the retail gasoline prices set in the German border region? The question aims not merely on finding *whether* there is a significant effect, but also on *quantifying* this possible effect.

Furthermore, I ask: how do the gasoline station density and brand composition change towards the border to Poland? For this purpose, I define gasoline station density relative to population density. My analysis shows that German pricing behaviour in the border region is rather conventional. This indicates that competition takes place at a different level, namely at the spatial decision-making stage, hence, where the gasoline station is to be located. I address this facet with my second research question.

Lastly, there may be implications for the fiscal policy of a country as noted by Banfi *et al.* (2003, p. 3), who argue that the impact of price differentials on fuelling behaviour "may imply a spatially differentiated fiscal policy, with a spatial graduation of fuel taxes, which should prevent car drivers from fuel-tanking trips abroad". I am not going to give fiscal policy recommendations due to lack of appropriate data.

To the best of my knowledge, I am the first researcher contributing to the gasoline retailing literature on price competition and retailing infrastructure in a German border region based on the comprehensive German dataset.

The remainder of this paper is structured as follows. The relevant literature is reviewed in section 2. My data are introduced in section 3, along with the specification of the econometric methodology. Section 4 presents and discusses the results and is followed by the conclusion in section 5.

2 Literature Review

A whole wave of literature analysing the German gasoline market appeared recently, triggered by the newly collected data from the German Market Transparency Unit for Fuels

(MTUF), made available by certain registered consumer information service providers (Bundeskartellamt, 2018a). Since August 2013, fuel stations are obliged to report price changes for the most common types of fuel to the MTUF (Bundeskartellamt, 2018a). This authority-unit was created by the German Federal Cartel Office (FCO, German: Bundeskartellamt) in order to enable the authority to "intervene in the case of illegal predatory strategies and other forms of market power abuse" (Bundeskartellamt, 2018a). I review the literature containing spatial analyses of gasoline markets, starting with publications from abroad, moving to investigations of the German gasoline market. Thereby, I start with analyses published in the past and move to more recent analyses.

In the 1950s, numerous publications on competition in fuel retailing appeared (Livingston and Levitt, 1959, p. 119). One of the first spatial investigations was conducted by Livingston and Levitt (1959) about competition in the retail fuel market in the Midwest of the USA. They found that lower prices are associated with disadvantages of service station type or location, where the location aspect consisted of traffic intensity and station density (Livingston and Levitt, 1959, p. 124). In line with these findings and based on data from a panel study in the USA, Borenstein (1991, p. 355) states that margin differences are best explained by gasoline stations exercising some local market power, but also by stations engaging in price discrimination against customers who are less likely to switch. Commonly, researchers control for the brand or brand type in their regression analyses, as done in the analyses at hand. Similarly to Borenstein (1991), Shepard (1993, p. 69) finds that prices decrease in the number of nearby rivals in her investigation of competition among gasoline retailers in eastern Massachusetts (USA). Consequently, she also concludes that fuel stations exercise some local market power.

Hosken *et al.* (2008, p. 1425) encounter substantial variation in retail margins in their analysis based on data from the United States of America. This finding is confirmed for Germany three years later by the FCO arguing that "in relation to the margin, price increases in the high two-digit percent range are at stake" (Bundeskartellamt, 2011a, p. 4). This indicates that gas stations have some scope in reacting to competition.

Clemenz and Gugler (2006) analyse the local competition in Austria. They find that higher station density reduces the average gasoline price. Moreover, they show that gasoline station density increases less than proportionally to population density, because competition drives the price down, and they show that the equilibrium price and the price variation decrease with the distance to competitors. They argue that causality runs from station density to price

and conclude that "spatial competition is an appropriate benchmark for judging the intensity (or lack thereof) of competition in the retail fuel market." (Clemenz and Gugler, 2006, p. 310). Another study of the Austrian gasoline market was provided by Pennerstorfer *et al.* (2020, p. 892), who show that a sequential search model – based on identifying the commuting share of customers – reveals an inverted U relationship between price dispersion and the share of informed (commuting) consumers. Additionally, they enter a variable capturing the number of competitors within a certain area around each station, showing that a station´s price decreases as the number of nearby rivals increases. Although this finding is not consistently statistically significant, the effect points in the expected direction. They claim to be the first ones using driving distance instead of "distance as the crow flies" as it was done in the previous literature (Pennerstorfer *et al.*, 2014, 12).

Extensive research on the German gasoline market remained rare until the year 2013, as noted by Haucap *et al.* (2015, p. 2). Kihm *et al.* (2014) investigated the German gasoline market and found stronger influence of the crude oil price on the retail price as local competition increases. They use variation in market concentration, gasoline station density, and spatial isolation from competitors to account for spatial competition. Haucap *et al.* (2015) provide a spatial investigation of the German gasoline market based on the novel German dataset to explain how and why retail prices differ across stations. The spatial component enters the multiple regression via variables defined by driving distance to a station's single closest competitor and via the number of competitors within a surrounding area defined by a critical value of driving distance or driving time. Based on random effects regression models, Haucap *et al.* (2015, p. 21) find that the average retail price increases significantly (at the 10% level) with the distance to the closest competitor and decreases with the number of nearby competitors, although the magnitude of the coefficients is very small.

Another recent study of the German gasoline market focusing on intraday fuel-price-cycles is provided by Neukirch and Wein (2016) and centres around the question whether market power is used and whether there is internal and external competition in the oligopoly consisting of Aral (PB), Esso (EXXonMobile), Shell, Total and Jet (ConocoPhillips). The authors find, that on the one hand, a high intra-day price-volatility may indicate effective competition, while, on the other hand, the uniform price setting indicates parallel behaviour, and hence, ineffective competition. I also include variables for oligopolistic group affiliation. Haucap *et al.* (2015, p. 4) provide a thorough outline of distantly related literature, also covering the price cycle literature that is essentially based on the work on Edgeworth cycle

theory by Maskin and Tirole (1988). This is also reviewed by the Federal German Cartel Office (Bundeskartellamt, 2011a, p. 26; 2011b, p. 127). However, I abstain from analysing intra-day price setting behaviour and focus on daily average, minimum and maximum prices.

Noteworthy is the extensive interest of the Bundeskartellamt (2011a, 2011b, 2018a) in competition on the gasoline market. The authority finalised its fuel sector inquiry (Bundeskartellamt, 2018b) by publishing a thorough report in May 2011. Objects of analysis were the four German cities Hamburg, Leipzig, Cologne, and Munich. Three findings are of special relevance for my analysis. Firstly, the motorway and off-motorway markets are fundamentally different from one another, since access to the motorway market is restricted. License allocation was initially restricted via quotas and is recently confined partly via quotas and partly via distribution through auctions. Secondly, the diesel and the petrol retail markets are considered to be strictly separate markets. The first finding implies the necessity to control for the motorway and the latter finding implies the need for systematic differentiation between the diesel and the petrol market. Thirdly, a group of five oligopolists jointly holds a dominating market position (Bundeskartellamt, 2011a, pp. 9–14).

Publications on cross-border effects of price differentials in the gasoline market are rare. Banfi *et al.* (2003) investigate gasoline station sales along the border in Switzerland and the fuel tourism from Italy, Germany and France, based on data for the period from 1985 to 1997. The dependent variable being fuel demand, they find that a decrease of 10% in the ratio of the Swiss gasoline price to the price charged in the neighbouring country yields an increase in demand of 6.7 to 7.7%. Furthermore, fuel tourism declined from accounting for 15% of overall gasoline sales in the three regions to about 7% over the mentioned time period. Based on these results, the authors conclude that "gasoline consumption by consumers in bordering regions is very sensitive to price differentials of standardized goods like gasoline" and moreover observe "lower fiscal revenues and a decrease of employment in the gasoline distribution sector" (Banfi *et al.*, 2003, p. 1) as a consequence of lower price differentials. The authors base their analysis on detailed quantity data which allows them to draw specific fiscal policy conclusions.

3 Data and Econometric Methodology

Of all German borders, the analysis focuses on the border to Poland for three major reasons. Firstly, the border to Poland is mainly formed by rivers (Oder and Neisse), which reduces

distortion of the data through unaccounted border crossing via unofficial roads. Secondly, data on gasoline prices of neighbouring countries are rare, but weekly price estimates for Poland exist. Thirdly, and arguably most importantly, I focus on Poland of all German neighbouring countries, because Polish weekly price estimates indicate systematically lower prices for petrol and diesel. Hence, if there is any cross-border-competition effect on the German gasoline market, it should be found here (most extreme case), see Appendix Figure 1[1].

The price difference doubtlessly results from differences in fuel taxes, which are illustrated in Appendix Figure 2[2] and based on data from the Organisation for Economic Co-operation and Development (2018b, 2018c). Taxes are about 0.68€/litre for petrol and about 0.50€/litre for diesel in Germany (Organisation for Economic Co-operation and Development, 2018b, p. 2). In contrast, taxes are about 0.40€/litre for petrol and about 0.36€/litre for diesel in Poland (Organisation for Economic Co-operation and Development, 2018c, p. 2).[3] Since 2003, the tax charged on road fuel remained constant at $0.6545\ {}^{€}/_{l}$ for petrol and $0.4704\ {}^{€}/_{l}$ for diesel (Bundesministerium der Finanzen, 2018) in Germany.[4] Additionally, the value added tax of 19% is charged (since the beginning of the year 2007 and 16% beforehand, Statista, 2018)[5]. Appendix Figure 1 shows no signs of tax-changes in Poland. Hence, it is assumed that no changes in taxation occurred in Poland during the time period investigated here. Other neighbouring countries have higher prices for both fuel types than Poland, Appendix Figure 6[6]. The differences in taxes of about $0.14\ {}^{€}/_{l}$ for diesel and about $0.28\ {}^{€}/_{l}$ for petrol most likely exceed the profit margins of gasoline stations by far.

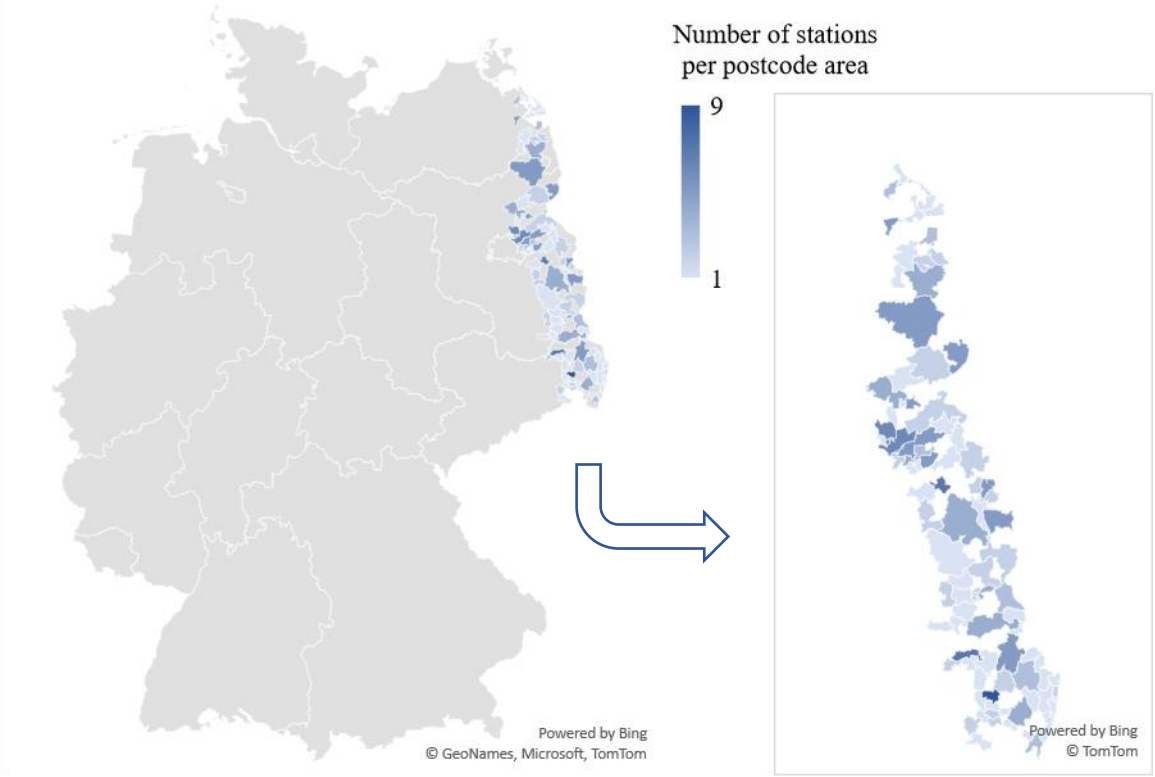
The data collected by the MTUF are provided (among others) by tankerkoenig.de (2019) and infoRoad GmbH (2019). Information on fuel station characteristics is partly contained in the price dataset from tankerkoenig.de (2019) and supplemented manually via the websites of infoRoad GmbH (2019) and of single brands, such as Aral and Shell. There is a substantial difference between the services provided by gasoline stations. The data at hand

[1] Appendix Figure 1 is based on data from globalpetrolprices.com (2019) and created using Excel 2016.
[2] Appendix Figure 2 is created using Excel 2016.
[3] Taxes per gigajoule (GJ) transformed into taxes per litre using conversion factors from the webpage of the University of California Berkley (2018).
[4] Difference compared to the OECD data from above may occur due to exchange rate and conversion rate differences. The OECD data are assumed to be internally consistent and, thus, comparable.
[5] The interested reader may find an overview of road fuel taxes in several countries by the Organisation for Economic Co-operation and Development (2018a).
[6] Appendix Figure 6 is adopted from the infoRoad GmbH (2019).

are panel data, thus, data for multiple German stations, in which each station is observed at several points in time, here, literally all price changes effectuated by each German gasoline station. There are numerous further variables, such as different brand categories, a variety of measures for local competition, an approximation for input costs, some demand side controls and station characteristics, as illustrated in Appendix Table 1. The underlying database comprises 211 German gasoline stations observed over the time-period of nine months, from January to September 2019.

The number of German gasoline station per postcode area is illustrated in Figure 1.[7] Just looking at this descriptive map does not reveal anything about the station infrastructure analysed later.[8]

FIGURE 1: OVERVIEW OF THE NUMBER OF GERMAN GASOLINE STATIONS PER POSTCODE AREA ALONG THE GERMAN-POLISH BORDER



The distances to Polish competitors as well as the distances between German gasoline stations are calculated based on OpenStreetMap data (OpenStreetMap contributors, 2019). The variable of interest "Dist. nearest Polish competitor" measures the driving distance to the closest Polish competitor. According to theory, I expect the coefficient to be positive.

[7] The map is created with Excel 2016.
[8] The brand composition and categorization are illustrated in Appendix Table 4.

The larger the distance to the nearest Polish competitor, the higher the price. Intuitively, the competition faced by a German gasoline station gets tenser the closer it is located to the nearest Polish competitor and vice versa.

Further local competition variables enter the regression. I estimate all driving distances between all German gasoline stations in order to identify the nearest German competitor and the number of German competitors in a predefined surrounding area, Appendix Table 2. Similar to Haucap *et al.* (2015, p. 21), I test different critical values (10km, 5km, 2km, and 1km) to define this surrounding area and find that the variable of interest is not notably affected. Due to easily available calculation capacity, all distances are estimated driving distances based on OpenSteetMap data (OpenStreetMap contributors, 2019).

The Polish average price variable shows a weekly snapshot price, based on a sample of the entire country drawn once per week. This snapshot price is applied to all days of the week.

The crude oil price is approximated by the Brent price as commonly done in the relevant literature, where the prices are obtained from Quandl (2019). The population density data are taken from the German Federal Statistical Office Statistisches Bundesamt (2019). Average weekly prices for Germany and weekly price estimates for Poland are purchased from globalpetrolprices.com (2019). The Polish weekly price estimates enter the regression analysis as approximation of the Polish average price. However, the dependent variable is the German daily average price of a station and is based on price observations that are reported on the second. I refer to the weekly price estimate as "Polish average price" for readability.[9] An overview over all variables is given in Appendix Table 1.

In accordance with the panel data and the objective to identify the effect that distance to Poland has on the price set by a German gasoline station, pooled OLS and random effects regression models are calculated. Moreover, I provide the reader with the more robust fixed effects regression models, in order to enable comparison for time-varying variables. For robustness, several nonlinear regression functions are considered. I also introduce an interaction term between distance to nearest Polish competitor and Polish average weekly price and estimate quadratic and cubic regression models as well as a log-log model. Robustness checks include changing the dependent variable from daily average prices to maximum or minimum daily prices. Furthermore, I consider a 13-hour day, from 7am to 8pm, because more than 90% of the gasoline stations are open during this period. Again, I

[9] Appendix Figure 1 is based solely based on data from globalpetrolprices.com to maintain internal consistency.

ran several different models for robustness. This alternative specification of the day prevents distortion caused by different market constellations in the late evening and early morning hours.

Moreover, I look at the two most common fuel types, namely diesel and 95 octane unleaded petrol, called "Bleifrei Super E5" in Germany (thereafter simply referred to as petrol).

Here, I introduce the pooled OLS regression model exemplarily. It can be written in non-matrix form as:

$$p_{it} = \beta_0 + \beta_1 DIS_i + \beta_2 PAP_t + \beta_3 CO_t + \beta_4 x_i + \beta_5 WEH_t + \varepsilon_{it} \qquad (1)$$

where p_{it} represents station i´s average (minimum or maximum) daily retail price (for petrol or diesel) at time t, DIS_i is station i´s distance to the closest Polish competitor, and PAP_t represents the Polish average weekly price at time t, as explained in the data section above. Similar to the specification by Haucap *et al.* (2015, p. 19), CO_t gives the crude oil price at time t, x_i represents a vector of all time-invariant, station-specific control variables as well as population density. WEH_t is a vector of dummy variables to control for particular days of the week, public holidays *et cetera*. The βs are the coefficients to be estimated, where β_0 is the constant. The ε_{it} is the error term, that can be expressed as $\varepsilon_{it} = \mu_i + u_{it}$, where it consists of an individual-specific time-invariant part, μ_i, also referred to as unobserved heterogeneity, and u_{it}, the idiosyncratic error that changes both over time and across space. The indices are denoting the individual stations $i = 1, \dots, n$, with a hypothetical maximum of $n = 211$, and the time periods $t = 1, \dots T$, with a hypothetical maximum of $T = 272$ for the diesel data. The model is estimated by OLS on the unbalanced panel data with $N < nT$ observations.

Even though the notation in the equation indicates how variables change over i or t, the panel structure of the data is ignored when calculating the pooled OLS regression model, in contrast to the more appropriate random effects model. The pooled OLS regression is performed by pooling all observations together, regardless of their belonging to a given individual (Millo, 2017, p. 5). Robust standard errors á la Driscoll and Kraay´s SCC (Driscoll and Kraay, 1998) are used for inference, as it accounts for heteroskedasticity, autocorrelation and cross-sectional dependence.[10]

[10] These standard errors á la Driscoll and Kray are used for all model specifications.

Note that for simplicity distance is modelled as being independent of time. Hence, the driving distance variable is used, whereas the driving time variable is not used because it may vary substantially over time, *exempli gratia* late evening compared to rush hour, or weekday compared to Sunday. The driving-time data for different times of the day are not available, neither are the data for different dates.

Finally, I divided all gasoline stations in the German border region into four zones. Zone A contains all gasoline stations with a driving distance of no more than 15km to the nearest Polish competitor, Zone B contains all stations with more than 15 but no more than 30km distance to the nearest Polish competitor. Analogously, Zone C contains the stations with a 30-45km distance and Zone D the remaining stations with a distance of up to 60km from the nearest Polish competitor. I conduct regression analysis to estimate the pricing behaviour by zone and continue by analysing the gasoline station infrastructure and brand composition in the different zones. However, the small number of stations and the large number of variables allows calculation of pooled OLS regression models and most random effects models but hinders calculation of one random effects model, as indicated later. Overall, coefficients are very similar for both models, however, the p-values should be interpreted rather cautiously when it comes to interpreting pooled OLS models.

In the following, I turn to the description of the methodology for analysing the gasoline station infrastructure. I calculate the population density for all postcode areas and assign it to each German gasoline station accordingly. Then, I calculate the average population density of each zone along with other local competition variables and the service index. Subsequently, I put the population density in relation to the number of gasoline stations in the different zones.

Clemenz and Gugler (2006) show that gasoline station density increases less than proportionally to population density. They argue that competition drives the price down. This means that the number of gasoline stations increases at a lower rate with the population density the higher the population density is. I compare the number of stations relative to population density for various distances to Poland. Moreover, I analyse how premium brand dominance changes with the distance to Poland using the zones defined above. For that, I consider the brand categorization named oligopoly of four (consisting of Aral, Shell, Esso and Total). For the sake of completeness, I include this categorization in some of the regression model specifications in the price analysis, differentiating between the oligopoly of five and the oligopoly of four, as done by Neukirch and Wein (2016, p. 201). This

categorization proves beneficial in light of the threat of multicollinearity introduced by entering brand-dummy variables in the regression analyses. However, I use the usual brand controls where possible. In addition, I compare the average number of price changes per day in order to provide another estimate for competition activity in the different zones.

4 Results and Discussion

For the sake of simplicity, I concentrate on the discussion of diesel data, because the results of the analysis of petrol data are essentially the same.[11] Table 1 displays the regression results obtained from regression analysis using solely diesel data. The dependent variable is the average daily price reported by German gasoline stations in the border region, considering prices reported over the whole day-cycle of 24 hours. The pooled OLS results show a statistically significant negative impact of distance to the nearest Polish competitor. A $1km$-increase in the distance to the nearest Polish competitor decreases the price set by the German gasoline station in the border region by about $0.00006\ {€}/{l}$ on average.[12] The descriptive statistics corresponding to the data underlying Table 1 are given in Appendix Table 2.[13]

Even though statistically significant, this effect is by no means economically relevant. No customer can be expected to drive, for example, to a petrol station $10km$ further inside Germany to save $10 * 0.00006 = 0.0006\ {€}/{l}$; even if she or he would fill in $50\ litres$, the total savings would amount to a ridiculously small saving of $0.006€$. It is striking that the distance to the nearest Polish competitor does not have any effect on the prices set by stations in the German border region and that the coefficient is even negative, contrary to what could theoretically be expected. I would have surmise, that the nearer a German gasoline station is located to a Polish competitor, the higher the competition it faces, and therefore, the lower the price it charges. The corresponding coefficient from the more appropriate random effects model is not even statistically significant and of the same small magnitude. Hence, it is not significantly different from zero and so small that it is economically irrelevant. For the time being, it should be noted that there is no considerable impact of distance to the nearest Polish

[11] Average daily diesel and petrol prices over the whole time period of nine months are illustrated in Appendix Figueres 3 and 5 respectively.
[12] The prices are given in ${EUR}/{litre}$ here, denoted ${€}/{l}$ while the dependent variable in regression tables is denoted in Cents per litre.
[13] Appendix Table 3 contains some statistical tests corresponding to the analysis in Table 1.

competitor based on this analysis. In the following, I refine the analyses further to provide a sound conclusion.

TABLE 1: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h)

	Dependent variable: Daily Average Price		
	Pooled (OLS)	Random-effects	Fixed-effects
`Dist. nearest Polish competitor`	-0.0055*** (0.0021)	-0.0064 (0.0292)	
`Polish average price`	0.0967 (0.0790)	0.0961 (0.0791)	0.0961 (0.0791)
`Crude oil price`	1.0108*** (0.0658)	1.0110*** (0.0658)	1.0110*** (0.0658)
`Dist. nearest German competitor`	-0.0893*** (0.0041)	-0.0796 (0.0574)	
`No. German competitors in 10km`	-0.0989*** (0.0117)	-0.0865 (0.1622)	
Motorway	12.8163*** (0.3581)	12.8170*** (4.9662)	
`National road`	-1.2009*** (0.0933)	-1.1737 (1.2914)	
`Population density`	-0.0003** (0.0002)	-0.0004 (0.0021)	
Agip	0.3164*** (0.0383)	0.3293 (0.5340)	
ARAL	2.5135*** (0.0704)	2.5174*** (0.9653)	
AVIA	-1.2489*** (0.1198)	-1.1248 (1.6076)	
ESSO	1.8063*** (0.0702)	1.7864* (0.9789)	
SB	-1.1153*** (0.0734)	-1.0950 (1.0099)	
GO	-1.2796*** (0.1268)	-1.2877 (1.7570)	
GULF	0.3339* (0.1900)	0.2841 (2.6456)	
HEM	-0.1056 (0.2399)	-0.1165 (3.3378)	
JET	-0.7646*** (0.0903)	-0.7598 (1.2535)	
Supermarket	-1.3972*** (0.0660)	-1.2488 (0.8856)	
OIL	-1.5709*** (0.1404)	-1.5199 (1.9334)	
Shell	3.1430*** (0.0948)	3.1536** (1.3108)	
Sprint	-0.7568*** (0.1020)	-0.7303 (1.4063)	
STAR	-1.8987*** (0.0805)	-1.8953* (1.1190)	
TOTAL	1.5030*** (0.0663)	1.5311* (0.9228)	
Tuesday	-0.2717 (0.2179)	-0.2709 (0.2178)	-0.2709 (0.2178)
Wednesday	-0.3849 (0.3033)	-0.3839 (0.3033)	-0.3838 (0.3033)
Thursday	-0.3721 (0.3153)	-0.3721 (0.3154)	-0.3721 (0.3154)
Friday	-0.3798 (0.2734)	-0.3795 (0.2734)	-0.3795 (0.2734)
Saturday	-0.2521 (0.2622)	-0.2513 (0.2623)	-0.2513 (0.2623)
Sunday	0.3002 (0.2218)	0.3019 (0.2220)	0.3020 (0.2220)
Holiday	1.1537** (0.4963)	1.1485** (0.4959)	1.1485** (0.4958)
Shop	-1.5407*** (0.0491)	-1.4220** (0.6508)	
Truck	0.0725* (0.0398)	0.0795 (0.5537)	
Bistro	-0.0269 (0.0610)	-0.0005 (0.8451)	
`Baking station`	0.4883*** (0.0424)	0.4524 (0.5871)	
Shower	-0.7016*** (0.0681)	-0.7151 (0.9502)	
`Vacuum cleaner`	-0.2679*** (0.0373)	-0.2461 (0.5176)	
ATM	-0.3555*** (0.0745)	-0.3690 (1.0267)	
`Pressure washer`	0.2397*** (0.0435)	0.2309 (0.5985)	

TABLE 1: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h)

	Dependent variable: Daily Average Price		
	Pooled (OLS)	Random-effects	Fixed-effects
`Car wash`	0.8417*** (0.0219)	0.8535*** (0.3001)	
`Tire pump`	1.3229*** (0.0534)	1.3144* (0.7338)	
Restaurant	1.7020*** (0.1432)	1.6896 (1.9814)	
`Service station`	-0.2416*** (0.0522)	-0.2489 (0.7243)	
`Credit card`	-0.6778*** (0.0795)	-0.5399 (1.0478)	
Constant	79.6784*** (8.4394)	79.4297*** (8.2636)	
Observations	54,760	54,760	54,760
R^2	0.6663	0.5945	0.5885
Adjusted R^2	0.6661	0.5941	0.5869
Remarks:	Significance Level: *** p < 0.01, ** p < 0.05, * p < 0.1; Heteroskedasticity and serial correlation consistent standard errors in parenthesis. Driscoll and Kraay - SCC estimator.		

The "Polish average price" variable is a sample price drawn once per week and extrapolated for all days of the according week. The coefficients are statistically insignificant in all model specifications in Table 1. This result is plausible because there is little variation in this price. Furthermore, it is very unlikely that the Polish price has an impact on the average prices in the German border region here because the border region contains all German stations with a driving distance of no more than 60km to the nearest Polish competitor.

The coefficient of the input cost variable, namely the coefficient of the crude oil price, is highly significant.[14] An increase of 0.01 $€/l$ in the price for crude oil causes an average increase of about 0.01 $€/l$ in the retail prices set in the German border region. This is roughly in line with investigations of average daily retail prices for diesel in the past. *Exempli gratia* it is slightly above the estimates by Haucap *et al.* (2015, p. 21), who obtain a coefficient of about 0.73.

Haucap *et al.* (2015, p. 21) find that the distance to the nearest competitor has a very small positive effect on the retail price set by a gasoline station. I find no significant effect of distance to the nearest German competitor. The variable of the number of competitors seems more comparable. The random effects model coefficient indicates that one additional German competitor within $10km$ of driving distance leads to an average decrease in the

[14] The crude oil price is approximated with the Brent price as common in the relevant literature and obtained from Quandl (2019). The changes of the crude oil price over the whole time period is illustrated in Appendix Figure 4.

price of about 0.001 €/l. Even though the sign of the coefficient is in line with theoretical expectations and other literature, it is statistically insignificant in the random effects model.[15]

The effect of a station being located on the motorway is estimated to be about 0.13 €/l, which is in line with literature dealing with the motorway market, *exempli gratia* Kleineberg (2020, p. 1) finds a premium of around 0.11 €/l throughout the day on gasoline sold by stations located on the motorway. A rather small coefficient of 0.06 €/l is found by Haucap *et al.* (2015, p. 21). The motorway results at hand are to be considered with care since only seven motorway gasoline stations are included in the dataset. In contrast to the effect of a station being located on the motorway, the coefficient on national roads is statistically insignificant.

In Table 1, the random effects coefficient of the demand variable, population density, is statistically insignificant. Hence, there is no effect of population density on the prices set in the German border region if the border region is defined as reaching 60km inland.

There are no surprises compared to existing literature when it comes to brand effects.[16] The premium brands ARAL and Shell charge significantly higher prices on average. More precisely, compared to the independent gasoline stations[17] they charge about 0.03 €/l more on average. Results for the other oligopoly players, ESSO and TOTAL, are weakly significant and indicate that they charge about 0.02 €/l more than independent stations. The insignificant coefficient for the last oligopoly player, JET, indicates a price that is 0.01 €/l lower on average. Moreover, the coefficient of the integrated player STAR is weakly significant and shows that it charges on average about 0.02 €/l less than independent gasoline stations. All other brand coefficients are statistically insignificant. These findings are roughly in line with Haucap *et al.* (2015, p. 23).

Estimations based on brand categorizations instead of single brands yield highly significant coefficients in the random effects model for the oligopoly group of four (ARAL, ESSO, TOTAL and Shell) and the oligopoly group of 5 (plus JET). The price is estimated to be on

[15] An alteration of the critical value of the perimeter from 10km to 5km, 2km and 1km leaves the coefficient small and insignificant. It may well be compared to the 2km of driving distance perimeter in the work by Haucap *et al.* (2015, p. 21).

[16] An overview of the brand composition in the dataset may be found in Appendix Table 4.

[17] The term "independent gasoline stations" refers to all gasoline stations not named explicitly. This group consists mainly of very small groups of retailers with only one or two gasoline stations. They are named *Others* in the descriptive statistics and omitted in the regression analysis to avoid the dummy variable trap.

average about 0.029 €/l and 0.027 €/l higher, respectively. The other variables do not change considerably compared to Table 1.

The control variables for single days of the week are insignificant in the random effects model except for the holiday variable that is significant at the 5% significance level and indicates that prices are on average about 0.01 €/l higher on public holidays. The results of the random and the fixed effects models match. The fixed effects regression model is provided in Table 1 to provide a comparison for time varying coefficients. The crucial assumption underlying the random effects model that the individual error component is uncorrelated with the regressors is rather unrealistic. If one assumes more realistically that the individual error component is correlated with the regressor, then the fixed effects estimator is solely consistent. My results show that the significance levels estimated using both models are the same, indicating that the random effects model may be interpreted confidently. Moreover, all three models´ coefficients are very similar.

In all regression analyses, it is controlled for services provided by gasoline stations via dummy variables. The random effects model shows three services that affect the price significantly. The highly significant dummy for the car wash facility indicates that this service raises the price on average by almost 0.01 €/l. The significant coefficient for shops indicates a negative impact on the price of more than 0.01 €/l on average. Providing a tire pump leads to a higher price of more than 0.01 €/l on average, though this effect is only weakly significant.

Appendix Tables 5-7[18] are based on the same data as Table 1, but they include different combinations of two novel variables: 1) the service index variable, and 2) the weekend holiday variable. The service index is used instead of single service dummy variables and the variable that accounts for weekend days and holidays jointly is used instead of single dummy variables for Saturday, Sunday and Holiday.

The service index variable was generated to prevent multicollinearity, especially in regression analyses based on different zones because there are fewer gasoline stations in the

[18] Appendix Table 5 contains different pooled OLS specifications that exactly match to Appendix Table 7, which contains analogous fixed effects specifications. Fixed effects specifications with variation in time invariant variables are provided for comparison reasons, because the underlying sample may change slightly with availability of different variables. Appendix Table 6 contains some random effects specifications that do not match the other tables because some models could not be estimated due to collinearity.

zones. Even though highly significant in the pooled OLS model, the variable is not significant in the more appropriate random effects model. The corresponding coefficients of both models indicate that providing one additional service raises the price by about $0.001\ ^{€}/_{l}$ on average. It is not surprising that no significant effect is detected because opposite effects of different variables are intermingled in this variable. It is preferable to use single service dummies instead of the service index whenever possible. The coefficient for distance to the nearest Polish competitor is not notably affected by the various different specifications.

Also, the joint dummy variable for weekend-days and holidays was generated to prevent multicollinearity. In the most appropriate model, the fixed effects regression model, the holiday coefficient is significant for all possible specifications. However, the Sunday-holiday variable is only weakly significant, and the weekend-holidays dummy is insignificant. It is preferable to use singly days dummies instead of joint dummies whenever possible.

The interested reader may find detailed regression analyses in the appendix, precisely pooled OLS models in Appendix Table 5, random effects models in Appendix Table 6, and fixed effects models in Appendix Table 7, all providing several different models that contain different variable combinations (as obvious from the regression table). In these appendix tables, the service index is disentangled in its single components as is the dummy variable indicating weekend-days and holidays. For the workshy reader, it shall be sufficient to know that there are no surprises in the appendix, and that the aforementioned results are roughly consistent to different specifications.

Another question is whether there is an interaction between distance to nearest Polish competitor and Polish average weekly price. The regression results corresponding to Table 1 but including an interaction term between the two variables of interest are provided in Appendix Table 8. The highly significant pooled OLS coefficient of the distance to nearest Polish competitor variable becomes even smaller, about -0.49.[19] The coefficient of the interaction term is statistically highly significant in the pooled OLS and fixed effects models provided.[20] Looking exemplarily at the pooled OLS, one can interpret the coefficient of about $0.000041\ ^{€}/_{l}$ as indicating, that the effect on the prices set in the German border region of one additional kilometre to the closest Polish competitor is greater, by the amount

[19] Coefficients of linear and nonlinear models cannot be directly compared. This difference is not contradictory to the above finding.
[20] The random effects model could not be estimated due to computational multicollinearity.

of $0.000041\ {€}/{l}$, for each additional $0.01€$ in the Polish average price. The interaction term indicates that the effect of a unit change in the distance to the nearest Polish competitor depends on the level of the Polish average price. The effect on the price in the German border region of a $1km$-increase in the distance to the closest Polish competitor, holding the Polish average price constant, is:

$$\frac{\Delta p_{it}}{\Delta DIS_i} = -0.4928 + 0.0041 * PAP_t, \qquad (2)$$

which depends on PAP_t. Here, the coefficient of DIS_i is -0.4928 and the interaction term coefficient is 0.0041 both in $Cent\ per\ litre$.

Consider a small example: If the Polish average price was $1€$ and the distance to the nearest Polish competitor was $10km$, the effect on the German price of a $1km$-increase in the distance to the nearest Polish competitor, holding the Polish price constant at $1€$, was $= -0.4928 + 0.0041 * 100 = -0.0828\ Cent\ per\ litre$. In contrast, if the Polish average price would be $1.5€$, then the effect of a $1km$-increase in the distance to the nearest Polish competitor, holding the Polish price constant at $1.5€$, would be $= -0.4928 + 0.0041 * 150 = +0.1222\ Cent\ per\ litre$. Hence, it is a difference of about $0.205\ Cent\ per\ litre$. Therefore, a hypothetically ridiculously high Polish average price may cause the effect on the German price of an $1km$-increase in the distance to the nearest Polish competitor to become positive. This means that the petrol becomes cheaper the nearer one comes to the Polish border, if one is far away from the border. However, such an interpretation, inserting a highly unrealistic Polish average price, is out of the scope of the methodology applied, which is limited to marginal changes in the interval covered. The effect of the distance to the nearest Polish competitor on the prices set in the German border region depends statistically on the level of the Polish average price. However, it is to be concluded, that the highly significant interaction term reveals an economically irrelevant relation between the distance to the nearest German competitor and the Polish average price. Therefore, it may be neglected.

I turn to further nonlinear functions, namely quadratic and cubic regression functions. The regression results are provided in Appendix Table 9. In the pooled OLS model, all coefficients of the distance to the nearest Polish competitor regressors are highly statistically significant, whether the regressor enters in linear or nonlinear form. The statistically significant coefficient of the distance to nearest Polish competitor regressor in the quadratic

regression model is -0.005. In the cubic regression model, the coefficient of the linear regressor is 0.1067, the one of the quadratic regressor is -0.0036 and the one of the cubic regressor is 0.00003.

Consider an example of an independent gasoline station for which all independent variables are exactly equal to the mean values of the data underlying Table 1 (compare Appendix Table 3). Assume that we estimate the expected price on a Monday and that the gas station does not provide any services and that it is neither located on the motorway nor on a national road. The following hypothetical price would be expected, following the quadratic pooled OLS regression model (model (1) in Appendix Table 9):

$$\begin{aligned} Price = {} & Constant + 0.0290 * DIS_i - 0.0005 * DIS_i^2 \\ & + 0.0967 * PAP_t + 1.0108 * CO_t - 0.0969 \\ & * DISG_i - 0.1221 * No.G.Comp_i - 0.0001 \\ & * PopDensity_i \\ Price = {} & 79.4093 + 0.029 * 35.045 - 0.0005 * 35.045^2 \\ & + 0.0967 * 117.971 + 1.0108 * 36.22 \\ & - 0.0969 * 3.508 - 0.1221 * 5.475 - 0.0001 \\ & * 244.360 \\ Price = {} & 126.8, \end{aligned} \tag{3}$$

where the values for the number of German competitors and for the population density were not rounded to integers. Now, this result shall be compared to the respective result that one would obtain from the very same calculations using model (1) from Table 1, for the same station as above:

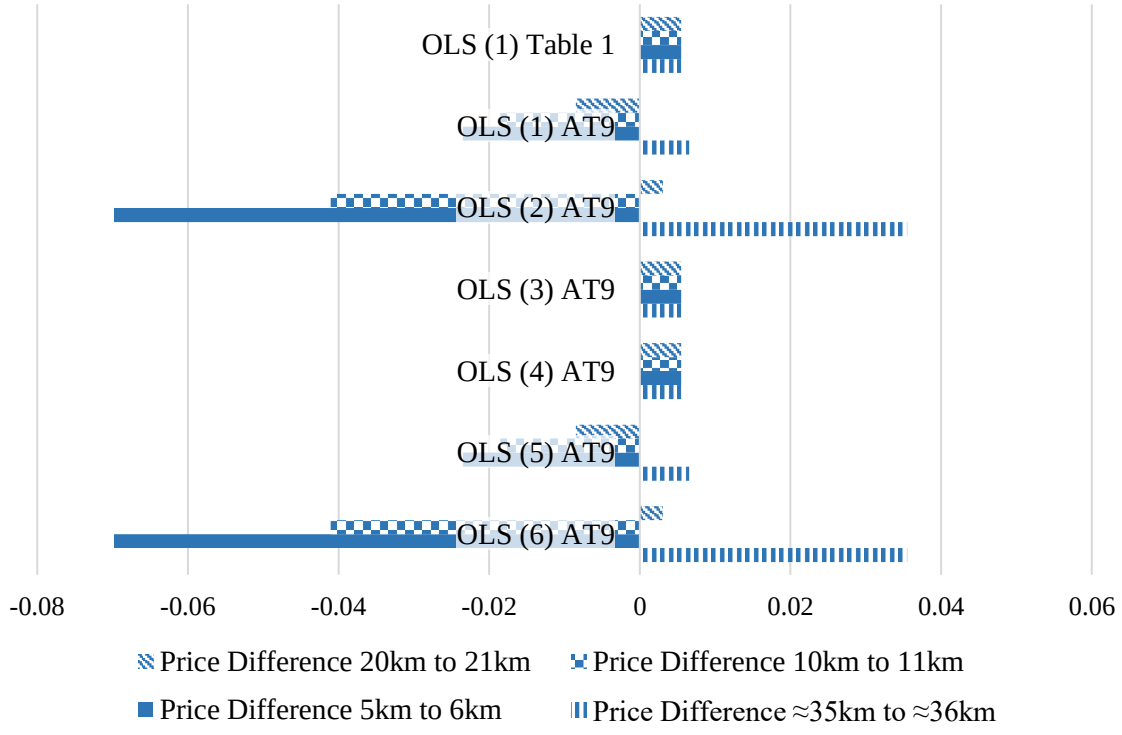
$$\begin{aligned} Price = {} & Constant - 0.0055 * DIS_i + 0.0967 * PAP_t \\ & + 1.0108 * CO_t - 0.0893 * DISG_i - 0.0989 \\ & * No.G.Comp_i - 0.0003 * PopDensity_i \\ Price = {} & 79.4093 - 0.0055 * 35.045 + 0.0967 * 117.971 \\ & + 1.0108 * 36.22 - 0.0893 * 3.508 - 0.0989 \\ & * 5.475 - 0.0003 * 244.360 \\ Price = {} & 126.3. \end{aligned} \tag{4}$$

Thus, the difference is $0.005\ {}^{€}/_{l}$. This example shows that there are no relevant changes with respect to the conclusion drawn above. Note that the random effects model could not

be estimated, presumably due to some kind of multicollinearity that might occur due to inaccurate rounding by the software. Hence, these findings are rather unreliable, although in line with the above findings. In general, the single coefficients in quadratic and cubic regression models are not easy to interpret directly.

Figure 2 shall help to get a more general overview of the quadratic and cubic pooled OLS regression models from Appendix Table 9. Price estimates based on the regression functions are simulated for four scenarios: 1) based on mean values for all regressors as in the example above, with $DIS_i = mean = 35.045km$ versus a situation in which $DIS_i = mean + 1km = 36.045km$; 2) based on the same mean values for all regressors as before, but setting $DIS_i = 5km$ versus a situation in which $DIS_i = 6km$; 3) as 2) but with $DIS_i = 10km$ versus $DIS_i = 11km$; and 4) with $DIS_i = 20km$ versus $DIS_i = 21km$. The figure shows that there are no substantial changes in the price differences in the varying models.[21] The "AT9" indicates that the models are taken from Appendix Table 9, while one of the models is taken from Table 1, as indicated. Almost all changes lie in a range of $0.001\ {}^{€}/_{l}$. The effects are economically irrelevant, hence, the above stated conclusion remains valid.[22]

FIGURE 2: DIFFERENCES IN PRICES, FOUR SCENARIOS



[21] Figure 6 was produced using Excel 2016.
[22] It is abstained from further statistical robustness checks with respect to the comparison of linear, quadratic and cubic regression models, because there is no economically relevant difference.

The last nonlinear regression specification, the log-log regression model, holds no surprises. Results of the pooled OLS and random effects model are provided in Appendix Table 10.

It is essentially the same regression underlying Table 1 above, except that the dependent variable as well as all continuous regressors are in natural logarithms.[23] Again, the coefficient of the distance to nearest Polish competitor regressors of the pooled OLS model is statistically significant in contrast to the one of the random effects model. An advantage of the log-log model is that the coefficients (in logs) can be interpreted as elasticities. For example, the coefficient of the distance to nearest Polish competitor regressor obtained in the pooled OLS model is -0.0008. It indicates that a hypothetical[24] 1% change in the distance to the nearest Polish competitor is associated with a 0.0008% decrease in the average daily price set in the German border region. The coefficient is the elasticity of p_{it} with respect to DIS_i and can approximately be written as:

$$\frac{\Delta p_{it}}{p_{it}} \cong \beta_{DIS_i} \frac{\Delta DIS_i}{DIS_i}, \text{ or}$$

$$\beta_{DIS_i} = \frac{\frac{\Delta p_{it}}{p_{it}}}{\frac{\Delta DIS_i}{DIS_i}} = \frac{percentage\ change\ in\ p_{it}}{percentage\ change\ in\ DIS_i}, \tag{2}$$

where all variables are defined as above. However, the more appropriate random effects model indicates that there is no effect significantly different from zero. The coefficients for the Polish average price regressor are insignificant. The crude oil coefficient is highly significant and indicates that a 1% increase in the crude oil price leads to an average increase of 0.29% in the price set by a German station in the border region. The other variables are economically similar to the results in Table 1. Note that the variance in the price explained by the random effects model is considerably higher in the log-log regression model than in the linear-linear specification in Table 1, with $\bar{R}^2 \cong 0.70$ and $\bar{R}^2 \cong 0.59$, respectively.

Hitherto, the analysis was based on daily average prices over the day cycle of 24 hours. For robustness, further regression specifications were estimated, including similar calculations to Table 1 based on minimum and maximum daily prices and analysis based on price data over a 13h day cycle, ranging from 7am to 8pm. This shorter day cycle was considered because more than 90% of gasoline stations open at 7am and do not close before 8pm. The

[23] I use solely the natural logarithm.
[24] It is hypothetical, because it is very unlikely to assume that a station changes its distance to the nearest Polish competitor in the short run.

market composition and especially the local competition networks might change tremendously during the night hours. However, the coefficient of interest, measuring the effect of distance to nearest Polish competitor on the prices set in the German border region, does not change notably, neither do any of the other coefficients. This result is maintained if the daily minimum or maximum price is used instead.

Eventually, the price analysis analogous to the one underlying Table 1 is conducted for the different zones. Zone A contains all gasoline stations no more than 15km away from their nearest Polish competitor; Zone B contains all stations more than 15km and up to 30km away; Zone C all stations more than 30km and up to 45km away; and Zone D all stations between 45km and 60km away.

Table 2 shows pooled OLS and random effects regression models for all four zones, except for Zone D for which estimation of the random effects model was not possible due to collinearity.[25] The coefficient of distance to the nearest Polish competitor is insignificant in all random effects models. Hence, in this case, there is no statistical effect different from zero. However, the sign of the coefficient is positive for Zone A and Zone B and turns negative for the other zones. This change is in line with theoretical expectations, namely that increasing the distance to Polish competitors yields a higher price up to a certain distance and does not affect the price thereafter. However, since the coefficients lack statistical significance and economically relevant magnitude, I conclude that gasoline stations in the German border region do not enter into price competition with their Polish counterparts.

TABLE 2: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h), ALL ZONES

	Dependent variable: Daily Average Price						
	Pooled (OLS)	Random-effects	Pooled (OLS)	Random-effects	Pooled (OLS)	Random-effects	Pooled (OLS)
	Zone A		Zone B		Zone C		Zone D
`Dist. nearest Polish competitor`	0.1535***	0.1538	0.0600***	0.0550	-0.0643***	-0.0670	-0.0597***
	(0.0101)	(0.1115)	(0.0094)	(0.0989)	(0.0054)	(0.0480)	(0.0111)
`Polish average price`	-0.0645	-0.0649	0.0514	0.0507	0.1352*	0.1340*	0.1598*
	(0.0779)	(0.0778)	(0.0740)	(0.0739)	(0.0784)	(0.0782)	(0.0878)
`Crude oil price`	1.0610***	1.0616***	1.0208***	1.0206***	1.0018***	1.0026***	0.9950***
	(0.0584)	(0.0583)	(0.0643)	(0.0641)	(0.0670)	(0.0668)	(0.0744)
`Dist. nearest German competitor`	-0.3035***	-0.2980**	-0.0671***	-0.0643	0.0007	0.0047	-0.0012
	(0.0105)	(0.1196)	(0.0063)	(0.0664)	(0.0128)	(0.1112)	(0.0069)

[25] Descriptive statistics for all four zones may be found in Appendix Tables 11-14.

TABLE 2: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h), ALL ZONES

	Dependent variable: Daily Average Price						
	Pooled (OLS)	Random-effects	Pooled (OLS)	Random-effects	Pooled (OLS)	Random-effects	Pooled (OLS)
	Zone A		Zone B		Zone C		Zone D
`No. German competitors in 10km`	-0.2225***	-0.2108	-0.1086***	-0.1032	0.0090	0.0191	-0.1772***
	(0.0329)	(0.3537)	(0.0170)	(0.1802)	(0.0223)	(0.1930)	(0.0284)
Motorway	7.0339***	7.0227	14.4225***	14.4507***	0.1422	0.1268	17.9485***
	(0.4417)	(4.9571)	(0.3392)	(3.6171)	(0.1830)	(1.6271)	(0.4894)
`Population density`	-0.0010***	-0.0012	0.0007*	0.0006	-0.0007	-0.0009	0.0018***
	(0.0002)	(0.0027)	(0.0004)	(0.0041)	(0.0004)	(0.0038)	(0.0002)
Oli4	2.5899***	2.6222***	2.3169***	2.3209**	2.2037***	2.2242***	2.4487***
	(0.0792)	(0.8948)	(0.0959)	(1.0262)	(0.0589)	(0.5222)	(0.0479)
Tuesday	-0.2678		-0.2152		-0.3317		-0.2445
	(0.2201)		(0.2109)		(0.2261)		(0.2302)
Wednesday	-0.3609		-0.3322		-0.4901		-0.3434
	(0.3084)		(0.3030)		(0.3042)		(0.3201)
Thursday	-0.3799		-0.3037		-0.4201		-0.3640
	(0.3198)		(0.3127)		(0.3242)		(0.3295)
Friday	-0.3351		-0.2817		-0.4339		-0.4234
	(0.2819)		(0.2697)		(0.2827)		(0.2869)
Saturday	-0.2005		-0.1774		-0.3785		-0.2149
	(0.2694)		(0.2593)		(0.2694)		(0.2736)
Sunday	0.1190		0.2724		0.2557		0.5106**
	(0.2315)		(0.2238)		(0.2305)		(0.2341)
Holiday	0.8892*	1.0269**	1.3264***	1.3973***	1.0662	1.2946**	1.2567***
	(0.5090)	(0.4431)	(0.4213)	(0.3569)	(0.6497)	(0.5887)	(0.4837)
`Service index`	-0.0614***	-0.0551	0.1023***	0.1244	-0.0699***	-0.0608	0.0411***
	(0.0125)	(0.1345)	(0.0224)	(0.2393)	(0.0243)	(0.2137)	(0.0117)
Constant	95.6851***	95.4231***	80.7279***	80.6447***	75.9289***	75.7830***	72.7256***
	(8.4325)	(8.5667)	(8.0470)	(8.6673)	(8.3562)	(8.0043)	(9.3398)
Observations	9,929	9,929	9,386	9,386	13,954	13,954	19,496
R^2	0.6176	0.5768	0.7010	0.6073	0.6041	0.6152	0.7709
Adjusted R^2	0.6170	0.5764	0.7004	0.6069	0.6036	0.6150	0.7708

Remarks: Significance Level: *** p < 0.01, ** p < 0.05, * p < 0.1; Heteroskedasticity and serial correlation consistent standard errors in parenthesis. Driscoll and Kraay - SCC estimator. The random effects model could not be estimated.

Beforehand, I showed that very different taxes exist on both sides of the border, but literally no cross-border price competition takes place between gasoline stations. Hence, short-run parameters show no sign of competition. However, tax rates are rather rigid over time and accordingly, retailers may internalise the difference in long-term decisions, *exempli gratia* where to locate a gasoline station. I analysed this impact on long-term parameters of competition and present the results along with further short-run variables in Table 3.

The first row shows the absolute number of gasoline stations per zone, which by itself does not allow any conclusions regarding the density yet. The second row presents the average population density, which is calculated based on the population density of all stations in the zone.

TABLE 3: SUMMARY OF INFRASTRUCTURAL ANALYSIS BY ZONE

	Zone A	**Zone B**	**Zone C**	**Zone D**
Gasoline Station Infrastructure				
Number of gasoline stations	39	36	59	77
Average population density	235.70	139.82	277.80	261.68
Population density in relation to the number of gasoline stations	6,04	3,88	4,71	3,4
Share of premium brands: Aral, Esso, Shell, Total (SUM) [Percentage]	7, 4, 3, 6, (20), [51,28%]	3, 5, 5, 5, (18), [50%]	7, 2, 9, 6, (24), [40,68%]	14, 4, 6, 12, (36), [46,15%]
Price Competition and Services				
Average number of price changes per day	14.62	14.4	13.87	12.91
Average service index (= number of services offered on average)	4.89	4.66	5.06	5.07
Local Competition				
Average distance to nearest Polish competitor	7.686	25.57	38.14	51.64
Average driving time to nearest Polish competitor	14.686	28.71	41.49	50.35
Average distance to nearest German competitor	3.259	3.96	3.653	3.315
Average driving time to nearest German competitor	4.957	5.335	5.273	4.82
No. of German competitor within 5km	3.139	2.874	3.758	3.467
No. of German competitor within 10km	4.326	3.963	6.741	5.88

In the third row, I take the ration of the population density to the number of gasoline stations in the according zone. This the resulting variable can be interpreted as the average number of people per square kilometre and gasoline station. Hence, it is a measure of station density. It varies substantially over the zones, with about 6 in Zone A, about 3.9 in Zone B, about 4.7 in Zone C and about 3.4 in Zone D. More precisely, there are about $\frac{6.04-3.88}{3.88} * 100 = 55.67\%$ more people per gasoline station and square kilometre in Zone A than in Zone B. This number drops to about 28.24% compared to Zone C and reaches about 77.65% compared to Zone D. Overall, there are many more people per square kilometre and gasoline

station in proximity of the border or, in other words, many fewer gasoline stations near the Polish border. This lack of infrastructure might point to a considerable amount of fuel tourism.

The finding that fewer gasoline stations exist relative to the population density gains momentum when put into context, both based on literature and on my calculations. Clemenz and Gugler (2006) analyse the local competition in Austria and find that gasoline station density increases less than proportionally to population density. I can confirm this finding based on the data underlying Table 1. I calculate the population density for all postcode areas and relate them to the number of stations in each area. A visualization may be found in Appendix Figure 7. I fitted several lines with various functional forms to the scatter plot, of which the quadratic relation seems to fit the data best. The population density level in both zones in the German interior exhibit slightly higher population density. Higher population density goes along with lower gasoline station density. Thus, the effect of at least 28% more people per gasoline station and square kilometre in Zone A relative to zones inland might be even larger.

The last infrastructural variable to discuss is the brand composition, more precisely the share of premium brands. I focus on the oligopoly of four consisting of the players ARAL, Shell, ESSO and TOTAL. I abstain from including JET because the above stated analysis reveals that it does not charge a significantly higher price. First, I present the absolute number of all four brands for the zones. Second, I build the sum and present it in parenthesis in Table 3. Third, I calculate the share relative to the absolute number of stations in the zone and present it in brackets. The share of premium brands decreases with distance to the Polish border, starting at about 51% in Zone A near the border, continuing at about 50% in Zone B and around 40% in Zone C and finally reaching a moderately higher level again of about 46% in Zone D. An economic explanation may include that non-premium brands compete primarily over the price, in contrast to premium brands. Thus, they try to attract consumers by setting a low price, instead of providing extra services.[26] However, gasoline stations primarily competing over the price face an even more difficult situation along the border in light of strong Polish competition across the border. Hence, the border region exhibits an above average share of premium brands. Presumably, premium brands do not compete primarily over the price.

[26] The average number of services provided by premium brands (ARAL, ESSO, TOTAL and Shell) is 5.23 compared to 4.69 for all other brands. These numbers are based on the data underlying Table 1.

The next variable shows the average number of price changes per day. There are moderately more price changes closer to the border, with on average of about 14.6 changes per day in Zone A, about 14.4 changes in Zone B, about 13.9 changes in Zone C and about 12.9 changes in Zone D. This may indicate a slightly more nervous competition situation in proximity of the border. The average number of services provided decreases slightly when approaching the border. Lastly, some descriptive statistics for local competition variables are provided in Table 3. There are no extreme and systematic differences between the zones.

In short, the price difference between the Polish and the German markets results from differences in taxes, as discussed before. Thus, it is a situation of permanent disadvantage for German gasoline stations at the border. The results indicate that German gas stations do not enter into price competition with their Polish opponents. Overall, the gasoline infrastructure shows considerable differences with respect to distance to Poland. Station density relative to population gets sparse while the share of premium brands increases slightly when moving towards the border.

5 Conclusion

Prices and spatial considerations shape competition on the German market for gasoline retailing. In this paper, I analyse competition in the German region at the border to Poland focusing on the effect of closeness to Polish competitors on prices set by German retailers and on gasoline station infrastructure near the border.

Early research identified the importance of spatial variables for competition on the retail markets for gasoline. Newly available data containing virtually all price changes for all German gasoline stations allow in depth analysis of spatial influences on the German gasoline market. I apply panel data econometrics with the latest robust standard error estimation to this new database. Several linear and non-linear regression specifications are considered, estimating minimum, mean and maximum prices over different time periods.

Moreover, I divide the border region into four 15km-zones in terms of driving distance to the nearest Polish competitor. Based on these zones, I run further regression models. Focusing on random effects models for estimation of German gasoline prices while controlling for various station characteristics, I find no evidence for price competition between German and Polish gasoline stations. In fact, the analysis reveals that there is no statistically significant effect on prices set by German stations when located closer to Polish

competitors. Furthermore, these insignificant effects are so small that they are economically irrelevant. This conclusion can be drawn with sound confidence, as it does not change with different model specifications.

Given the enormous tax differences between Germany and Poland, this result is not surprising. These tax differences probably exceed the profit margins of German gasoline stations by far, which means that German stations cannot compete with Polish gasoline stations even if they were to reduce their price to marginal costs.

If German gasoline stations do not enter into price competition with their Polish opponents, how does the difference in taxes on gasoline between Germany and Poland impact the German gasoline market? In the short run, gasoline retailers compete over the price because relocating a gasoline station is costly and takes time. However, in the long run, retailing companies and other potential players may internalize this permanent competition influence from Poland and consider it in their decision where to locate their gasoline stations in the German border region. Following the price analysis based on the different zones, I analysed the gasoline station infrastructure in each of them. This analysis reveals increasingly sparse gasoline station infrastructure when approaching the Polish border, along with an increasing share of premium brands.

More precisely, there are at least 28% more people per gasoline station and square kilometre in the zone directly at the border compared to the zones inland, the zone directly at the border being defined by a driving distance of no more than 15km to the nearest Polish competitor. Overall, there are many more people per square kilometre and gasoline station near the border or, in other words, much fewer gasoline stations near the Polish border.

Furthermore, I find a higher share of premium brands in proximity of the Polish border. The share of premium brands decreases with distance to the Polish border, from about 51% in the zone closest to the border to between 40% and 46% in regions further inland. An economic explanation may include that non-premium brands compete primarily over the price, in contrast to premium brands and, hence, are located more sparsely at the border. Overall, the border region exhibits an above average share of premium brands.

This lack of infrastructure as well as the different brand composition point to a considerable amount of fuel tourism. Fuel tourism describes the phenomenon of people crossing borders in order to fuel their cars. A high degree of fuel tourism may raise the question of fiscal intervention, that may aim at limiting such undesirable behaviour in terms of climate and

fiscal policy. An estimation of the extent of fuel tourism, similar to Banfi *et al.* (2003), can only be made based on quantity data, which are not recorded yet, but might become available soon. In a draft law, the Ministry for Economic Affairs and Energy (Bundesministeriums für Wirtschaft und Energie, 2020, p. 2) recently proposed the transmission of quantity data to competition authorities to be made mandatory. This would enable researchers to carry out new analyses on the basis of which fiscal policy assessments can be made.

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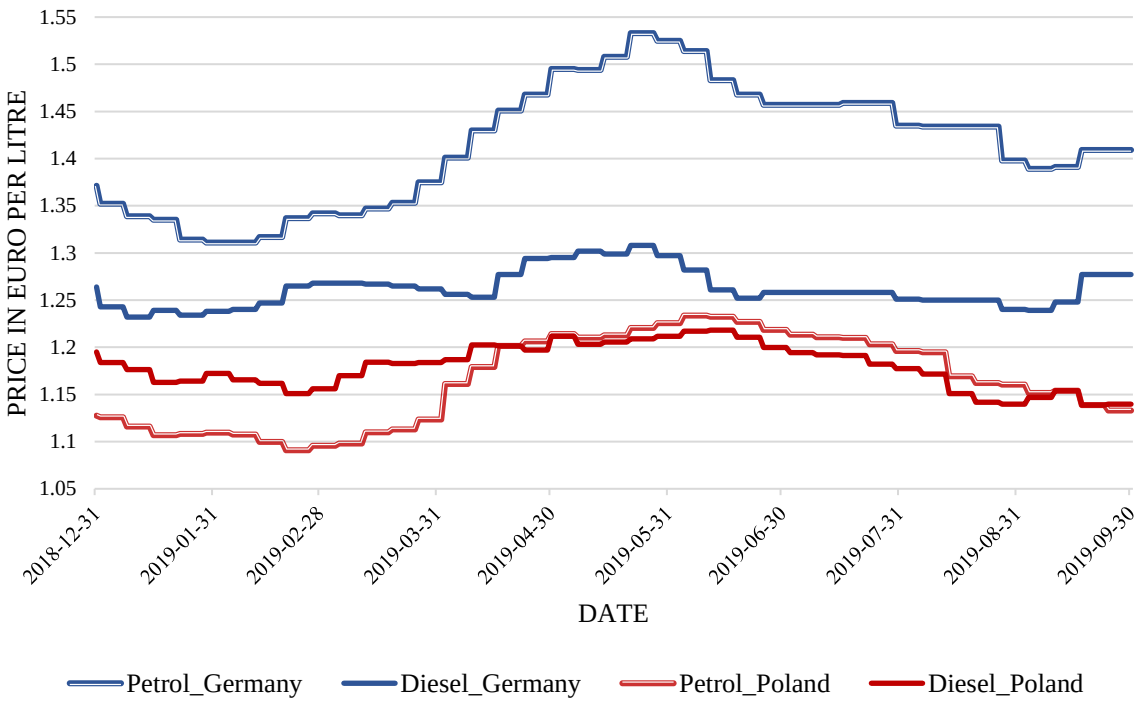
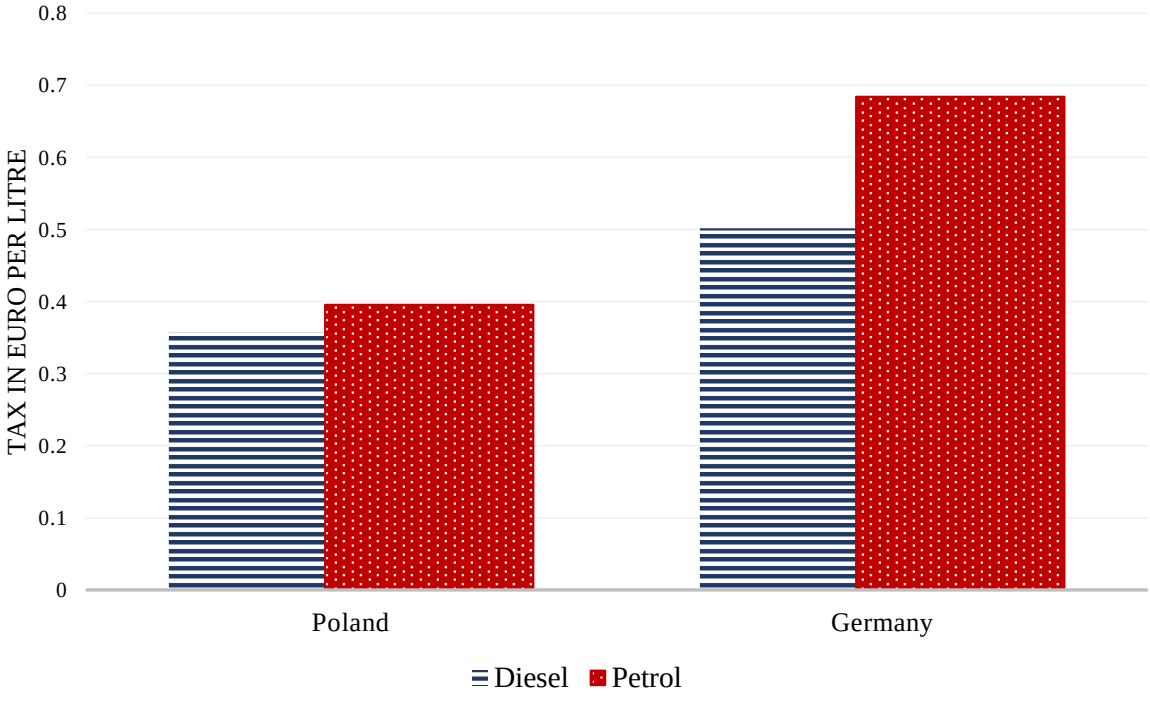
Appendix

Figures

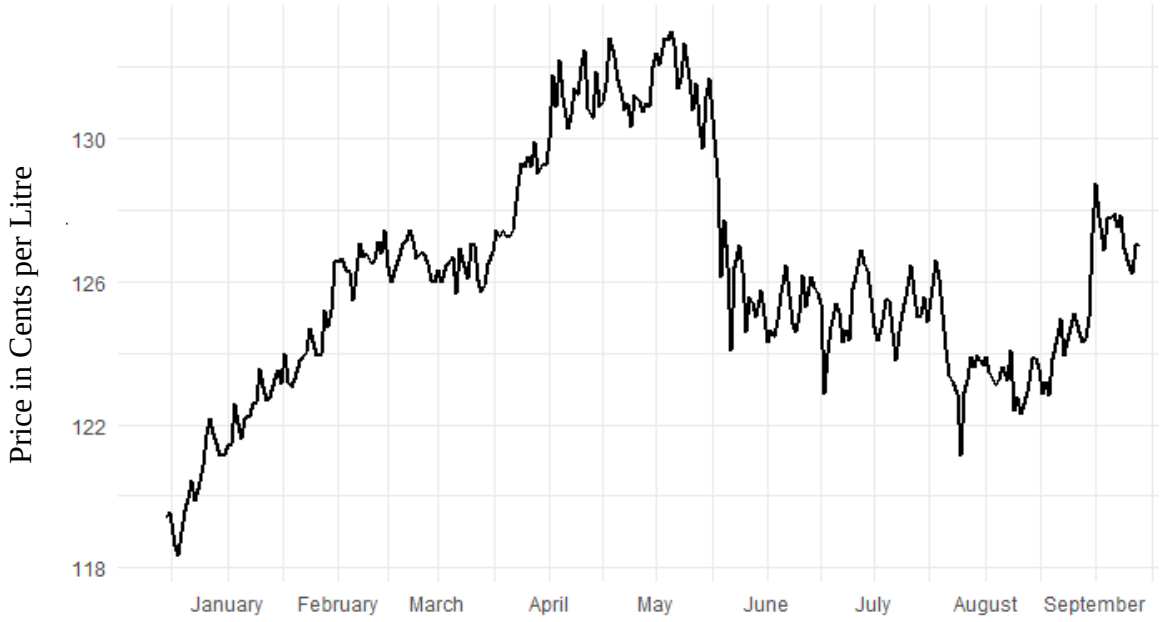
APPENDIX FIGURE 1: AVERAGE WEEKLY FUEL PRICES FOR POLAND AND GERMANY, JAN-SEP 2019



APPENDIX FIGURE 2: EFFECTIVE TAX RATES ON ENERGY USE IN EUR PER LITRE, 2015



APPENDIX FIGURE 3: AVERAGE DAILY DIESEL PRICE, JAN-SEP 2019

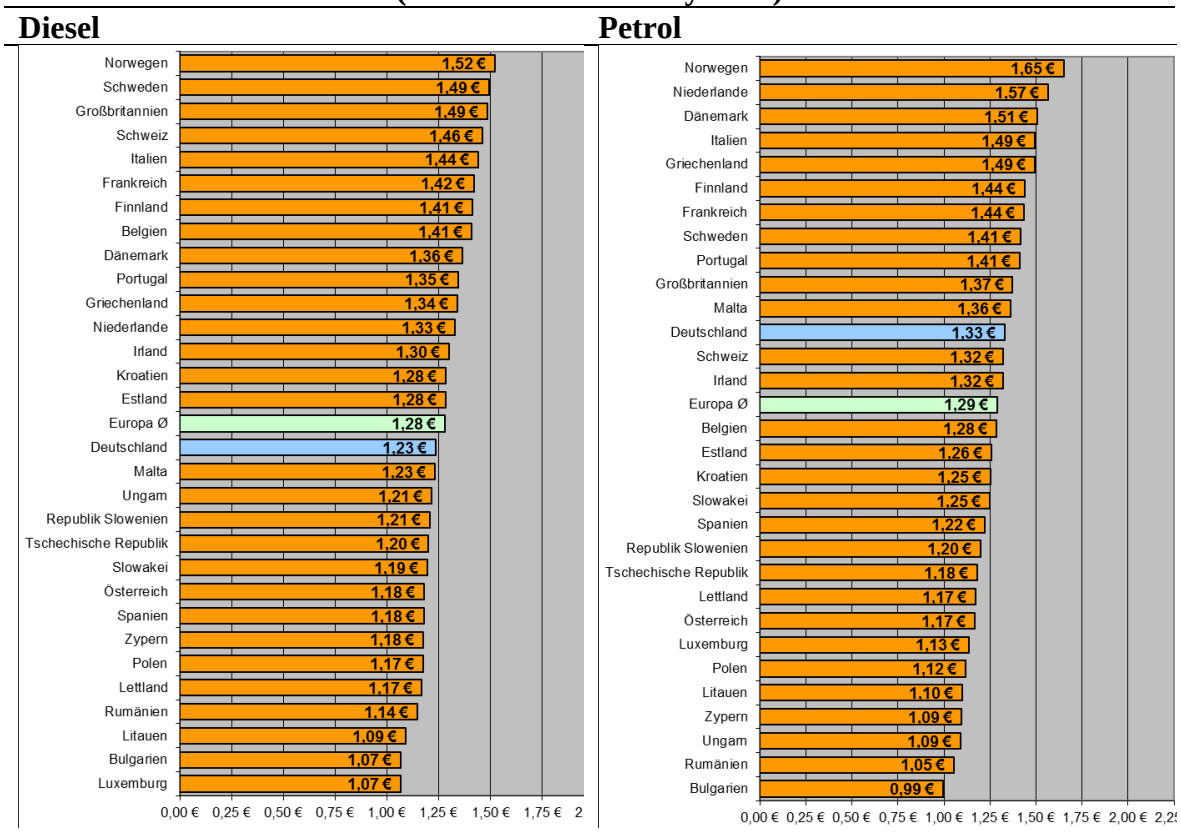


APPENDIX FIGURE 4: CRUDE OIL PRICE, JAN-SEP 2019

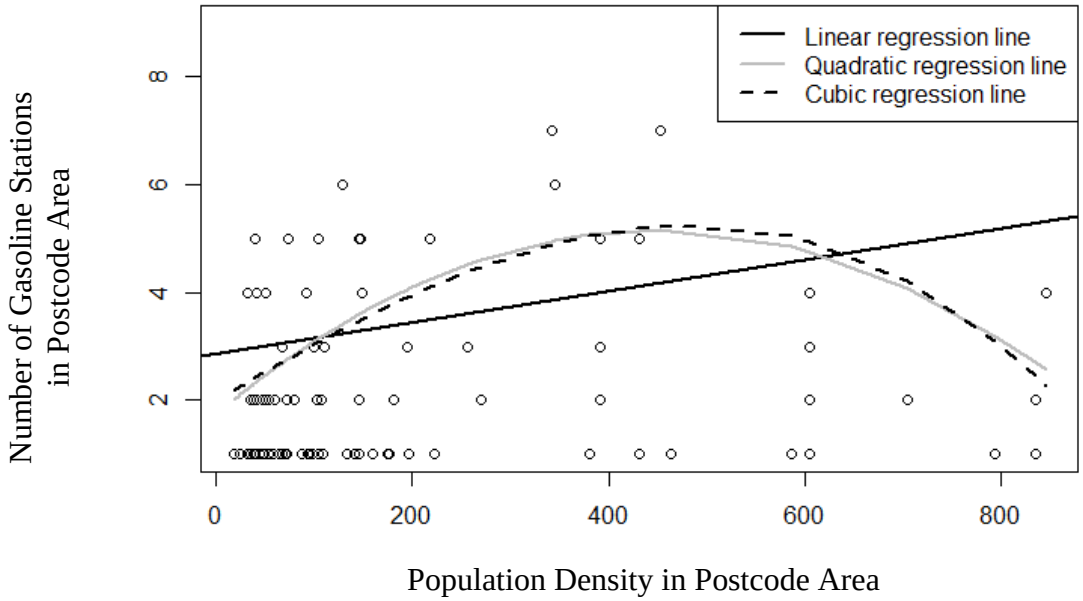
APPENDIX FIGURE 5: AVERAGE DAILY PETROL PRICE, JAN-SEP 2019

Month of the Year 2019

APPENDIX FIGURE 6: DIESEL PRICES PER LITRE FOR EUROPE (effective 15th January 2019)



APPENDIX FIGURE 7: NUMBER OF GASOLINE STATIONS AND POPULATION DENSITY PER POSTCODE AREA



Tables

APPENDIX TABLE 1: VARIABLES

Category	Variable
Dependent variables	Average daily price, minimum daily price, maximum daily price (day of 24 hours or day of 16 hours)
Brand categories	Brand
	Oli5
	Oli4
Local competition	Dist. nearest Polish competitor
	Time nearest Polish competitor
	Polish average price
	Dist. nearest German competitor
	Time nearest German competitor
	No. German competitors in 5km
	No. German competitors in 5min
	No. German competitors in 10min
	No. German competitors in 15min
	No. German competitors in 20min
Input costs	Crude oil
Demand-side controls	Weekday
	Holiday
	Weekend Holiday
	Population density
Station type	Motorway
Station characteristics	Shop
	Truck
	Bistro
	Baking station
	Shower
	Vacuum cleaner
	ATM
	Pressure washer
	Car wash
	Tire pump
	Restaurant
	Service station Credit card
	Service index

Note: The "service index" simply counts the number of services provided by a gasoline station.

APPENDIX TABLE 2: DESCRIPTIVE STATISTICS FOR TABLE 1

Statistic	Min	Mean	Median	Max	N	St. Dev.	Pctl(25)	Pctl(75)
Price	111.355	126.355	125.700	159.471	54,760	5.042	123.082	128.800
Dist..nearest.Polish.competitor	1.950	35.045	39.340	59.790	54,760	16.743	24.420	48.980
Time.nearest.Polish.competitor	3.729	37.291	35.117	149.865	54,760	19.685	25.266	50.029
Polish.average.price	113.875	117.971	118.269	121.817	54,760	2.368	116.188	120.133
German.average.price	123.200	126.201	125.800	130.800	54,760	1.995	124.800	127.700
Crude.oil.price	29.504	36.220	35.939	42.377	54,760	2.570	34.290	37.668
Dist..nearest.German.competitor	0.100	3.508	1.850	22.390	54,760	4.026	0.890	4.180
Time.nearest.German.competitor	0.227	5.058	3.517	25.528	54,760	4.608	1.750	6.600
No..German.competitors.in.5km	1	3.377	3	11	54,760	2.150	2	5
No..German.competitors.in.10km	1	5.475	5	14	54,760	3.333	3	7
Motorway	0	0.040	0	1	54,760	0.195	0	0
National.road	0	0.054	0	1	54,760	0.226	0	0
Population.density	17.838	244.360	145.554	844.884	54,760	227.170	64.937	391.431
Agip	0	0.050	0	1	54,760	0.217	0	0
ARAL	0	0.154	0	1	54,760	0.361	0	0
AVIA	0	0.025	0	1	54,760	0.156	0	0
ESSO	0	0.075	0	1	54,760	0.263	0	0
GO	0	0.025	0	1	54,760	0.156	0	0
GULF	0	0.020	0	1	54,760	0.140	0	0
HEM	0	0.030	0	1	54,760	0.170	0	0
JET	0	0.025	0	1	54,760	0.156	0	0
OIL	0	0.025	0	1	54,760	0.156	0	0
Others	0	0.132	0	1	54,760	0.338	0	0
SB	0	0.058	0	1	54,760	0.234	0	0
Shell	0	0.114	0	1	54,760	0.318	0	0
Sprint	0	0.024	0	1	54,760	0.153	0	0
STAR	0	0.060	0	1	54,760	0.237	0	0
Supermarket	0	0.042	0	1	54,760	0.200	0	0
TOTAL	0	0.144	0	1	54,760	0.351	0	0
Oli4	0	0.486	0	1	54,760	0.500	0	1
Oli5	0	0.511	1	1	54,760	0.500	0	1
Monday	0	0.137	0	1	54,760	0.344	0	0
Tuesday	0	0.141	0	1	54,760	0.348	0	0
Wednesday	0	0.141	0	1	54,760	0.348	0	0
Thursday	0	0.141	0	1	54,760	0.348	0	0
Friday	0	0.141	0	1	54,760	0.348	0	0
Saturday	0	0.145	0	1	54,760	0.352	0	0
Sunday	0	0.131	0	1	54,760	0.337	0	0
Holiday	0	0.021	0	1	54,760	0.145	0	0
Shop	0	0.866	1	1	54,760	0.340	1	1
Truck	0	0.502	1	1	54,760	0.500	0	1
Bistro	0	0.506	1	1	54,760	0.500	0	1
Baking.station	0	0.402	0	1	54,760	0.490	0	1
Shower	0	0.040	0	1	54,760	0.195	0	0

APPENDIX TABLE 2: DESCRIPTIVE STATISTICS FOR TABLE 1

Statistic	Min	Mean	Median	Max	N	St. Dev.	Pctl(25)	Pctl(75)
Vacuum.cleaner	0	0.218	0	1	54,760	0.413	0	0
ATM	0	0.252	0	1	54,760	0.434	0	1
Pressure.washer	0	0.089	0	1	54,760	0.284	0	0
Car.wash	0	0.664	1	1	54,760	0.472	0	1
Tire.pump	0	0.099	0	1	54,760	0.298	0	0
Restaurant	0	0.025	0	1	54,760	0.156	0	0
Service.station	0	0.204	0	1	54,760	0.403	0	0
Credit.card	0	0.940	1	1	54,760	0.237	1	1
Open	0	3.622	5	9	54,760	2.838	0	6
Close	12	22.379	22	24	54,760	1.570	22	24
Open.24.hours	0	0.361	0	1	54,760	0.480	0	1

APPENDIX TABLE 3: STATISTICAL TESTS FOR DIESEL DATA (MEAN 24h)

Test	Test statistic	df	p-value	Alternative hypothesis	Result
Breusch-Pagan test for heteroskedasticity	BP = 18807	df = 213	p-value < 0.0000	Presence of heteroskedasticity	Here, the test indicates presence of heteroskedasticity. Hence, robust covariance matrix estimation must be applied.
Lagrange Multiplier Test - (Breusch-Pagan) for unbalanced panels ***– RE vs. pooled OLS***	chisq = 1005600	df = 1	p-value < 0.0000	significant effects	Here, there is evidence of significant differences across stations, therefore a random effects model is preferred over a simple OLS regression.
Hausman Test ***– FE vs. RE***	chisq = 27.646	df = 9	p-value = 0.001093	one model is inconsistent	Since the p-value < 0.05 => fixed effects model is preferred!
F test for individual effects ***– FE vs. pooled OLS***	F = 190.03	df1 = 170, df2 = 54546	p-value < 0.0000	significant effects	If the p-value is < 0.05 then the fixed effects model is a better choice.
F test for time-fixed effects ***- FE***	F = 120.99	df1 = 263, df2 = 54283	p-value < 0.0000	significant effects	The null is no time-fixed effects are needed. If p-value < 0.05, then use time-fixed effects. Here, it indicates to use time-fixed effects... however, when using time and entity fixed effects the model would be empty.
Lagrange Multiplier Test - time effects (Breusch-Pagan) for unbalanced panels ***- FE***	chisq = 285768	df = 1	p-value < 0.0000	significant effects	Basically, same result as with the test above this one.
Breusch-Pagan LM test for cross-sectional dependence in panels ***- FE***	chisq = 1297953	df = 20910	p-value < 0.0000	cross-sectional dependence	There is cross-sectional dependence.
Breusch-Pagan LM test for cross-sectional dependence in panels ***– pooled OLS***	chisq = 1297857	df = 20910	p-value < 0.0000	cross-sectional dependence	There is cross-sectional dependence.
Breusch-Pagan LM test for cross-sectional dependence in panels ***– RE***	chisq = 1297951	df = 20910	p-value < 0.0000	cross-sectional dependence	There is cross-sectional dependence.
Pesaran CD test for cross-sectional dependence in panels ***– pooled OLS, RE, FE***	z = 1013.8		p-value < 0.0000	cross-sectional dependence	There is cross-sectional dependence.
Breusch-Godfrey/Wooldridge test for serial correlation in panel models ***- FE***	chisq = 33057	df = 54	p-value < 0.0000	serial correlation in idiosyncratic errors	The null hypothesis states that there is no serial correlation. There is serial correlation in idiosyncratic errors. The result is basically the same for different orders of correlation.
Breusch-Godfrey/Wooldridge test for serial correlation in panel models (order 1-3) ***- FE***	Value similar to above value.		p-value < 0.0000		
Breusch-Godfrey/Wooldridge test for serial correlation in panel models (up to order 3) ***– pooled OLS***	Different values > 38900		p-value < 0.0000	serial correlation in idiosyncratic errors	There is serial correlation in idiosyncratic errors.

APPENDIX TABLE 3: STATISTICAL TESTS FOR DIESEL DATA (MEAN 24h)

Test	Test statistic	df	p-value	Alternative hypothesis	Result
*Breusch-Godfrey/Wooldridge test for serial correlation in panel models (up to order 3) – **RE***	Different values > 30900		p-value < 0.0000	serial correlation in idiosyncratic errors	There is serial correlation in idiosyncratic errors.
*Breusch-Godfrey/Wooldridge test for serial correlation in panel models (up to order 3) – **FD***	Different values > 4600		p-value < 0.0000	serial correlation in idiosyncratic errors	There is serial correlation in idiosyncratic errors.

APPENDIX TABLE 4: BRAND COMPOSITION IN THE DIESEL DATASET

Brand	Number of Stations
Oligopoly player brand	
ARAL	31
ESSO	15
JET	5
Shell	23
TOTAL	29
AVIA	5
Further selected brands	
Agip	10
GO	5
GULF	5
HEM	6
OIL!	8
SB	12
Sprint	5
STAR	12
Stations belonging to supermarkets	
Supermarkt	10
All other stations	
Others	30

APPENDIX TABLE 5: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h), POOLED OLS MODEL

	Dependent variable: Daily average diesel price								
	Pooled (OLS) (1)	Pooled (OLS) (2)	Pooled (OLS) (3)	Pooled (OLS) (4)	Pooled (OLS) (5)	Pooled (OLS) (6)	Pooled (OLS) (7)	Pooled (OLS) (8)	Pooled (OLS) (9)
`Dist. nearest Polish competitor`	-0.0094***	-0.0055***	-0.0055***	-0.0055***	-0.0055***	-0.0052**	-0.0052**	-0.0052**	-0.0052**
	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0022)	(0.0022)	(0.0022)	(0.0022)
`Polish average price`	0.0988	0.0967	0.1036	0.1058	0.0959	0.0917	0.0985	0.1007	0.0909
	(0.0790)	(0.0790)	(0.0772)	(0.0772)	(0.0789)	(0.0787)	(0.0769)	(0.0769)	(0.0786)
`Crude oil price`	1.0088***	1.0108***	1.0137***	1.0150***	1.0113***	1.0137***	1.0166***	1.0179***	1.0142***
	(0.0655)	(0.0658)	(0.0658)	(0.0658)	(0.0657)	(0.0662)	(0.0662)	(0.0663)	(0.0662)
`Dist. nearest German competitor`	-0.0607***	-0.0893***	-0.0894***	-0.0896***	-0.0894***	-0.0695***	-0.0696***	-0.0698***	-0.0695***
	(0.0044)	(0.0041)	(0.0041)	(0.0041)	(0.0041)	(0.0036)	(0.0036)	(0.0036)	(0.0036)
`No. German competitors in 10km`	-0.0727***	-0.0989***	-0.0988***	-0.0997***	-0.0989***	-0.0725***	-0.0724***	-0.0731***	-0.0725***
	(0.0117)	(0.0117)	(0.0117)	(0.0117)	(0.0117)	(0.0116)	(0.0116)	(0.0116)	(0.0116)
Motorway	13.1161***	12.8163***	12.8161***	12.8164***	12.8166***	13.2650***	13.2658***	13.2662***	13.2651***
	(0.3588)	(0.3581)	(0.3581)	(0.3581)	(0.3581)	(0.3607)	(0.3607)	(0.3607)	(0.3607)
`National road`	-1.5154***	-1.2009***	-1.1998***	-1.1981***	-1.2008***	-1.5732***	-1.5723***	-1.5708***	-1.5732***
	(0.0811)	(0.0933)	(0.0932)	(0.0933)	(0.0933)	(0.0826)	(0.0826)	(0.0826)	(0.0826)
`Population density`	-0.0005***	-0.0003**	-0.0003**	-0.0003**	-0.0003**	-0.0005***	-0.0005***	-0.0005***	-0.0005***
	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Agip	0.3115***	0.3164***	0.3161***	0.3172***	0.3163***	0.0562	0.0552	0.0570	0.0562
	(0.0423)	(0.0383)	(0.0383)	(0.0382)	(0.0383)	(0.0418)	(0.0418)	(0.0418)	(0.0418)
ARAL	1.9496***	2.5135***	2.5134***	2.5116***	2.5136***	1.9762***	1.9762***	1.9787***	1.9762***
	(0.0605)	(0.0704)	(0.0704)	(0.0703)	(0.0704)	(0.0720)	(0.0720)	(0.0721)	(0.0720)
AVIA	-0.7917***	-1.2489***	-1.2531***	-1.2496***	-1.2483***	-1.1983***	-1.2009***	-1.1971***	-1.1983***
	(0.1085)	(0.1198)	(0.1196)	(0.1197)	(0.1197)	(0.0840)	(0.0838)	(0.0839)	(0.0840)
ESSO	2.0602***	1.8063***	1.8053***	1.8043***	1.8064***	1.9266***	1.9260***	1.9279***	1.9266***
	(0.0575)	(0.0702)	(0.0701)	(0.0701)	(0.0702)	(0.0583)	(0.0583)	(0.0583)	(0.0583)
SB	-1.0517***	-1.1153***	-1.1158***	-1.1266***	-1.1152***	-1.0645***	-1.0641***	-1.0663***	-1.0645***
	(0.0586)	(0.0734)	(0.0732)	(0.0730)	(0.0734)	(0.0571)	(0.0572)	(0.0572)	(0.0571)
GO	-1.6189***	-1.2796***	-1.2810***	-1.2809***	-1.2796***	-1.7031***	-1.7057***	-1.7032***	-1.7031***
	(0.1010)	(0.1268)	(0.1265)	(0.1265)	(0.1268)	(0.1037)	(0.1030)	(0.1031)	(0.1037)
GULF	-0.8123***	0.3339*	0.3310*	0.3313*	0.3341*	-0.3727**	-0.3759**	-0.3718**	-0.3727**
	(0.1530)	(0.1900)	(0.1898)	(0.1898)	(0.1900)	(0.1726)	(0.1723)	(0.1722)	(0.1726)
HEM	-0.2615	-0.1056	-0.1097	-0.1134	-0.1055	-0.4700**	-0.4731**	-0.4718**	-0.4700**
	(0.2182)	(0.2399)	(0.2397)	(0.2397)	(0.2399)	(0.2091)	(0.2090)	(0.2090)	(0.2091)
JET	-0.9706***	-0.7646***	-0.7636***	-0.7597***	-0.7645***	-1.0050***	-1.0040***	-0.9995***	-1.0049***
	(0.0720)	(0.0903)	(0.0903)	(0.0904)	(0.0903)	(0.0731)	(0.0732)	(0.0733)	(0.0731)

APPENDIX TABLE 5: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h), POOLED OLS MODEL

	Dependent variable: Daily average diesel price								
	Pooled (OLS) (1)	Pooled (OLS) (2)	Pooled (OLS) (3)	Pooled (OLS) (4)	Pooled (OLS) (5)	Pooled (OLS) (6)	Pooled (OLS) (7)	Pooled (OLS) (8)	Pooled (OLS) (9)
Supermarket	-1.0477***	-1.3972***	-1.3975***	-1.4556***	-1.3968***	-0.7680***	-0.7674***	-0.8249***	-0.7680***
	(0.0670)	(0.0660)	(0.0659)	(0.0677)	(0.0660)	(0.1104)	(0.1104)	(0.1111)	(0.1104)
OIL	-0.7801***	-1.5709***	-1.5727***	-1.5717***	-1.5708***	-0.9774***	-0.9798***	-0.9774***	-0.9774***
	(0.1122)	(0.1404)	(0.1403)	(0.1403)	(0.1404)	(0.1109)	(0.1107)	(0.1107)	(0.1109)
Shell	2.5557***	3.1430***	3.1437***	3.1412***	3.1432***	2.4919***	2.4933***	2.4957***	2.4920***
	(0.0568)	(0.0948)	(0.0950)	(0.0948)	(0.0948)	(0.0649)	(0.0652)	(0.0654)	(0.0649)
Sprint	-0.4694***	-0.7568***	-0.7577***	-0.7643***	-0.7566***	-0.6349***	-0.6361***	-0.6435***	-0.6349***
	(0.0767)	(0.1020)	(0.1018)	(0.1018)	(0.1019)	(0.0807)	(0.0804)	(0.0803)	(0.0807)
STAR	-2.0179***	-1.8987***	-1.8993***	-1.8992***	-1.8986***	-2.2547***	-2.2556***	-2.2539***	-2.2547***
	(0.0649)	(0.0805)	(0.0804)	(0.0804)	(0.0805)	(0.0722)	(0.0721)	(0.0722)	(0.0722)
TOTAL	1.0221***	1.5030***	1.5034***	1.5036***	1.5030***	0.8070***	0.8065***	0.8079***	0.8070***
	(0.0614)	(0.0663)	(0.0663)	(0.0663)	(0.0663)	(0.0564)	(0.0564)	(0.0563)	(0.0564)
Tuesday	-0.2657	-0.2717	-0.2732	-0.2737		-0.2660	-0.2675	-0.2681	
	(0.2190)	(0.2179)	(0.2181)	(0.2184)		(0.2182)	(0.2185)	(0.2187)	
Wednesday	-0.3781	-0.3849	-0.3853	-0.3855		-0.3828	-0.3833	-0.3834	
	(0.3040)	(0.3033)	(0.3035)	(0.3037)		(0.3045)	(0.3048)	(0.3050)	
Thursday	-0.3660	-0.3721	-0.3726	-0.3727		-0.3703	-0.3708	-0.3709	
	(0.3157)	(0.3153)	(0.3154)	(0.3155)		(0.3161)	(0.3163)	(0.3164)	
Friday	-0.3766	-0.3798	-0.3806	-0.3808		-0.3842	-0.3849	-0.3851	
	(0.2740)	(0.2734)	(0.2734)	(0.2735)		(0.2743)	(0.2743)	(0.2744)	
Saturday	-0.2491	-0.2521	-0.2534		0.0312	-0.2489	-0.2502		0.0333
	(0.2630)	(0.2622)	(0.2622)		(0.1965)	(0.2633)	(0.2633)		(0.1972)
Sunday	0.2946	0.3002			0.5834***	0.3010			0.5831***
	(0.2229)	(0.2218)			(0.1966)	(0.2230)			(0.1971)
Holiday	1.1693**	1.1537**			1.4382***	1.1312**			1.4146***
	(0.4963)	(0.4963)			(0.4311)	(0.5028)			(0.4374)
`Sunday Holiday`			0.4152*				0.4129*		
			(0.2317)				(0.2331)		
`Weekend Holiday`				0.0864				0.0883	
				(0.2340)				(0.2350)	
Shop		-1.5407***	-1.5415***	-1.5388***	-1.5405***				
		(0.0491)	(0.0491)	(0.0490)	(0.0491)				
Truck		0.0725*	0.0736*	0.0749*	0.0725*				
		(0.0398)	(0.0399)	(0.0399)	(0.0398)				
Bistro		-0.0269	-0.0263	-0.0265	-0.0269				
		(0.0610)	(0.0610)	(0.0610)	(0.0610)				
`Baking station`		0.4883***	0.4881***	0.4867***	0.4883***				
		(0.0424)	(0.0424)	(0.0424)	(0.0424)				
Shower		-0.7016***	-0.7015***	-0.7030***	-0.7015***				

APPENDIX TABLE 5: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h), POOLED OLS MODEL

	Dependent variable: Daily average diesel price								
	Pooled (OLS) (1)	Pooled (OLS) (2)	Pooled (OLS) (3)	Pooled (OLS) (4)	Pooled (OLS) (5)	Pooled (OLS) (6)	Pooled (OLS) (7)	Pooled (OLS) (8)	Pooled (OLS) (9)
		(0.0681)	(0.0681)	(0.0681)	(0.0681)				
`Vacuum cleaner`		-0.2679***	-0.2672***	-0.2667***	-0.2679***				
		(0.0373)	(0.0373)	(0.0373)	(0.0373)				
ATM		-0.3555***	-0.3545***	-0.3532***	-0.3556***				
		(0.0745)	(0.0745)	(0.0745)	(0.0745)				
`Pressure washer`		0.2397***	0.2389***	0.2365***	0.2396***				
		(0.0435)	(0.0436)	(0.0436)	(0.0435)				
`Car wash`		0.8417***	0.8417***	0.8439***	0.8417***				
		(0.0219)	(0.0219)	(0.0219)	(0.0219)				
`Tire pump`		1.3229***	1.3236***	1.3222***	1.3229***				
		(0.0534)	(0.0534)	(0.0534)	(0.0534)				
Restaurant		1.7020***	1.7031***	1.7060***	1.7018***				
		(0.1432)	(0.1429)	(0.1428)	(0.1432)				
`Service station`		-0.2416***	-0.2424***	-0.2432***	-0.2415***				
		(0.0522)	(0.0521)	(0.0520)	(0.0522)				
`Credit card`		-0.6778***	-0.6782***	-0.6726***	-0.6773***				
		(0.0795)	(0.0795)	(0.0795)	(0.0795)				
`Service index`						0.0978***	0.0982***	0.0986***	0.0978***
						(0.0092)	(0.0092)	(0.0092)	(0.0092)
Constant	78.3871***	79.6784***	78.7619***	78.4508***	79.4762***	78.5104***	77.6123***	77.3061***	78.3081***
	(8.4569)	(8.4394)	(8.1546)	(8.1632)	(8.4672)	(8.4372)	(8.1504)	(8.1586)	(8.4656)
Observations	56,391	54,760	54,760	54,760	54,760	52,765	52,765	52,765	52,765
R^2	0.6508	0.6663	0.6658	0.6645	0.6658	0.6589	0.6584	0.6572	0.6583
Adjusted R^2	0.6506	0.6661	0.6656	0.6643	0.6655	0.6587	0.6582	0.6570	0.6582
Remarks:	Significance Level: *** p < 0.01, ** p < 0.05, * p < 0.1; Heteroskedasticity and serial correlation consistent standard errors in parenthesis. Driscoll and Kraay - SCC estimator.								

APPENDIX TABLE 6: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h), RANDOM RFFECTS MODEL

	Dependent variable: Daily average diesel price					
	Random Effects (1)	Random Effects (2)	Random Effects (3)	Random Effects (4)	Random Effects (5)	Random Effects (6)
`Dist. nearest Polish competitor`	-0.0098	-0.0064	-0.0064	-0.0064	-0.0064	-0.0052
	(0.0298)	(0.0292)	(0.0291)	(0.0289)	(0.0295)	(0.0313)
`Polish average price`	0.0983	0.0961	0.1029	0.1052	0.0953	0.0911
	(0.0791)	(0.0791)	(0.0773)	(0.0773)	(0.0789)	(0.0786)
`Crude oil price`	1.0087***	1.0110***	1.0138***	1.0151***	1.0114***	1.0141***
	(0.0655)	(0.0658)	(0.0658)	(0.0659)	(0.0657)	(0.0661)
`Dist. nearest German competitor`	-0.0529	-0.0796	-0.0797	-0.0800	-0.0797	-0.0687
	(0.0625)	(0.0574)	(0.0572)	(0.0569)	(0.0580)	(0.0510)
`No. German competitors in 10km`	-0.0628	-0.0865	-0.0864	-0.0874	-0.0865	-0.0671
	(0.1618)	(0.1622)	(0.1616)	(0.1607)	(0.1635)	(0.1635)
Motorway	13.0903***	12.8170***	12.8168***	12.8169***	12.8175**	13.2516***
	(5.0399)	(4.9662)	(4.9452)	(4.9182)	(5.0093)	(5.1412)
`National road`	-1.4716	-1.1737	-1.1725	-1.1706	-1.1736	-1.5143
	(1.1360)	(1.2914)	(1.2866)	(1.2799)	(1.3026)	(1.1735)
`Population density`	-0.0006	-0.0004	-0.0004	-0.0004	-0.0004	-0.0006
	(0.0020)	(0.0021)	(0.0021)	(0.0021)	(0.0021)	(0.0021)
Agip	0.3537	0.3293	0.3290	0.3303	0.3292	0.0504
	(0.5675)	(0.5340)	(0.5316)	(0.5285)	(0.5386)	(0.5951)
ARAL	1.9918**	2.5174***	2.5172***	2.5153***	2.5174***	1.9632*
	(0.8475)	(0.9653)	(0.9602)	(0.9547)	(0.9737)	(1.0245)
AVIA	-0.7749	-1.1248	-1.1287	-1.1255	-1.1234	-1.2090
	(1.4969)	(1.6076)	(1.5999)	(1.5916)	(1.6201)	(1.1932)
ESSO	2.0909***	1.7864*	1.7854*	1.7844*	1.7865*	1.9131**
	(0.8054)	(0.9789)	(0.9736)	(0.9683)	(0.9874)	(0.8311)
SB	-1.0132	-1.0950	-1.0955	-1.1077	-1.0947	-1.0800
	(0.8134)	(1.0099)	(1.0034)	(0.9971)	(1.0183)	(0.8083)
GO	-1.5778	-1.2877	-1.2891	-1.2890	-1.2877	-1.7121
	(1.3902)	(1.7570)	(1.7474)	(1.7379)	(1.7722)	(1.4702)
GULF	-0.8081	0.2841	0.2813	0.2818	0.2845	-0.3829
	(2.1085)	(2.6456)	(2.6381)	(2.6237)	(2.6682)	(2.4466)
HEM	-0.2076	-0.1165	-0.1206	-0.1247	-0.1165	-0.4739
	(3.0450)	(3.3378)	(3.3250)	(3.3071)	(3.3667)	(2.9774)
JET	-0.9601	-0.7598	-0.7587	-0.7544	-0.7594	-1.0272

APPENDIX TABLE 6: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h), RANDOM RFFECTS MODEL

	Dependent variable: Daily average diesel price					
	Random Effects (1)	Random Effects (2)	Random Effects (3)	Random Effects (4)	Random Effects (5)	Random Effects (6)
	(1.0213)	(1.2535)	(1.2473)	(1.2399)	(1.2642)	(1.0509)
Supermarket	-1.0047	-1.2488	-1.2491	-1.3073	-1.2480	-0.7885
	(0.9337)	(0.8856)	(0.8883)	(0.8926)	(0.8939)	(1.5140)
OIL	-0.7473	-1.5199	-1.5217	-1.5207	-1.5196	-0.9838
	(1.5366)	(1.9334)	(1.9261)	(1.9157)	(1.9499)	(1.5750)
Shell	2.5971***	3.1536**	3.1543**	3.1516**	3.1539**	2.4823***
	(0.7935)	(1.3108)	(1.3057)	(1.2982)	(1.3221)	(0.9201)
Sprint	-0.4247	-0.7303	-0.7312	-0.7388	-0.7299	-0.6387
	(1.0619)	(1.4063)	(1.3989)	(1.3910)	(1.4180)	(1.1455)
STAR	-1.9876**	-1.8953*	-1.8959*	-1.8959*	-1.8951*	-2.2703**
	(0.8941)	(1.1190)	(1.1138)	(1.1076)	(1.1286)	(1.0282)
TOTAL	1.0710	1.5311*	1.5316*	1.5317*	1.5313*	0.8054
	(0.8411)	(0.9228)	(0.9185)	(0.9136)	(0.9306)	(0.8014)
Tuesday	-0.2658	-0.2709	-0.2723	-0.2729		
	(0.2189)	(0.2178)	(0.2181)	(0.2183)		
Wednesday	-0.3782	-0.3839	-0.3843	-0.3845		
	(0.3040)	(0.3033)	(0.3036)	(0.3037)		
Thursday	-0.3665	-0.3721	-0.3726	-0.3727		
	(0.3158)	(0.3154)	(0.3155)	(0.3156)		
Friday	-0.3771	-0.3795	-0.3802	-0.3805		
	(0.2740)	(0.2734)	(0.2734)	(0.2735)		
Saturday	-0.2493	-0.2513	-0.2527		0.0315	0.0333
	(0.2631)	(0.2623)	(0.2623)		(0.1965)	(0.1973)
Sunday	0.3037	0.3019			0.5847***	0.5924***
	(0.2230)	(0.2220)			(0.1967)	(0.1972)
Holiday	1.1661**	1.1485**			1.4326***	1.4192***
	(0.4959)	(0.4959)			(0.4305)	(0.4373)
`Sunday Holiday`			0.4160*			
			(0.2318)			
`Weekend Holiday`				0.0867		
				(0.2341)		
Shop		-1.4220**	-1.4228**	-1.4202**	-1.4214**	
		(0.6508)	(0.6477)	(0.6440)	(0.6564)	
Truck		0.0795	0.0806	0.0821	0.0795	
		(0.5537)	(0.5499)	(0.5466)	(0.5585)	
Bistro		-0.0005	0.0001	-0.0002	-0.0004	
		(0.8451)	(0.8416)	(0.8370)	(0.8525)	

APPENDIX TABLE 6: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h), RANDOM RFFECTS MODEL

	Dependent variable: Daily average diesel price					
	Random Effects (1)	Random Effects (2)	Random Effects (3)	Random Effects (4)	Random Effects (5)	Random Effects (6)
`Baking station`		0.4524	0.4523	0.4508	0.4524	
		(0.5871)	(0.5844)	(0.5810)	(0.5922)	
Shower		-0.7151	-0.7150	-0.7168	-0.7150	
		(0.9502)	(0.9462)	(0.9412)	(0.9582)	
`Vacuum cleaner`		-0.2461	-0.2454	-0.2449	-0.2461	
		(0.5176)	(0.5143)	(0.5115)	(0.5221)	
ATM		-0.3690	-0.3680	-0.3665	-0.3692	
		(1.0267)	(1.0227)	(1.0172)	(1.0355)	
`Pressure washer`		0.2309	0.2302	0.2275	0.2307	
		(0.5985)	(0.5966)	(0.5938)	(0.6038)	
`Car wash`		0.8535***	0.8536***	0.8559***	0.8537***	
		(0.3001)	(0.2986)	(0.2973)	(0.3028)	
`Tire pump`		1.3144*	1.3150*	1.3135*	1.3144*	
		(0.7338)	(0.7310)	(0.7270)	(0.7401)	
Restaurant		1.6896	1.6907	1.6942	1.6893	
		(1.9814)	(1.9714)	(1.9602)	(1.9985)	
`Service station`		-0.2489	-0.2498	-0.2506	-0.2489	
		(0.7243)	(0.7200)	(0.7159)	(0.7305)	
`Credit card`		-0.5399	-0.5402	-0.5348	-0.5388	
		(1.0478)	(1.0449)	(1.0401)	(1.0574)	
`Service index`						0.0961
						(0.1317)
Constant	78.3570***	79.4297***	78.5203***	78.2105***	79.2266***	78.2848***
	(8.3180)	(8.2636)	(8.0170)	(8.0213)	(8.2927)	(8.6384)
Observations	56,391	54,760	54,760	54,760	54,760	52,765
R^2	0.5946	0.5945	0.5936	0.5911	0.5932	0.5897
Adjusted R^2	0.5943	0.5941	0.5932	0.5908	0.5929	0.5895
Remarks:	Significance Level: *** p < 0.01, ** p < 0.05, * p < 0.1; Heteroskedasticity and serial correlation consistent standard errors in parenthesis. Driscoll and Kraay - SCC estimator.					

APPENDIX TABLE 7: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h), FIXED EFFECTS MODEL

	Dependent variable: Daily average diesel price								
	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
`Polish average price`	0.0983	0.0961	0.1029	0.1051	0.0952	0.0919	0.0986	0.1009	0.0911
	(0.0791)	(0.0791)	(0.0772)	(0.0773)	(0.0789)	(0.0788)	(0.0769)	(0.0770)	(0.0786)
`Crude oil price`	1.0087***	1.0110***	1.0138***	1.0151***	1.0115***	1.0136***	1.0165***	1.0178***	1.0141***
	(0.0655)	(0.0658)	(0.0659)	(0.0659)	(0.0658)	(0.0662)	(0.0662)	(0.0663)	(0.0661)
Tuesday	-0.2658	-0.2709	-0.2723	-0.2729		-0.2661	-0.2676	-0.2681	
	(0.2189)	(0.2178)	(0.2181)	(0.2183)		(0.2182)	(0.2185)	(0.2187)	
Wednesday	-0.3782	-0.3838	-0.3843	-0.3845		-0.3826	-0.3831	-0.3832	
	(0.3040)	(0.3033)	(0.3036)	(0.3037)		(0.3046)	(0.3048)	(0.3050)	
Thursday	-0.3665	-0.3721	-0.3726	-0.3727		-0.3701	-0.3706	-0.3708	
	(0.3158)	(0.3154)	(0.3155)	(0.3156)		(0.3161)	(0.3162)	(0.3164)	
Friday	-0.3771	-0.3795	-0.3802	-0.3804		-0.3842	-0.3849	-0.3852	
	(0.2740)	(0.2734)	(0.2734)	(0.2735)		(0.2743)	(0.2743)	(0.2744)	
Saturday	-0.2493	-0.2513	-0.2526		0.0316	-0.2489	-0.2502		0.0333
	(0.2631)	(0.2623)	(0.2623)		(0.1965)	(0.2633)	(0.2633)		(0.1973)
Sunday	0.3038	0.3020			0.5847***	0.3104			0.5925***
	(0.2230)	(0.2220)			(0.1967)	(0.2230)			(0.1971)
Holiday	1.1661**	1.1485**			1.4326***	1.1358**			1.4192***
	(0.4958)	(0.4958)			(0.4304)	(0.5028)			(0.4373)
`Sunday Holiday`			0.4161*				0.4217*		
			(0.2318)				(0.2330)		
`Weekend Holiday`				0.0867				0.0924	
				(0.2341)				(0.2351)	
Observations	56,391	54,760	54,760	54,760	54,760	52,765	52,765	52,765	52,765
R^2	0.5890	0.5885	0.5876	0.5850	0.5874	0.5896	0.5886	0.5861	0.5884
Adjusted R^2	0.5874	0.5869	0.5860	0.5834	0.5858	0.5880	0.5870	0.5845	0.5869

Remarks: Significance Level: *** p < 0.01, ** p < 0.05, * p < 0.1; Heteroskedasticity and serial correlation consistent standard errors in parenthesis. Driscoll and Kraay - SCC estimator.

APPENDIX TABLE 8: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h) WITH INTERACTION TERM

	Dependent variable: Daily Average Price	
	Pooled (OLS)	Fixed-effects
`Dist. nearest Polish competitor`	-0.4928*** (0.0843)	
`Polish average price`	-0.0480 (0.0795)	-0.0473 (0.0795)
DrivDist.PolPrice.Interaction	0.0041*** (0.0007)	0.0041*** (0.0007)
`Crude oil price`	1.0109*** (0.0658)	1.0110*** (0.0658)
`Dist. nearest German competitor`	-0.0895*** (0.0041)	
`No. German competitors in 10km`	-0.0990*** (0.0117)	
Motorway	12.8162*** (0.3581)	
`National road`	-1.2004*** (0.0933)	
`Population density`	-0.0003** (0.0002)	
Agip	0.3164*** (0.0382)	
ARAL	2.5140*** (0.0705)	
AVIA	-1.2491*** (0.1198)	
ESSO	1.8067*** (0.0702)	
SB	-1.1149*** (0.0734)	
GO	-1.2794*** (0.1268)	
GULF	0.3351* (0.1899)	
HEM	-0.1053 (0.2399)	
JET	-0.7645*** (0.0903)	
Supermarket	-1.3995*** (0.0660)	
OIL	-1.5711*** (0.1404)	
Shell	3.1435*** (0.0949)	
Sprint	-0.7562*** (0.1020)	
STAR	-1.8988*** (0.0805)	
TOTAL	1.5029*** (0.0663)	
Tuesday	-0.2717 (0.2179)	-0.2708 (0.2178)
Wednesday	-0.3849 (0.3033)	-0.3838 (0.3033)
Thursday	-0.3721 (0.3153)	-0.3721 (0.3154)
Friday	-0.3799 (0.2734)	-0.3795 (0.2734)
Saturday	-0.2521 (0.2622)	-0.2513 (0.2623)
Sunday	0.3003 (0.2218)	0.3021 (0.2220)
Holiday	1.1499** (0.4966)	1.1447** (0.4961)
Shop	-1.5417*** (0.0490)	
Truck	0.0724* (0.0398)	
Bistro	-0.0269 (0.0610)	
`Baking station`	0.4886*** (0.0424)	
Shower	-0.7016*** (0.0681)	
`Vacuum cleaner`	-0.2680*** (0.0373)	
ATM	-0.3558*** (0.0745)	
`Pressure washer`	0.2399*** (0.0435)	
`Car wash`	0.8414*** (0.0219)	
`Tire pump`	1.3231*** (0.0534)	
Restaurant	1.7021*** (0.1432)	
`Service station`	-0.2414*** (0.0522)	

APPENDIX TABLE 8: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h) WITH INTERACTION TERM

	Dependent variable: Daily Average Price	
	Pooled (OLS)	Fixed-effects
`Credit card`	-0.6778*** (0.0795)	
Constant	96.7555*** (8.5280)	
Observations	54,760	54,760
R^2	0.6674	0.5906
Adjusted R^2	0.6671	0.5890
Remarks:	Significance Level: *** p < 0.01, ** p < 0.05, * p < 0.1; Heteroskedasticity and serial correlation consistent standard errors in parenthesis. Driscoll and Kraay - SCC estimator.	

APPENDIX TABLE 9: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h) WITH QUADRATIC AND CUBIC SPECIFICATIONS

	Dependent variable: Daily Average Price							
	Pooled (OLS)	Pooled (OLS)	Pooled (OLS)	Pooled (OLS) (without consistent SE)	Pooled (OLS)	Pooled (OLS) (without consistent SE)	Fixed-effects	Fixed-effects (without consistent SE)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
`Dist. nearest Polish competitor`	0.0290***	0.1067***	-0.0055***	-0.0055***	0.0290***	0.1067***		
	(0.0047)	(0.0114)	(0.0021)	(0.0008)	(0.0047)	(0.0103)		
DrivDist.Squared	-0.0005***	-0.0036***			-0.0005***	-0.0036***		
	(0.0001)	(0.0005)			(0.0001)	(0.0004)		
DrivDist.Cubic		0.00003***				0.00003***		
		(0.00001)				(0.000004)		
`Polish average price`	0.0967	0.0967	-20.6850***	192.1569***	-20.6846***	192.4038***	-20.7902***	190.2977***
	(0.0790)	(0.0790)	(6.8778)	(52.7883)	(6.8779)	(52.7136)	(6.8748)	(41.5879)
PolPrice.Squared			0.0883***	-1.7184***	0.0883***	-1.7205***	0.0888***	-1.7031***
			(0.0293)	(0.4481)	(0.0293)	(0.4474)	(0.0293)	(0.3530)
PolPrice.Cubic				0.0051***		0.0051***		0.0051***
				(0.0013)		(0.0013)		(0.0010)
`Crude oil price`	1.0108***	1.0109***	0.9746***	0.9847***	0.9746***	0.9847***	0.9746***	0.9846***
	(0.0658)	(0.0658)	(0.0631)	(0.0061)	(0.0631)	(0.0061)	(0.0632)	(0.0048)
`Dist. nearest German competitor`	-0.0969***	-0.0963***	-0.0889***	-0.0889***	-0.0965***	-0.0959***		
	(0.0046)	(0.0046)	(0.0040)	(0.0040)	(0.0045)	(0.0041)		
`No. German competitors in 10km`	-0.1221***	-0.1115***	-0.0985***	-0.0985***	-0.1217***	-0.1111***		
	(0.0131)	(0.0140)	(0.0117)	(0.0068)	(0.0131)	(0.0073)		
Motorway	12.8171***	12.8084***	12.8151***	12.8152***	12.8159***	12.8072***		
	(0.3581)	(0.3577)	(0.3581)	(0.0796)	(0.3580)	(0.0795)		
`National road`	-1.1288***	-1.1691***	-1.2013***	-1.2012***	-1.1293***	-1.1695***		
	(0.0952)	(0.0965)	(0.0932)	(0.0630)	(0.0950)	(0.0636)		
`Population density`	-0.0001	-0.0001	-0.0003**	-0.0003***	-0.0001	-0.0001		
	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0001)		
Agip	0.3024***	0.2779***	0.3170***	0.3169***	0.3030***	0.2784***		
	(0.0378)	(0.0386)	(0.0384)	(0.0810)	(0.0379)	(0.0810)		
ARAL	2.5100***	2.5136***	2.5135***	2.5135***	2.5100***	2.5136***		
	(0.0705)	(0.0705)	(0.0704)	(0.0570)	(0.0705)	(0.0569)		
AVIA	-1.1916***	-1.2353***	-1.2501***	-1.2499***	-1.1928***	-1.2363***		
	(0.1204)	(0.1219)	(0.1198)	(0.0975)	(0.1204)	(0.0977)		
ESSO	1.7911***	1.7547***	1.8058***	1.8058***	1.7905***	1.7542***		
	(0.0687)	(0.0723)	(0.0701)	(0.0727)	(0.0686)	(0.0727)		
SB	-1.1400***	-1.1323***	-1.1151***	-1.1151***	-1.1398***	-1.1320***		
	(0.0715)	(0.0711)	(0.0734)	(0.0704)	(0.0715)	(0.0703)		
GO	-1.4036***	-1.3866***	-1.2804***	-1.2805***	-1.4044***	-1.3875***		
	(0.1348)	(0.1358)	(0.1267)	(0.0985)	(0.1348)	(0.0993)		
GULF	0.3392*	0.2545	0.3306*	0.3307***	0.3360*	0.2512**		
	(0.1903)	(0.1932)	(0.1901)	(0.1054)	(0.1904)	(0.1058)		
HEM	-0.1753	-0.1091	-0.1074	-0.1075	-0.1772	-0.1109		
	(0.2314)	(0.2227)	(0.2401)	(0.0928)	(0.2316)	(0.0933)		
JET	-0.8018***	-0.8208***	-0.7648***	-0.7647***	-0.8020***	-0.8209***		
	(0.0923)	(0.0902)	(0.0903)	(0.0952)	(0.0924)	(0.0951)		
Supermarket	-1.4861***	-1.5081***	-1.3950***	-1.3950***	-1.4840***	-1.5059***		
	(0.0687)	(0.0679)	(0.0661)	(0.0813)	(0.0689)	(0.0817)		
OIL	-1.6203***	-1.6205***	-1.5709***	-1.5709***	-1.6202***	-1.6205***		
	(0.1348)	(0.1349)	(0.1404)	(0.0932)	(0.1349)	(0.0932)		
Shell	3.1198***	3.0652***	3.1438***	3.1438***	3.1206***	3.0660***		
	(0.0934)	(0.0940)	(0.0949)	(0.0666)	(0.0935)	(0.0669)		
Sprint	-0.7256***	-0.8136***	-0.7570***	-0.7570***	-0.7258***	-0.8138***		
	(0.1017)	(0.1047)	(0.1020)	(0.0940)	(0.1017)	(0.0946)		
STAR	-1.8551***	-1.8626***	-1.8987***	-1.8986***	-1.8551***	-1.8625***		
	(0.0830)	(0.0833)	(0.0805)	(0.0718)	(0.0830)	(0.0718)		

APPENDIX TABLE 9: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h) WITH QUADRATIC AND CUBIC SPECIFICATIONS

	Dependent variable: Daily Average Price							
	Pooled (OLS)	Pooled (OLS)	Pooled (OLS)	Pooled (OLS) (without consistent SE)	Pooled (OLS)	Pooled (OLS) (without consistent SE)	Fixed-effects	Fixed-effects (without consistent SE)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
TOTAL	1.5177***	1.5297***	1.5039***	1.5040***	1.5186***	1.5307***		
	(0.0663)	(0.0667)	(0.0663)	(0.0662)	(0.0663)	(0.0662)		
Tuesday	-0.2717	-0.2715	-0.3050	-0.3076***	-0.3050	-0.3074***	-0.3044	-0.3070***
	(0.2179)	(0.2179)	(0.1963)	(0.0466)	(0.1963)	(0.0466)	(0.1962)	(0.0367)
Wednesday	-0.3849	-0.3847	-0.3976	-0.3976***	-0.3976	-0.3974***	-0.3966	-0.3967***
	(0.3033)	(0.3033)	(0.2808)	(0.0466)	(0.2808)	(0.0465)	(0.2807)	(0.0367)
Thursday	-0.3721	-0.3720	-0.3843	-0.3845***	-0.3843	-0.3845***	-0.3844	-0.3846***
	(0.3153)	(0.3153)	(0.2910)	(0.0466)	(0.2910)	(0.0466)	(0.2910)	(0.0367)
Friday	-0.3799	-0.3797	-0.4056	-0.4077***	-0.4057	-0.4076***	-0.4054	-0.4075***
	(0.2734)	(0.2734)	(0.2607)	(0.0466)	(0.2607)	(0.0466)	(0.2606)	(0.0367)
Saturday	-0.2521	-0.2519	-0.2757	-0.2770***	-0.2758	-0.2769***	-0.2750	-0.2763***
	(0.2622)	(0.2622)	(0.2562)	(0.0463)	(0.2562)	(0.0463)	(0.2562)	(0.0365)
Sunday	0.2997	0.3009	0.2904	0.2898***	0.2900	0.2905***	0.2922	0.2916***
	(0.2218)	(0.2218)	(0.2123)	(0.0476)	(0.2123)	(0.0475)	(0.2124)	(0.0375)
Holiday	1.1544**	1.1536**	0.7612	0.7419***	0.7620	0.7418***	0.7541	0.7349***
	(0.4964)	(0.4962)	(0.6226)	(0.0929)	(0.6227)	(0.0928)	(0.6223)	(0.0732)
Shop	-1.5263***	-1.6002***	-1.5395***	-1.5395***	-1.5251***	-1.5991***		
	(0.0496)	(0.0523)	(0.0491)	(0.0597)	(0.0496)	(0.0603)		
Truck	0.0064	-0.0399	0.0728*	0.0728**	0.0068	-0.0396		
	(0.0384)	(0.0358)	(0.0398)	(0.0319)	(0.0383)	(0.0331)		
Bistro	-0.0298	-0.0410	-0.0262	-0.0262	-0.0291	-0.0403		
	(0.0607)	(0.0615)	(0.0609)	(0.0474)	(0.0606)	(0.0473)		
`Baking station`	0.4757***	0.5188***	0.4874***	0.4874***	0.4748***	0.5180***		
	(0.0432)	(0.0441)	(0.0424)	(0.0515)	(0.0432)	(0.0518)		
Shower	-0.6155***	-0.5342***	-0.7017***	-0.7016***	-0.6156***	-0.5342***		
	(0.0603)	(0.0681)	(0.0681)	(0.0782)	(0.0603)	(0.0792)		
`Vacuum cleaner`	-0.2828***	-0.2695***	-0.2672***	-0.2672***	-0.2821***	-0.2687***		
	(0.0373)	(0.0378)	(0.0373)	(0.0455)	(0.0373)	(0.0455)		
ATM	-0.3492***	-0.3295***	-0.3547***	-0.3547***	-0.3483***	-0.3287***		
	(0.0739)	(0.0749)	(0.0746)	(0.0377)	(0.0739)	(0.0377)		
`Pressure washer`	0.3353***	0.3847***	0.2393***	0.2392***	0.3349***	0.3843***		
	(0.0443)	(0.0444)	(0.0435)	(0.0540)	(0.0443)	(0.0552)		
`Car wash`	0.8372***	0.8770***	0.8419***	0.8419***	0.8375***	0.8773***		
	(0.0220)	(0.0247)	(0.0219)	(0.0351)	(0.0220)	(0.0354)		
`Tire pump`	1.3189***	1.3103***	1.3228***	1.3228***	1.3188***	1.3102***		
	(0.0536)	(0.0529)	(0.0534)	(0.0511)	(0.0537)	(0.0510)		
Restaurant	1.8792***	1.9369***	1.7027***	1.7027***	1.8799***	1.9376***		
	(0.1294)	(0.1364)	(0.1432)	(0.0945)	(0.1295)	(0.0964)		
`Service station`	-0.2495***	-0.2688***	-0.2420***	-0.2421***	-0.2500***	-0.2693***		
	(0.0518)	(0.0530)	(0.0523)	(0.0488)	(0.0519)	(0.0488)		
`Credit card`	-0.6849***	-0.6234***	-0.6760***	-0.6758***	-0.6832***	-0.6214***		
	(0.0799)	(0.0782)	(0.0793)	(0.0636)	(0.0797)	(0.0640)		
Constant	79.4093***	78.9397***	1,302.9830***	-7,053.0470***	1,302.6920***	-7,063.4760***		
	(8.4389)	(8.4342)	(403.6014)	(2,072.5860)	(403.6124)	(2,069.6530)		
Observations	54,760	54,760	54,760	54,760	54,760	54,760	54,760	54,760
R^2	0.6669	0.6673	0.6742	0.6743	0.6748	0.6753	0.6042	0.6044
Adjusted R^2	0.6666	0.6670	0.6740	0.6741	0.6745	0.6750	0.6026	0.6028

Remarks: Significance Level: *** p < 0.01, ** p < 0.05, * p < 0.1; Heteroskedasticity and serial correlation consistent standard errors in parenthesis. Driscoll and Kraay - SCC estimator. However, for the models 4, 6, 8 and 10 no consistent standard errors could be computed.

APPENDIX TABLE 10: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h), LOG-LOG SPECIFICATIONS

	Dependent variable: Daily Average Price	
	Pooled (OLS)	Random-effects (without population density)
log(`Dist. nearest Polish competitor`)	-0.0008** (0.0004)	-0.0009 (0.0046)
log(`Polish average price`)	0.0953 (0.0717)	0.0951 (0.0718)
log(`Crude oil price`)	0.2888*** (0.0188)	0.2888*** (0.0188)
log(`Dist. nearest German competitor`)	-0.0029*** (0.0001)	-0.0029* (0.0015)
log(`No. German competitors in 10km`)	-0.0021*** (0.0004)	-0.0019 (0.0050)
Motorway	0.0962*** (0.0025)	0.0962*** (0.0336)
`National road`	-0.0098*** (0.0007)	-0.0095 (0.0096)
log(`Population density`)	-0.0020*** (0.0003)	-0.0021 (0.0042)
Agip	0.0020*** (0.0003)	0.0021 (0.0041)
ARAL	0.0202*** (0.0005)	0.0203*** (0.0067)
AVIA	-0.0068*** (0.0009)	-0.0057 (0.0111)
ESSO	0.0136*** (0.0006)	0.0136* (0.0076)
SB	-0.0078*** (0.0006)	-0.0076 (0.0076)
GO	-0.0080*** (0.0010)	-0.0080 (0.0127)
GULF	0.0038** (0.0016)	0.0038 (0.0206)
HEM	-0.0002 (0.0020)	-0.0002 (0.0258)
JET	-0.0063*** (0.0008)	-0.0060 (0.0105)
Supermarket	-0.0088*** (0.0005)	-0.0078 (0.0063)
OIL	-0.0113*** (0.0011)	-0.0110 (0.0149)
Shell	0.0246*** (0.0007)	0.0248*** (0.0095)
Sprint	-0.0074*** (0.0008)	-0.0071 (0.0105)
STAR	-0.0145*** (0.0005)	-0.0144** (0.0071)
TOTAL	0.0116*** (0.0005)	0.0117* (0.0066)
Tuesday	-0.0021 (0.0017)	-0.0021 (0.0017)
Wednesday	-0.0030 (0.0024)	-0.0030 (0.0024)
Thursday	-0.0029 (0.0025)	-0.0029 (0.0025)
Friday	-0.0031 (0.0022)	-0.0031 (0.0022)
Saturday	-0.0021 (0.0021)	-0.0021 (0.0021)
Sunday	0.0023 (0.0017)	0.0023 (0.0017)
Holiday	0.0088** (0.0039)	0.0088** (0.0039)
Shop	-0.0102*** (0.0003)	-0.0094** (0.0045)
Truck	0.0005 (0.0003)	0.0005 (0.0044)
Bistro	-0.0002 (0.0005)	-0.0001 (0.0064)
`Baking station`	0.0041*** (0.0003)	0.0039 (0.0044)
Shower	-0.0061*** (0.0005)	-0.0062 (0.0069)
`Vacuum cleaner`	-0.0010*** (0.0003)	-0.0010 (0.0041)
ATM	-0.0030*** (0.0006)	-0.0031 (0.0072)
`Pressure washer`	0.0008** (0.0003)	0.0008 (0.0044)
`Car wash`	0.0068*** (0.0002)	0.0069*** (0.0023)
`Tire pump`	0.0096*** (0.0004)	0.0096* (0.0056)
Restaurant	0.0130*** (0.0011)	0.0129 (0.0146)
`Service station`	-0.0013*** (0.0004)	-0.0014 (0.0055)
`Credit card`	-0.0053*** (0.0006)	-0.0043 (0.0082)

APPENDIX TABLE 10: REGRESSION OF AVERAGE DAILY RETAIL PRICE FOR DIESEL (24h), LOG-LOG SPECIFICATIONS

	Dependent variable: Daily Average Price	
	Pooled (OLS)	Random-effects (without population density)
Constant	3.3652*** (0.3198)	3.3649*** (0.3186)
Observations	54,760	54,760
R^2	0.6669	0.7039
Adjusted R^2	0.6667	0.7037
Remarks:	Significance Level: *** p < 0.01, ** p < 0.05, * p < 0.1; Heteroskedasticity and serial correlation consistent standard errors in parenthesis. Driscoll and Kraay - SCC estimator.	

APPENDIX TABLE 11: DESCRIPTIVE STATISTICS, ZONE A

Statistic	Min	Mean	Median	Max	N	St. Dev.	Pctl(25)	Pctl(75)
Price	111.963	126.809	126.257	151.233	10,463	4.798	123.552	129.424
Dist..nearest.Polish.competitor	1.950	7.686	7.100	14.870	10,463	3.652	4.320	10.860
Time.nearest.Polish.competitor	3.729	14.703	12.257	96.384	10,463	14.779	7.909	14.666
Polish.average.price	113.875	117.970	118.269	121.817	10,463	2.368	116.188	120.133
German.average.price	123.200	126.200	125.800	130.800	10,463	1.996	124.800	127.700
Crude.oil.price	29.504	36.218	35.939	42.377	10,463	2.570	34.252	37.668
Dist..nearest.German.competitor	0.100	3.259	1.800	14.060	10,463	3.475	0.910	5.250
Time.nearest.German.competitor	0.394	4.957	3.498	18.923	10,463	4.448	2.117	7.670
No..German.competitors.in.5km	1	3.139	3	7	10,463	1.746	1	5
No..German.competitors.in.10km	1	4.326	4	8	10,463	1.998	3	6
Motorway	0	0.052	0	1	10,463	0.221	0	0
National.road	0	0.052	0	1	10,463	0.222	0	0
Population.density	34.873	233.464	145.554	834.182	10,463	236.025	72.924	391.431
Agip	0	0.078	0	1	10,463	0.268	0	0
ARAL	0	0.182	0	1	10,463	0.386	0	0
AVIA	0	0.026	0	1	10,463	0.159	0	0
ESSO	0	0.104	0	1	10,463	0.305	0	0
GO	0	0.000	0	0	10,463	0.000	0	0
GULF	0	0.052	0	1	10,463	0.222	0	0
HEM	0	0.000	0	0	10,463	0.000	0	0
JET	0	0.000	0	0	10,463	0.000	0	0
OIL	0	0.026	0	1	10,463	0.159	0	0
Others	0	0.125	0	1	10,463	0.331	0	0
SB	0	0.078	0	1	10,463	0.268	0	0
Shell	0	0.078	0	1	10,463	0.268	0	0
Sprint	0	0.026	0	1	10,463	0.159	0	0
STAR	0	0.026	0	1	10,463	0.159	0	0
Supermarket	0	0.044	0	1	10,463	0.204	0	0
TOTAL	0	0.156	0	1	10,463	0.363	0	0
Oli4	0	0.520	1	1	10,463	0.500	0	1
Oli5	0	0.520	1	1	10,463	0.500	0	1

APPENDIX TABLE 11: DESCRIPTIVE STATISTICS, ZONE A

Statistic	Min	Mean	Median	Max	N	St. Dev.	Pctl(25)	Pctl(75)
Monday	0	0.138	0	1	10,463	0.345	0	0
Tuesday	0	0.141	0	1	10,463	0.348	0	0
Wednesday	0	0.141	0	1	10,463	0.348	0	0
Thursday	0	0.141	0	1	10,463	0.349	0	0
Friday	0	0.142	0	1	10,463	0.349	0	0
Saturday	0	0.145	0	1	10,463	0.352	0	0
Sunday	0	0.130	0	1	10,463	0.336	0	0
Holiday	0	0.021	0	1	10,463	0.144	0	0
Shop	0	0.853	1	1	10,463	0.354	1	1
Truck	0	0.390	0	1	10,463	0.488	0	1
Bistro	0	0.442	0	1	10,463	0.497	0	1
Baking.station	0	0.390	0	1	10,463	0.488	0	1
Shower	0	0.026	0	1	10,463	0.159	0	0
Vacuum.cleaner	0	0.208	0	1	10,463	0.406	0	0
ATM	0	0.230	0	1	10,463	0.421	0	0
Pressure.washer	0	0.182	0	1	10,463	0.386	0	0
Car.wash	0	0.646	1	1	10,463	0.478	0	1
Tire.pump	0	0.104	0	1	10,463	0.305	0	0
Restaurant	0	0.052	0	1	10,463	0.222	0	0
Service.station	0	0.234	0	1	10,463	0.423	0	0
Credit.card	0	0.927	1	1	10,463	0.260	1	1
Open	0	3.760	5	8	10,463	2.770	0	6
Close	12	22.388	22	24	10,463	1.476	22	24
Open.24.hours	0	0.337	0	1	10,463	0.473	0	1

APPENDIX TABLE 12: DESCRIPTIVE STATISTICS, ZONE B

Statistic	Min	Mean	Median	Max	N	St. Dev.	Pctl(25)	Pctl(75)
Price	111.355	126.712	126.208	148.900	9,658	4.646	123.669	129.150
Dist..nearest.Polish.competitor	18.090	25.549	26.680	29.870	9,658	3.487	22.900	28.640
Time.nearest.Polish.competitor	17.668	28.659	30.299	35.117	9,658	4.897	25.022	32.617
Polish.average.price	113.875	117.968	118.269	121.817	9,658	2.368	116.188	120.133
German.average.price	123.200	126.199	125.800	130.800	9,658	1.995	124.800	127.700
Crude.oil.price	29.504	36.218	35.939	42.377	9,658	2.568	34.252	37.668
Dist..nearest.German.competitor	0.190	3.960	1.730	22.130	9,658	4.698	1.350	5.750
Time.nearest.German.competitor	0.286	5.335	3.079	22.507	9,658	5.219	2.415	7.133
No..German.competitors.in.5km	1	2.874	3	10	9,658	1.752	1	4
No..German.competitors.in.10km	1	3.963	4	13	9,658	2.317	2	5
Motorway	0	0.028	0	1	9,658	0.165	0	0
National.road	0	0.056	0	1	9,658	0.231	0	0
Population.density	31.617	139.997	67.649	605.078	9,658	153.644	42.031	148.506
Agip	0	0.056	0	1	9,658	0.231	0	0
ARAL	0	0.084	0	1	9,658	0.278	0	0
AVIA	0	0.056	0	1	9,658	0.231	0	0
ESSO	0	0.141	0	1	9,658	0.348	0	0

APPENDIX TABLE 12: DESCRIPTIVE STATISTICS, ZONE B

Statistic	Min	Mean	Median	Max	N	St. Dev.	Pctl(25)	Pctl(75)
GO	0	0.000	0	0	9,658	0.000	0	0
GULF	0	0.056	0	1	9,658	0.231	0	0
HEM	0	0.000	0	0	9,658	0.000	0	0
JET	0	0.028	0	1	9,658	0.165	0	0
OIL	0	0.028	0	1	9,658	0.165	0	0
Others	0	0.084	0	1	9,658	0.278	0	0
SB	0	0.084	0	1	9,658	0.278	0	0
Shell	0	0.141	0	1	9,658	0.348	0	0
Sprint	0	0.000	0	0	9,658	0.000	0	0
STAR	0	0.028	0	1	9,658	0.165	0	0
Supermarket	0	0.071	0	1	9,658	0.257	0	0
TOTAL	0	0.141	0	1	9,658	0.348	0	0
Oli4	0	0.507	1	1	9,658	0.500	0	1
Oli5	0	0.535	1	1	9,658	0.499	0	1
Monday	0	0.138	0	1	9,658	0.345	0	0
Tuesday	0	0.142	0	1	9,658	0.349	0	0
Wednesday	0	0.142	0	1	9,658	0.349	0	0
Thursday	0	0.142	0	1	9,658	0.349	0	0
Friday	0	0.142	0	1	9,658	0.349	0	0
Saturday	0	0.145	0	1	9,658	0.352	0	0
Sunday	0	0.130	0	1	9,658	0.336	0	0
Holiday	0	0.021	0	1	9,658	0.143	0	0
Shop	0	0.868	1	1	9,658	0.338	1	1
Truck	0	0.563	1	1	9,658	0.496	0	1
Bistro	0	0.422	0	1	9,658	0.494	0	1
Baking.station	0	0.366	0	1	9,658	0.482	0	1
Shower	0	0.028	0	1	9,658	0.165	0	0
Vacuum.cleaner	0	0.197	0	1	9,658	0.398	0	0
ATM	0	0.225	0	1	9,658	0.418	0	0
Pressure.washer	0	0.000	0	0	9,658	0.000	0	0
Car.wash	0	0.619	1	1	9,658	0.486	0	1
Tire.pump	0	0.113	0	1	9,658	0.316	0	0
Restaurant	0	0.000	0	0	9,658	0.000	0	0
Service.station	0	0.225	0	1	9,658	0.418	0	0
Credit.card	0	0.948	1	1	9,658	0.222	1	1
Open	0	3.960	5	8	9,658	2.792	0	6
Close	16	22.113	22	24	9,658	1.645	21	24
Open.24.hours	0	0.314	0	1	9,658	0.464	0	1

APPENDIX TABLE 13: DESCRIPTIVE STATISTICS, ZONE C

Statistic	Min	Mean	Median	Max	N	St. Dev.	Pctl(25)	Pctl(75)
Price	113.025	125.966	125.700	140.536	14,589	3.876	123.260	128.488
Dist..nearest.Polish.competitor	30.150	38.012	39.340	44.790	14,589	4.786	33.010	42.000
Time.nearest.Polish.competitor	19.117	41.169	40.792	149.865	14,589	17.927	31.331	45.748
Polish.average.price	113.875	117.977	118.269	121.817	14,589	2.364	116.188	120.133
German.average.price	123.200	126.203	125.800	130.800	14,589	1.993	124.800	127.700
Crude.oil.price	29.504	36.223	35.939	42.377	14,589	2.570	34.290	37.668
Dist..nearest.German.competitor	0.280	3.653	2.060	22.390	14,589	4.213	0.890	4.520
Time.nearest.German.competitor	0.838	5.273	3.993	25.528	14,589	4.490	1.974	6.861
No..German.competitors.in.5km	1	3.758	3	11	14,589	2.364	2	6
No..German.competitors.in.10km	1	6.741	7	14	14,589	4.060	3	10
Motorway	0	0.019	0	1	14,589	0.135	0	0
National.road	0	0.034	0	1	14,589	0.182	0	0
Population.density	17.838	291.464	256.790	605.078	14,589	216.153	87.676	451.974
Agip	0	0.056	0	1	14,589	0.230	0	0
ARAL	0	0.131	0	1	14,589	0.337	0	0
AVIA	0	0.019	0	1	14,589	0.135	0	0
ESSO	0	0.037	0	1	14,589	0.189	0	0
GO	0	0.075	0	1	14,589	0.263	0	0
GULF	0	0.000	0	0	14,589	0.000	0	0
HEM	0	0.075	0	1	14,589	0.263	0	0
JET	0	0.037	0	1	14,589	0.189	0	0
OIL	0	0.019	0	1	14,589	0.135	0	0
Others	0	0.102	0	1	14,589	0.303	0	0
SB	0	0.050	0	1	14,589	0.218	0	0
Shell	0	0.167	0	1	14,589	0.373	0	0
Sprint	0	0.019	0	1	14,589	0.135	0	0
STAR	0	0.056	0	1	14,589	0.230	0	0
Supermarket	0	0.047	0	1	14,589	0.211	0	0
TOTAL	0	0.112	0	1	14,589	0.315	0	0
Oli4	0	0.447	0	1	14,589	0.497	0	1
Oli5	0	0.484	0	1	14,589	0.500	0	1
Monday	0	0.138	0	1	14,589	0.345	0	0
Tuesday	0	0.142	0	1	14,589	0.349	0	0
Wednesday	0	0.142	0	1	14,589	0.349	0	0
Thursday	0	0.142	0	1	14,589	0.349	0	0
Friday	0	0.142	0	1	14,589	0.349	0	0
Saturday	0	0.146	0	1	14,589	0.353	0	0
Sunday	0	0.128	0	1	14,589	0.334	0	0
Holiday	0	0.021	0	1	14,589	0.144	0	0
Shop	0	0.838	1	1	14,589	0.368	1	1
Truck	0	0.578	1	1	14,589	0.494	0	1
Bistro	0	0.503	1	1	14,589	0.500	0	1
Baking.station	0	0.354	0	1	14,589	0.478	0	1
Shower	0	0.019	0	1	14,589	0.135	0	0
Vacuum.cleaner	0	0.205	0	1	14,589	0.404	0	0
ATM	0	0.297	0	1	14,589	0.457	0	1

APPENDIX TABLE 13: DESCRIPTIVE STATISTICS, ZONE C

Statistic	Min	Mean	Median	Max	N	St. Dev.	Pctl(25)	Pctl(75)
Pressure.washer	0	0.075	0	1	14,589	0.263	0	0
Car.wash	0	0.726	1	1	14,589	0.446	0	1
Tire.pump	0	0.131	0	1	14,589	0.337	0	0
Restaurant	0	0.019	0	1	14,589	0.135	0	0
Service.station	0	0.205	0	1	14,589	0.404	0	0
Credit.card	0	0.938	1	1	14,589	0.241	1	1
Open	0	3.497	5	9	14,589	2.933	0	6
Close	17	22.506	22	24	14,589	1.427	21	24
Open.24.hours	0	0.401	0	1	14,589	0.490	0	1

APPENDIX TABLE 14: DESCRIPTIVE STATISTICS, ZONE D

Statistic	Min	Mean	Median	Max	N	St. Dev.	Pctl(25)	Pctl(75)
Price	113.686	126.230	125.133	159.471	20,050	5.984	122.483	128.479
Dist..nearest.Polish.competitor	45.070	51.739	50.580	59.790	20,050	4.125	48.250	55.720
Time.nearest.Polish.competitor	28.836	50.415	50.552	138.877	20,050	14.615	40.157	57.812
Polish.average.price	113.875	117.967	118.269	121.817	20,050	2.370	116.188	120.133
German.average.price	123.200	126.201	125.800	130.800	20,050	1.996	124.800	127.700
Crude.oil.price	29.504	36.219	35.939	42.377	20,050	2.570	34.252	37.668
Dist..nearest.German.competitor	0.170	3.315	1.780	18.260	20,050	3.773	0.500	4.180
Time.nearest.German.competitor	0.227	4.820	3.553	20.789	20,050	4.443	1.419	6.484
No..German.competitors.in.5km	1	3.467	3	10	20,050	2.287	2	5
No..German.competitors.in.10km	1	5.880	6	13	20,050	3.249	3	8
Motorway	0	0.054	0	1	20,050	0.227	0	0
National.road	0	0.068	0	1	20,050	0.251	0	0
Population.density	24.334	266.043	146.018	844.884	20,050	243.146	72.666	345.474
Agip	0	0.027	0	1	20,050	0.162	0	0
ARAL	0	0.190	0	1	20,050	0.392	0	0
AVIA	0	0.014	0	1	20,050	0.116	0	0
ESSO	0	0.054	0	1	20,050	0.227	0	0
GO	0	0.014	0	1	20,050	0.116	0	0
GULF	0	0.000	0	0	20,050	0.000	0	0
HEM	0	0.027	0	1	20,050	0.162	0	0
JET	0	0.027	0	1	20,050	0.162	0	0
OIL	0	0.027	0	1	20,050	0.162	0	0
Others	0	0.179	0	1	20,050	0.383	0	0
SB	0	0.041	0	1	20,050	0.198	0	0
Shell	0	0.081	0	1	20,050	0.273	0	0
Sprint	0	0.039	0	1	20,050	0.192	0	0
STAR	0	0.095	0	1	20,050	0.293	0	0
Supermarket	0	0.023	0	1	20,050	0.149	0	0
TOTAL	0	0.163	0	1	20,050	0.369	0	0
Oli4	0	0.488	0	1	20,050	0.500	0	1
Oli5	0	0.516	1	1	20,050	0.500	0	1
Monday	0	0.137	0	1	20,050	0.344	0	0

APPENDIX TABLE 14: DESCRIPTIVE STATISTICS, ZONE D

Statistic	Min	Mean	Median	Max	N	St. Dev.	Pctl(25)	Pctl(75)
Tuesday	0	0.141	0	1	20,050	0.348	0	0
Wednesday	0	0.141	0	1	20,050	0.348	0	0
Thursday	0	0.141	0	1	20,050	0.348	0	0
Friday	0	0.141	0	1	20,050	0.348	0	0
Saturday	0	0.144	0	1	20,050	0.351	0	0
Sunday	0	0.135	0	1	20,050	0.341	0	0
Holiday	0	0.022	0	1	20,050	0.146	0	0
Shop	0	0.893	1	1	20,050	0.309	1	1
Truck	0	0.475	0	1	20,050	0.499	0	1
Bistro	0	0.581	1	1	20,050	0.493	0	1
Baking.station	0	0.459	0	1	20,050	0.498	0	1
Shower	0	0.068	0	1	20,050	0.251	0	0
Vacuum.cleaner	0	0.242	0	1	20,050	0.428	0	0
ATM	0	0.244	0	1	20,050	0.430	0	0
Pressure.washer	0	0.093	0	1	20,050	0.290	0	0
Car.wash	0	0.651	1	1	20,050	0.477	0	1
Tire.pump	0	0.066	0	1	20,050	0.248	0	0
Restaurant	0	0.027	0	1	20,050	0.162	0	0
Service.station	0	0.176	0	1	20,050	0.381	0	0
Credit.card	0	0.945	1	1	20,050	0.228	1	1
Open	0	3.479	5	9	20,050	2.807	0	6
Close	12	22.409	22	24	20,050	1.663	22	24
Open.24.hours	0	0.368	0	1	20,050	0.482	0	1

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