Price Cycles in the German Gasoline Market

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Contents

1. Introduction

The theory of Edgeworth Price Cycles goes back to Edgeworth (1925), who argued that in a oligopolistic market with capacity constrained firms, price cycles would be more likely than stable prices. This is because two firms would undercut each other's prices until they were so low that it would be more profitable for one firm to raise the price and serve the remaining demand that the other firm can no longer satisfy. Maskin and Tirole (1988) formalized these cyclical pricing pattern as a possible outcome of a dynamic duopoly game. The authors assume two identical firms that sell a homogeneous good, compete in price and the demand is constant. The firms pricing is sequential and the costs are zero, whereby the one with the lowest price serves the entire market and they share the market equally when they charge the same price. This setting results into two possible types of equilibrium. The first shows stable prices over time, while the other reveals asymmetric cycles – the so-called Edgeworth Price Cycles. The process is as follows: Starting from a high price level, the duopolists alternately undercut each other in small steps in order to serve the entire market ("gradual price war") until price reaches marginal cost and the firms are in a zero profit situation. In this situation, there is no incentive to reduce the price further, but a higher level would be beneficial for both. The other company would, however, react to an increase with a slightly lower increase and then serve the entire demand. Maskin and Tirole (1988) describe this situation as a "war of attrition", in which the firms play a mixed strategy, mixing between a price hike and keeping the price at the marginal cost level. The price remains at the low level until a player, given a certain probability, deviates from it and the undercutting of each other begins again. Thus, the cycle starts anew without an exogenous demand or cost shock.

Eckert (2003) extends the model by varying the relative size of the duopolists. In the case of price equality, the firms no longer divide the market equally, instead they divide it according to their size. It shows that the more asymmetrically the sizes are distributed, the more likely it is that cycles will occur, with price reductions being initiated by the smaller firm and increases by the larger. In a framework that allows for fluctuating marginal costs, Noel (2008) shows that Edgeworth Price Cycles continue to exist in the model if symmetrical or asymmetrical capacity constraints exist, products are slightly differentiated, the elasticity of demand or the discount factor is varied and a triopoly is assumed instead of a duopoly. He proves, among other things, that the form of the cycles changes with the parameter values. With less elastic demand curves, his simulations show more aggressive undercutting and cycles that are more rapid and less asymmetric. When symmetrical capacity constraints are tightened, the cycles become less fast and more asymmetrical. Assuming asymmetric capacity constraints, the simulations show that the firm that is not constrained implements the price increases. When the restriction of the other company is tightened, the cycle becomes faster, smaller in amplitude and less asymmetric. The constrained company is increasingly aggressive in underbidding and the other will raise the price more frequently. Further extensions were carried out by Wallner (1999), who introduced a finite time horizon, and Bloch and Wills-Johnson (2010), who demonstrated how Edgeworth Cycles could emerge in a market where spatial competition is important.

In addition to these theoretical considerations, Allvine and Patterson (1974) first observed asymmetric price cycles in the U.S. retail gasoline market in southern and western cities in the early 1970s, and Castanias and Johnson (1993) were the first to link this to the theory of Maskin and Tirole (1988). Since then, the existence of price cycles has been empirically shown in retail gasoline markets in the U.S. (Zimmerman et al. 2013; Doyle et al. 2010), Canada (e.g. Eckert 2003; Noel 2007a, 2007b), Australia (Byrne and Roos 2019; Wang 2009), Norway (Foros and Steen 2013) and Germany (e.g. Siekmann 2017; Eibelshäuser and Wilhelm 2018).

Several researchers have investigated in which markets price cycles are more likely to occur and which factors influence the shape of the cycles. Eckert (2003) and Noel (2007a) show for Canadian as well as Lewis (2009) and Zimmerman et al. (2013) for U.S. cities that price cycles are more prevalent where the share of independent retail stations is larger, the market concentration is lower, the concentration of vertically integrated stations is higher and the population density is greater. Furthermore, it had been shown that the duration of the undercutting phase is shortened when there are more small firms, so cycles are faster and less asymmetric (Noel 2007a). Finally, price undercutting is initiated by small firms and price restoration by large, which is also in line with the theoretical model and its extensions. (Noel 2007b; Atkinson 2009).

Atkinson et al. (2014) show that a local supply shock, a refinery fire in Ontario, Canada, in 2007, caused the decade-long retail price cycles in several cities to come to a standstill. When the refinery returned to normal operation, the cycles did not return in the market. In more distant cities, no change in pricing before or after the fire could be observed. In Western Australia, retailers have been obliged since 2001 to report the next day's price, which is then set at 6 a.m. and remains unchanged for the next 24 hours. This regulatory intervention caused the cycles to lose their rhythm in the short run, but they rebounded after four months. Thus, price cycles can continue to exist even with simultaneous pricing and price commitment. (Wang 2009)

Another question is whether price cycles are competitive or collusive. Some literature has pointed out that the cycles are more collusive (Foros and Steen 2013; Linder 2018; Byrne and Roos 2019; Wang 2008), and these concerns are shared by several competition authorities (e.g. U.S., Australia, Canada, Norway, and Germany). Noel (2015) argues, if the cycles were actually the result of collusion, they should lead to higher prices and he uses the already mentioned refinery fire in Canada, that caused price cycles to stop in some cities, as experiment. Thus, he can compare the periods with and without cycles and measure the impact of them on the price level using a difference-in-differences framework. He finds that cycles have a price-reducing effect and agrees with previous studies for Canadian and U.S. cities (Doyle et al. 2010; Zimmerman et al. 2013). Wang (2008), on the other hand, shows how the coordination problem was solved and how new rounds of cycles were started, based on the telephone activity of the market leader in the Australian gasoline cartel.

but contradicts results for Australia (Wang 2009). Some empirical studies link Edgeworth Price Cycles to the literature on asymmetric cost pass-through, the so-called "rockets and feathers" effect. This effect describes that price increases of input costs (e.g. crude oil or wholesale prices) quickly lead to rising retail prices, but are slowly passed through when costs fall. Lewis (2009) shows that high retail margins dissipated faster after Hurricane Rita in 2005 in cities where price cycles were observed. Lewis and Noel (2011) demonstrate that cost changes are passed on two to three times faster in cycling markets than in markets without cycles in the U.S. from 2004 to 2005. In both studies, no cities changed to or away from cycles during the periods analysed, whereby a changed shape of the cycles is not discussed in detail.

The German gasoline market was also examined by government institutions. The Federal Cartel Office (Bundeskartellamt 2011) observed daily and weekly price cycles as well as a dominant oligopoly consisting of five companies – Aral (BP), Shell, Esso (ExxonMobil), Total S.A. and Jet (Phillips 66) – from the beginning of 2007 to mid-2010. As a result, the Market Transparency Unit for Fuels was established to reduce information asymmetry between suppliers and consumers and thus enhance competition. Since December 2013, all petrol stations in Germany are obliged to report their prices in real time to this unit, which are made available online to consumers, and thus also to the scientific community.

This new and unique data source makes it possible for the first time to analyse price cycles in different regions in Germany without relying on daily or even weekly average prices.

For this thesis, I use a variety of price data between March 2014 and March 2019 in the following chapters and contribute to the existing empirical literature on how price cycles occur in different market structures, how price cycles respond to supply shocks and to what extent market power is exercised.

The following Chapter 2, with the title "Das Auf und Ab der Tankstellenpreise – Die Rolle des Binnen- und Außenwettbewerbs" (co-authored by Thomas Wein), uses this new data source to verify the findings of the Federal Cartel Office from 2007 to 2010 (Bundeskartellamt 2011). In particular, to investigate the question if the alleged five-party oligopoly is exploiting market power and if there is internal and external competition. For this purpose, real-time price data from four metropolitan areas – Hamburg, Cologne, Leipzig and Munich – from 120 days in 2014 are examined. Therefore, the price level in the course of the day and week as well as the number, timing and amount of the price increases or price reductions and the respective reactions of the competitors are analysed in detail.

We show that all petrol stations start with high prices in the morning, these are successively reduced in small steps during the day and the lowest level is reached in the early evening hours. Then the prices are increased and reach the highest level at midnight at the latest. These high prices are maintained until the following morning, after which the cycle starts all over again. These asymmetric sequences are very similar to the Edgeworth Price Cycles theoretically described by

Maskin and Tirole (1988). Aral and Shell pursue a high price strategy, Esso and Total remain somewhat behind. Jet and the other market participants tend to set lower prices, go up much later in the evening and not so strongly, but in principle produce the same pattern. Aral and Shell pursue a high price strategy, Esso and Total remain somewhat behind. Jet and the other market participants tend to set lower prices, go up much later in the evening and not so strongly, but in principle produce the same pattern. Almost all price increasing rounds in the evening are started by Aral or Shell. Both brands follow each other's price changes within five to thirty minutes on average. Esso and Total only react between one and one and a half hours later. Jet usually reacts even later and only moderately to the price increases. The companies that do not belong to the supposed oligopoly increase their prices more strongly and earlier than Jet. The stable, but brand-specific different price increase patterns are a sign of parallel behaviour. However, a presumption of market dominance cannot be based on Jet's belonging to the oligopoly.

In contrast to the previous section, the focus of the analysis of Chapter 3, "Collusive Upward Gasoline Price Movements in Medium-Sized German Cities" (co-authored by Thomas Wein), is not on metropolitan regions in Germany, instead it is on cities with 60,000 to 100,000 inhabitants. Assuming strong competitive relationships between petrol stations in 52 smaller German cities and using price data from four months of 2014, we analyse which brands initiate price increases, the first average price surcharge in the evening and the subsequent price development. In addition, we measure how long competitors take to react to price increases and how much prices change. Using multivariate estimations, we control for the composition of market participants, the wholesale price and the initial price level.

The descriptive results show that Aral or Shell initiates a round of price increases and the other then follows more or less immediately. Total, Esso and Non-Oligopolists react within one to two hours. Jet behaves more as an "outsider" with later reaction times and lower price mark-ups. Multivariate estimations indicate that the single cause "price change by competitors" is less important and nearly irrelevant for Jet. Logit estimations, including market conditions, are not able to explain why the companies initiate up-ward price movements. Hence, parallel behaviour of gas stations seems less likely, if multivariate estimations are used compared to simple descriptive checks.

In Chapter 4, “Price Gouging at the Pump? The Lerner Index and the German Fuel Market” (co-authored by Thomas Wein), we explore the extent to which market power is exercised in the German fuel market. Especially high surcharges in the late evening are perceived as price gouging. The Federal Cartel Office used these surcharges between 2007 and 2010 in four metropolitan regions as evidence of oligopolistic market power. We use data for eight metropolitan areas and 65 medium-sized cities from May 2016 to June 2019 and show that the lowest daytime price level is reached in the early evening and then rises sharply. Using the well-known Lerner Index, we measure the market power in these evening hours. Our descriptive analysis shows that the Lerner Indices of the premium brands increase after 10 pm, i.e. after a large part of the price-aggressive petrol stations have closed. The results are around 0.1 for diesel and 0.08 for petrol. Other companies achieve lower values of 0.05-0.07. Compared to other international studies dealing with the fuel market, we find a similar level of Lerner Indices, but only for a few hours and not for the whole day. Multivariate estimates cannot show that a larger market share of the studied brand or a smaller market share of price-aggressive companies increases the index. Nor can influences of days of the week, different cities or wholesale prices be demonstrated. So the petrol market seems to be competitive, at least in a higher dimension than it is perceived by the public. The price behaviour in the evening and night hours can therefore not be used as evidence for a serious abuse of market power by petrol stations.

The 5th and final chapter, “Effects of a local supply shock on gasoline price cycles”, links to the literature on how the shape of Edgeworth price cycles can be influenced. Studies for Canadian and Australian cities have shown that these cycles can be interrupted or stopped by supply shocks or regulatory intervention. I use a natural experiment to study the impact of a supply shock on intraday price cycles in Germany. The unusually hot temperatures in Europe in 2018 caused the water level of the Rhine to drop to a record low, which led to restrictions on inland navigation, which in turn caused fuel shortages in some regions of Germany and caused prices to rise sharply. Using a difference-in-differences approach, I find that the cycles did not disappear, but premium brands reduced the intensity and changed the timing of price increases and decreases. When supply was unrestricted again, the cycles returned in their original form.

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2. Das Auf und Ab der Tankstellenpreise
– Die Rolle des Binnen- und Außenwettbewerbs

Arne Neukirch und Thomas Wein

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Zusammenfassung

Wettbewerbspolitisch stellt sich die Frage, ob im 5er-Oligopol mit Aral, Shell, Esso, Total und Jet Binnenwettbewerb fehlt und ob dieses Oligopol wirksam Außenseiterwettbewerb ausgesetzt ist. In Fortführung der Sektoruntersuchung des Bundeskartellamts von 2007 bis 2010 verwenden wir Sekunden genaue Daten der Markttransparenzstelle aus 2014 für die vier damals ausgewählten Metropolen. Es zeigt sich, dass Aral und Shell eine Hochpreisstrategie verfolgen, etwas weniger Esso und Total; Jet und die Nicht-Oligopolisten setzen niedrigere Preise. Morgens starten alle Tankstellen mit hohen Preisen, sukzessive im Laufe des Tages senkend, um in den frühen Abendstunden das niedrigste Niveau zu erreichen; das Vierer-Oligopol ohne Jet erhöht kurz nach 18.00 die Preise, Jet folgt deutlich später, spätestens zu Mitternacht sind alle zurück beim alten Preis. Kontrolliert man für andere Einflussfaktoren auf das Preiserhöhungsausmaß fällt auf, dass Shell gleich stark zu Aral die Preise erhöht, unter Umständen sogar stärker. Jet und die Nicht-Oligopolisten verhalten sich ebenfalls parallel zu Aral, aber deutlich schwächer. Bei von Shell ausgehenden Preiserhöhungen ist die Reaktionsverbundenheit bei Aral und Jet deutlich geringer. Die stabilen, jedoch markenspezifisch unterschiedlichen Preiserhöhungsmuster sind ein deutliches Zeichen für Parallelverhalten gemäß § 18, V GWB. Eine Marktbeherrschungsvermutung nach § 18, VI GWB darf sich jedoch nicht auf die Oligopolzugehörigkeit von Jet stützen.

JEL Classification: L13, L41, L81

Schlüsselwörter: Marktbeherrschung, Parallelverhalten, Benzinpreise

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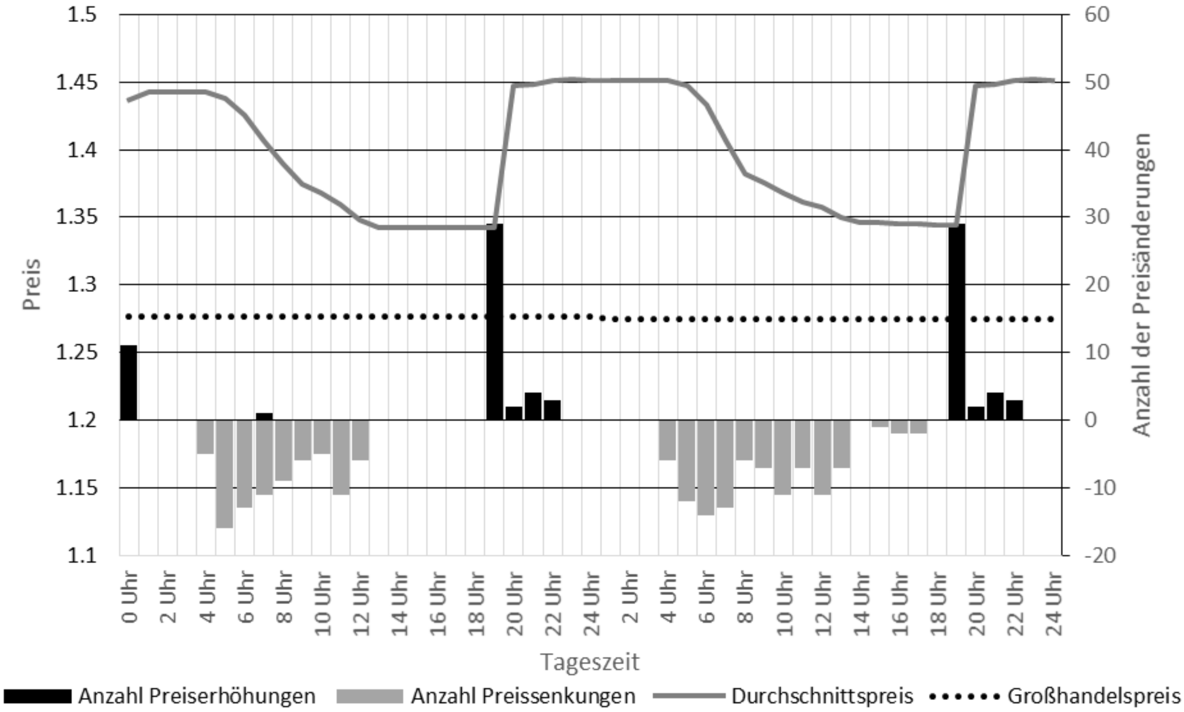
2.1. Das Problem

Immer wieder war der deutsche Tankstellenmarkt Gegenstand wettbewerbsrechtlicher Entscheidungen. Kontrovers war zuletzt vor allem die geplante Fusion Total/OMV. Mit Beschluss vom 29.04.2009 hatte das Bundeskartellamt (2009) das Zusammenschlussvorhaben der Total Deutschland GmbH und der OMV Deutschland GmbH untersagt, wonach Total von OMV 59 Tankstellenbetriebe in Sachsen und Thüringen erwerben wollte (Bundeskartellamt 2009). Nach Ansicht des Bundeskartellamtes hätte dieser Erwerb in den relevanten regionalen Tankstellenmärkten bestehende marktbeherrschende Stellungen, sich ergebend aus der Gruppe Aral (BP), Jet (ConocoPhillips), Esso (ExxonMobil), Shell und Total, verstärkt. Im Einzelnen hätte der Zusammenschluss den Binnenwettbewerb der fünf genannten Oligopolisten geschwächt sowie den Außenwettbewerb vermindert, da zwar ein relativ kleines, aber effizientes „Außenseiterunternehmen" als eigenständiger Marktakteuer durch die Tankstellenübernahme vom Markt verschwunden wäre. Das OLG Düsseldorf hat mit seinem Beschluss vom 04.08.2010 die Entscheidung des Bundeskartellamts aufgehoben, da der Senat zwischen den beiden Mineralölfirmen OMV und Total insgesamt wirksamen Wettbewerb und daher die Marktbeherrschungsvermutung von den Fusionierenden gemäß § 19 III, Satz 2 GWB (alt) als widerlegt ansah (Oberlandesgericht Düsseldorf 2010). Entgegen der unstreitig bedenklichen wettbewerbsbeschränkenden Strukturmerkmale in diesem Markt (Bundeskartellamt 2011, S. 50-60) gäbe es sowohl bezüglich des Binnen- als auch des Außenwettbewerbs deutliche Anzeichen für wirksamen Wettbewerb. In Bezug auf den Außenwettbewerb übten kleinere Wettbewerber Preisdruck aus, hätten teilweise regional höhere Marktanteile als vermeintliche Oligopolmitglieder und manche hätten ihre Marktanteile steigern können. Im Binnenwettbewerb sei auffällig, dass Preiserhöhungsrunden, vorangetrieben vor allem durch die beiden großen Oligopolisten Aral und Shell, nicht bestehen blieben, insofern sei das zu beobachtende Preisgeschehen geradezu Ausdruck von wirksamen Wettbewerb. Ferner würde der vermeintliche Oligopolist Jet, der eine aggressive Preispolitik betreibe, von den übrigen Oligopolisten gerade nicht sanktioniert. Am 02.12.2011 hat der BGH den Beschluss des OLG Düsseldorfs aufgehoben bzw. die Rechtssache an das Untergericht zurückverwiesen (Bundesgerichtshof 2011). Im Gegensatz zum OLG sah der BGH doch einen fehlenden Binnenwettbewerb als gegeben an, da Preisvorstöße des einen sofort durch seinen Konkurrenten erkannt und gleichförmig „beantwortet" werden; vorstoßende Unternehmen erzielten durch Preissenkungen weder höhere Marktanteile noch andere Vorteile, abweichendes Verhalten würde somit wirksam sanktioniert. Substantielle Marktanteilsveränderungen seien gerade nicht zu beobachten. Für das Vorliegen eines Parallelverhaltens der Oligopolisten reiche es aus, dass abweichendem Verhalten klare Grenzen gesetzt würden, indem nur eindeutige, dauerhafte Preissenkungsvorstöße sanktioniert würden. Es sei nicht zu beobachten, dass derartige Preissenkungen, falls sie überhaupt stattfinden, nicht sanktioniert würden. Ferner habe das OLG zu wenig berücksichtigt, dass Preiserhöhungen regelmäßig von Shell oder Aral ausgehen würden. Insofern seien beide klare Preisführer, um die jeweiligen Oligopol-Gleichgewichte zu finden. Das Preissetzungsverhalten von Jet sei nicht „hinreichend“ preisaggressiv, da Jet jeweils nur um 1 ct. unterbiete, was durch Kundenbindungsprogramme der beiden Großen mindestens aufgewogen würde. Vermutlich seien die aufgeführten, eher singulären Preiskämpfe durch regionale Marktzutritte verursacht und damit kein Indiz für einen fehlenden Abschreckungsmechanismus. Im November 2010 verkaufte OMV fast alle in Frage stehenden Tankstellen an Orlen (Finanznachrichten 2010), ohne dass wettbewerbsrechtlich hierzu Bedenken angemeldet wurde.

Die hier aufgeworfenen, letztendlich nicht gerichtlich abschließend entschiedenen Fragen beziehen sich grundsätzlich auf das Ob einer Marktbeherrschung in Oligopolmärkten. Gemäß § 18 V GWB (neu) sind mehrere Unternehmen marktbeherrschend, wenn zwischen ihnen kein wesentlicher Wettbewerb besteht (kein Binnenwettbewerb) und wenn sie in ihrer Gesamtheit marktbeherrschend sind (kein Außenwettbewerb). Nach § 18 VI und VII GWB normieren eine sogenannte Marktbeherrschungsvermutung, wenn drei oder weniger Unternehmen mindestens 50% Marktanteil oder fünf oder weniger mindestens Marktanteile in Höhe von zwei Dritteln aufweisen. Allerdings können sie diese Vermutung durch den Nachweis, dass zwischen ihnen wesentlicher Wettbewerb besteht oder sie in ihrer Gesamtheit im Verhältnis zu übrigen Wettbewerbern keine überragende Marktstellung aufweisen, widerlegen. Fehlt es sowohl am Außen- als auch am Binnenwettbewerb, so kommt es nach der Wertung des Gesetzgebers (unvermeidlich) zu Parallelverhalten, wodurch die marktbeherrschende Stellung missbraucht wird (Bundeskartellamt 2009, Tz. 36). Mit „verursacht“ aus dem Rechtstreit Total/OMV hat sich das Bundeskartellamt unter dem Stichwort der Sektoruntersuchung Kraftstoffe (§ 32e GWB) mit den Marktverhältnissen im Tankstellenmarkt detailliert auseinandergesetzt. Hinsichtlich des tatsächlichen Marktverhaltens wurden die Preise aller Tankstellen in den Metropolregionen Hamburg, Köln, Leipzig und München über den Zeitraum Januar 2007 bis Juni 2010 für Diesel- und Otto-Kraftstoffe erfasst (Bundeskartellamt 2011, S. 80-104). Für die jeweiligen Regionalmärkte wurde insgesamt ermittelt, dass es wochentags- und uhrzeitspezifisch besondere Preisspitzen und -täler gab, dass seltener die Preise erhöht als gesenkt wurden und dass es zu Ferienzeiten höhere Preise gab. Hier wurde jedoch nicht zwischen dem Preisgeschehen im Binnen- bzw. Außenwettbewerb differenziert. Insbesondere die zu beobachtenden flächendeckenden Preiserhöhungsrunden deuten auf ein Parallelverhalten der Oligopolisten im Binnenwettbewerb hin. Preiserhöhungsrunden initiierten entweder Aral oder Shell. In 90% aller Fälle folgte das jeweils andere Unternehmen exakt drei Stunden nach Beginn der Preiserhöhungsrunde. Fünf Stunden nach Beginn der Preiserhöhungsrunde zog Jet in knapp 70% aller Fälle nach. Esso reagierte in 70% der Fälle ebenfalls nach einem exakten Stundenrhythmus, regional unterschiedlich nach drei bis sechs Stunden. Fast die Hälfte der Preiserhöhungsrunden begann von Montag bis Donnerstag um exakt 18.00 Uhr. Vieles deutet daraufhin, dass es sich hier um typische Edgeworth-Preiszyklen handelt (Bundeskartellamt 2011, S. 115-134 sowie Maskin und Tirole 1988). Durch die Einführung der sogenannten Markttransparenzstelle für Kraftstoffe (MTS-K) aufgrund des § 47k GWB, deren Regelbetrieb im Dezember 2013 begann, gibt es eine aktuellere Datengrundlage. Da die Markttransparenz nun auch für die Mineralölfirmen angestiegen ist,[1] würde man ein Mehr an Parallelverhalten erwarten (Bundeskartellamt 2015, S. 3 und Dewenter und Schwalbe 2016).

Abbildung 2.1: Preisbewegungen Diesel bei Aral – Hamburg 03./04.03.2014



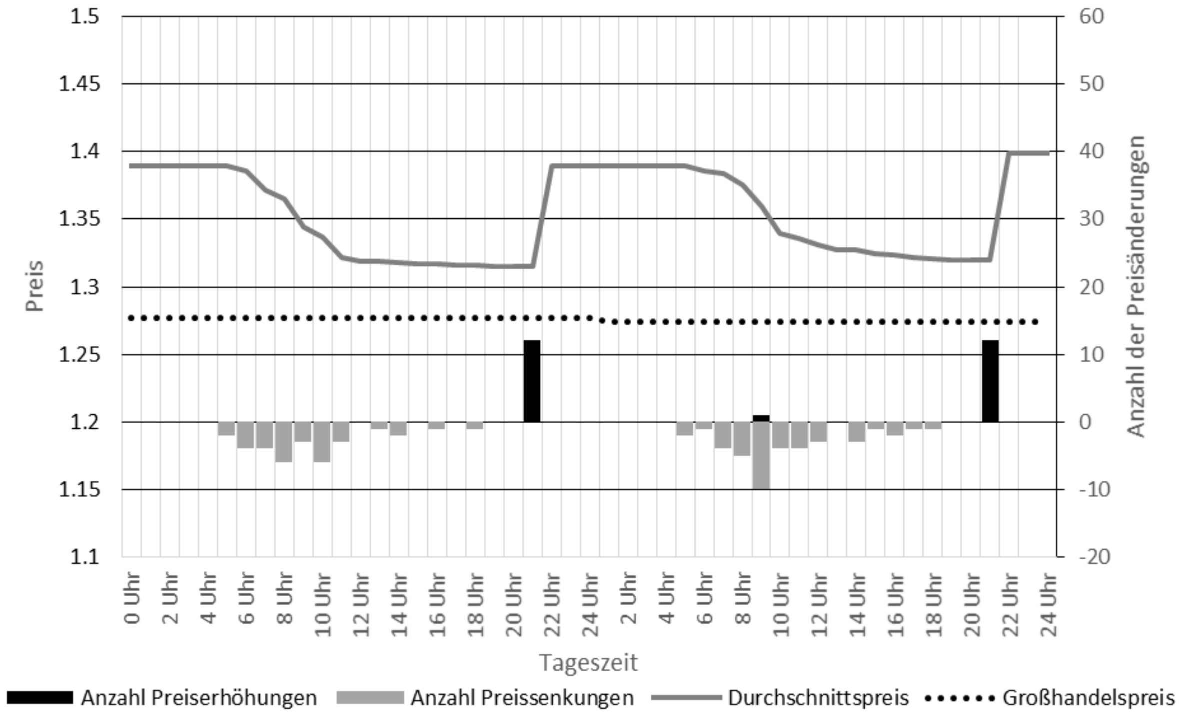
Das Bundeskartellamt hat hierzu im November 2014 einen Zwischenbericht unter dem Titel „Ein Jahr Markttransparenzstelle für Kraftstoffe" vorgelegt (Bundeskartellamt 2014). Räumlich bezieht sich deren Auswertung auf die Großstädte Berlin, Hamburg, München, Köln, Frankfurt am Main, Stuttgart, Leipzig und Dresden. Alle Preisdaten liegen für die Monate Februar - Mai 2014 für die umsatzstärkste Kraftstoffsorte Super E5 vor. Im Gegensatz zu den Ergebnissen aus der Sektoruntersuchung gibt es jetzt keine billigen und teuren Wochentage mehr. Vielmehr werden niedrige Preise meist am Spätnachmittag und Abend gesetzt, vor allem nach 18.00 und vor 20.00. Meist werden die Preise zwischen 20.00 und 24.00 erhöht, dagegen zwischen 6.00 und 18.00 relativ gleich häufig gesenkt. Zwischen 20.00 und 21.00 würden überwiegend Aral und Shell die Preise erhöhen, ab 21.00 gehen Esso und Total nach oben, dann Jet ab 23.00.[2]

[1] Der Präsident des Bundeskartellamts sieht keine höhere Markttransparenz auf der Angebotsseite, da bereits vor Einführung der MTS-K konkurrierende Preisbeobachtung üblich gewesen wäre (Süddeutsche Zeitung 2015). Da jedoch der Informationsaustausch wesentlich kostgünstiger sowie schneller wurde und jetzt umfassend ist, muss man wohl mehr Transparenz auch bei den Anbietern als Folge der MTS-K erwarten.

[2] Jüngste Untersuchungen des ADACs für das Frühjahr 2015 scheinen diese Ergebnisse zu bestätigen (Frankfurter Allgemeine Zeitung 2015)

Eigene Berechnungen mit Daten aus dem Jahr 2014 bestätigen diese Ergebnisse und deuten auf ein feststehendes Muster hin (beispielhaft Abbildung 2.1und 2.2): Die Preise sinken im Laufe des Tages bis in die Abendstunden, um dann wieder bis Mitternacht anzusteigen. Am nächsten Morgen beginnt der Zyklus mit dem im wesentlich gleichen Startwert neu.

Abbildung 2.2: Preisbewegungen Diesel bei Jet – Hamburg 03./04.03.2014



Haucap et al. (2016) verwenden die Daten der Markttransparenzstelle des Jahres 2014, um die durchschnittlichen Tagespreise der Tankstellen für Super-Benzin E5 und E10 sowie Diesel mit Hilfe von Panelschätzverfahren zu erklären. Bei den Tagespreisen wird zwischen 24 h-Preise und Preisen zu den Hauptöffnungszeiten unterschieden. Als erklärende Variable werden die Marken, die freien Tankstellen, Tankstellencharakteristika (sonstiges Angebot, Lage, etc.), die lokalen Wettbewerbsbedingungen und nachfrageseitige Faktoren herangezogen. Der im Dezember 2015 vom Bundeskartellamt veröffentlichte Bericht „Das 2. Jahr Markttransparenzstelle für Kraftstoffe" zeigt für den Zeitraum Dezember 2014 bis Ende Mai 2015, dass die Preiszyklen in den acht Großstädten weiterhin zu beobachten sind. Im Sommer 2015 sind systematisch Mittagspreiserhöhungen hinzugekommen. Aber auch hier konzentriert sich das Bundeskartellamt lediglich auf den großstädtischen Raum, beleuchtet das Preissetzungsverhalten der freien Tankstellen nicht und verzichtet auf eine wettbewerbsökonomische Einordnung ihrer Datenauswertung. Dewenter und Schwalbe (2016) analysieren die kürzlich von den Markenanbietern HEM und Shell angebotenen Preisgarantien mit Hilfe von Preisdaten der Markttransparenzstelle. HEM verspricht in Zusammenarbeit mit clever-tanken.de seit 1. April 2015 für Super-Benzin und Diesel sich an den Preis des billigsten Anbieters im Umkreis von 5 km anzupassen, wenn der Tankkunde binnen 30 min einen App-generierten Barcode vorzeigt. Shell zog im Mai 2015 nach, indem sie von Shell Club-

Smartkunden automatisch nur 2 ct. pro Liter mehr verlangt als der niedrigste Preis der zehn in der Umgebung liegenden Markentankstellen. Als Preisdaten gehen in den Difference-in-Differences-Ansatz jeweils die ungewichteten durchschnittlichen Preise je Tag ein; die HEM-Garantie hat eine leicht signifikante preissenkende Wirkung, das Shell-Versprechen dagegen eine leicht erhöhende. Die Einführung einer Markttransparenzstelle kann einerseits die Preistransparenz für die Nachfrager erhöhen und damit preissenkend wirken; anderseits können sich die Anbieter ebenfalls leichter über Preise informieren und damit werden Preissenkungen weniger lohnend. Dewenter et al. (2017) verwenden daher die wöchentlichen Benzin- und Dieselpreise aus 28 Mitgliedsstaaten der Europäischen Union (ohne Österreich) der Jahre 2003 bis 2015, um mit einem Difference-in-Differences-Ansatz zu testen, ob das Treatment „Einführung der Markttransparenzstelle in Deutschland Ende 2013" Preiswirkungen hat. Nach diesem Schätzansatz sind die Benzinpreise durch die Transparenzstelle zwischen 1,2 und 3,3 ct. nach oben gegangen, bei Diesel um ca. 2 ct. Neukirch und Wein (2016) untersuchen mit den täglichen, sekundenbasierten Preisdaten der Markttransparenzstelle die Muster für Preiserhöhungen. Im Gegensatz zur Sektoruntersuchung des Bundeskartellamtes und ihren beiden Jahresberichten zur Markttransparenzstelle sowie in diesem Papier wird dort auch eine engere Marktabgrenzung verwendet. Metropolen oder Großstädte sind vermutlich zu groß, um sie jeweils als einen Markt anzusehen. Tankstellen in Städten zwischen 60.000 und 100.000 Einwohnern stehen vermutlich (stärker) im Wettbewerb zueinander. Noch engere regionale Abgrenzungen sind kaum heranziehbar, da dort die Diversität der vorhandenen Marken sehr begrenzt wäre.

Im weiteren Verlauf dieses Papiers werden Ergebnisse einer Auswertung von sekundenbasierten Preisdaten vorgestellt, die letztlich von der MTS-K für das Jahr 2014 erfasst wurden. Kapitel 2.2 beschreibt die zugrunde gelegte Datenbasis. Da für die wettbewerbsrechtliche Beurteilung des Tankstellenmarktes die tatsächliche Wirksamkeit des Binnen- und Außenwettbewerbs strittig ist, beziehen sich die folgenden Auswertungen ausschließlich auf Unterschiede im Preissetzungsverhalten zwischen den fünf Oligopolisten und der Außenseiterkonkurrenz, sowie innerhalb des Oligopols zwischen Jet und den vier anderen Oligopolisten. In Kapitel 2.3werden nach diesem Muster die durchschnittlichen Preise zu bestimmten Tageszeiten und für einzelne Wochentage verglichen. Unter Punkt 2.4 wird überprüft, ob es systematische Unterschiede im Binnen- und Außenwettbewerb hinsichtlich der durchschnittlichen Anzahl der täglichen Preiserhöhungen und -senkungen gibt und welche Oligopolisten im Binnenwettbewerb mit Preiserhöhungen vorangehen, bzw. in welchem Ausmaß die anderen Oligopolisten nachziehen. Um die Vergleichbarkeit mit der Sektoruntersuchung und den Zwischenberichten des Bundeskartellamtes zu erhalten, beschränken wir uns auf die Regionen Hamburg, Köln, Leipzig und München. Mit dem letzten Kapitel 2.5 bewerten wir die Entwicklung des Binnen- und Außenwettbewerbs nach Einführung der MTS-K.

2.2. Verwendete Daten und Methoden

Alle verwendeten Preisdaten stammen von dem Internet- und App-Anbieter clevertanken.de, der uns für insgesamt 120 Tage im März, April, Mai und September 2014[3] verwertbare Preisdaten der MTS-K zur Verfügung gestellt hat. Preise über 2 C werden als vermutliche Erfassungsfehler entfernt (6 Beobachtungen). Preisangaben, die länger als sieben Tage nicht verändert wurden, sind vermutlich unplausibel und werden deshalb aus dem Datensatz gelöscht (445 Beobachtungen). Da der Verkauf von Kraftstoffen auf Autobahnen vermutlich einen eigenen Markt darstellt (Bundeskartellamt 2011, S. 13-14), wurden Kraftstoffpreise, die von Autobahntankstellen gemeldet wurden, nicht berücksichtigt. Alle Preisangaben werden in Euro pro Liter inklusive aller Steuern angegeben. Hinsichtlich der Vielzahl von Tankstellenbetreibern werden vereinfachend die fünf Oligopolisten „Aral, Shell, Esso, Total und Jet“ jeweils einzeln und gemeinsam als Oligopol-5 (Oli5), ohne Jet als Oligopol-4 (Oli4) sowie alle anderen Betreiber, die nicht zu dem kartellrechtlich streitigen Oligopol gehören, als Nicht-Oligopolisten (NO) abgegrenzt. Nur Preise für Dieselkraftstoffe und Ottokraftstoffe Super E10 gehen in die Analyse ein, da die Preisdaten der anderen Kraftstoffsorten nicht über den gesamten Beobachtungszeitraum verfügbar waren. Durch die Verwendung von Daten des Anbieters PetrolView mit den Angaben über Öffnungszeiten können insbesondere die Preise um 24 Uhr allein auf geöffnete Tankstellen bezogen werden. Die vier Regionen – Hamburg (HH), Köln (K), Leipzig (L) und München (M) – werden entsprechend der Vorgehensweise des Bundeskartellamtes in der Sektoruntersuchung Kraftstoffe herangezogen[4], im Vergleich zu dem vom Bundeskartellamt üblicherweise verwendeten Erreichbarkeitsmodell (max. 25 km Radius) ein sehr grobes Konzept (Bundeskartellamt 2011, S. 45 f. und kritisch Steinvorth 2014). Die gleiche regionale Abgrenzung wie in der Sektoruntersuchung zu verwenden, erlaubt es uns, die zeitliche Entwicklung der Preisdynamik herauszustellen. Tabelle 2.1 und 2.2 beschreiben die Anzahl der erfassten Tankstellen sowie die der eingehenden Preisbeobachtungen.

Tabelle 2.1: Anzahl der erfassten Tankstellen

	Aral	Shell	Esso	Jet	Total	NO	Summe	Oli4	Oli5	Anteil Oli4	Anteil Oli5
Hamburg	29	28	15	12	5	38	127	77	89	61%	70%
Köln	35	18	11	10	6	35	115	70	80	61%	70%
Leipzig	12	3	1	3	12	31	62	28	31	45%	50%
München	29	20	16	11	4	60	140	69	80	49%	57%
Summe	105	69	43	36	27	164	444	244	280		

[3] Für folgende Zeiträume liegen vollständige Daten vor: 01.-31.03.2014; 02.-15.04.2014; 17.-27.04.2014; 29.04.-01.06.2014; 01.-30.09.2014.

[4] Bundeskartellamt (2011, S. 76): Postleitzahlbezirke für Hamburg: 20095-20539, 21107-21109, 22041-22119, 22297-22309, 22453-22529, 22761-22769; Köln: 50667-51149; München: 80331-81929; Leipzig: 04103-04357.

Tabelle 2.2: Anzahl der Beobachtungen

	Hamburg	Köln	Leipzig	München	Summe
Diesel	73.193	63.217	41.473	64.144	242.027
E10	70.066	61.931	38.068	60.104	230.169
Summe	143.259	125.148	79.541	124.248	472.196

Bezüglich der erfassten Preise werden zunächst in der jeweiligen Region die Diesel- und Super E10-Preise zu bestimmten Zeitpunkten (0, 6, 12, 16, 18 und 20 Uhr), getrennt für die jeweiligen Oligopolisten, die Gruppen Oli5 und Oli4 sowie die Nicht-Oligopolisten, ermittelt. Da insbesondere um Mitternacht nicht alle Tankstellen geöffnet haben, geht in die berechneten Durchschnittspreise eine unterschiedliche Anzahl an Tankstellen ein. Als Tagesdurchschnittspreis wird für die jeweilige Betreibergruppe das arithmetische Mittel aus den genannten sechs Tagesspreisen berechnet. Um der hohen Volatilität der Preisbewegungen am späten Nachmittag und Abend Rechnung zu tragen, wurden die drei Tageszeitpunkte 16, 18 und 20 Uhr aufgenommen. Für die Abschätzung der Anzahl und Ausmaße der Preissenkungen bzw. -erhöhungen wurden die Zeiträume Mitternacht bis 6 Uhr, 6 Uhr bis Mittag, Mittag bis 18 Uhr sowie 18 Uhr bis Mitternacht berechnet. Da die meisten Preiserhöhungen unmittelbar nach 18 Uhr stattfinden, wird ab diesem Zeitpunkt bis Mitternacht analysiert, welche Marke eine flächendeckende (mehr als 50% aller Tankstellen der jeweiligen Marke in der jeweiligen Region) Preiserhöhung vorgenommen hat, um wieviel Uhr diese Preiserhöhung stattfand, um wieviel ct. der Preis zu diesem Zeitpunkt nach oben ging und wie stark der Preis insgesamt bis Mitternacht des jeweiligen Tages angehoben wurde. Anhand Tabelle 2.3 wird die Vorgehensweise beispielhaft erläutert. Dort beginnt Aral eine flächendeckende Preiserhöhungsrunde um 18 Uhr 10 mit einer ersten Erhöhungswelle in Höhe von 5,3 ct., die bis Mitternacht auf 10,3 ct. ansteigt. Bei Aral gehen die Preiserhöhungen auf 3,66 Preisänderungen je Tankstelle zurück. Die anderen Marken können diese Preiserhöhungen mitgehen, wobei wichtig ist, wie lang es dauert, bis der erste Konkurrent die Preise nach oben setzt und in welchem Ausmaß die jeweilige Marke bis Mitternacht die Preise verändert. Laut Tabelle 2.3 reagiert Shell erstmals um 19 Uhr und erhöht bis Mitternacht um 13 ct.; ein Außenseiter reagiert als Erster um 19:25 Uhr, und alle Außenseiter setzen im Durchschnitt die Preise um 14 ct. herauf. Die Nicht-Oligopolisten und Shell ändern im Mittel jeweils viermal ihre Preise pro Tankstelle. Die Methodik, wie die Preisdynamik abgebildet wird, entspricht – soweit als möglich – der des Bundeskartellamtes in der Sektoruntersuchung (Bundeskartellamt 2011), wiederum um die zeitliche Vergleichbarkeit herzustellen.

Tabelle 2.3: Beispielhafte Preiserhöhungsrunde von Aral und Reaktionen Wettbewerber

Uhrzeit	18					19					23					24	Start ↑	Erste +	Insge-	Reak-
	00	05	10	15	…	00	05	…	25	…	00	…	30	35	55	00			samt +	tionszeit
Aktionen																				
Aral 1	1,28	1,35	1,36	1,36	1,40	1,40	1,38		1,38	1,37	1,37		1,37	1,37	1,37	1,37				
Aral 2	1,28	1,28	1,36	1,36	1,40	1,40	1,40		1,40	1,41	1,38		1,38	1,38	1,38	1,38				
Aral 3	1,28	1,28	1,28	1,35	1,35	1,40	1,40		1,40	1,40	1,40		1,40	1,40	1,40	1,40				
Durchschnitt	1,28	1,30	1,33	1,35	1,38	1,40	1,39		1,39	1,39	1,38		1,38	1,38	1,38	1,38	18:10	0,053	0,103	
Anzahl der Preisveränderungen bei Aral: 11											Durchschnittliche Anzahl der Preisreaktionen bei Aral: 3,66									
Reaktionen																				
Shell 1	1,28	1,28	1,28	1,28	1,28	1,40	1,38		1,39	1,41	1,41		1,41	1,41	1,41	1,41				
Shell 2	1,28	1,28	1,28	1,28	1,28	1,28	1,40		1,38	1,39	1,41		1,41	1,41	1,41	1,41			0,13	19:00
Durchschnitt	1,28	1,28	1,28	1,28	1,28	1,34	1,39		1,39	1,40	1,41		1,41	1,41	1,41	1,41				
Anzahl der Preisveränderungen bei Shell: 8											Durchschnittliche Anzahl der Preisreaktionen bei Shell: 4									
NO 1	1,28	1,28	1,28	1,28	1,28	1,28	1,28		1,38	1,39	1,41		1,41	1,41	1,41	1,40				
NO 2	1,28	1,28	1,28	1,28	1,28	1,28	1,28		1,28	1,39	1,41		1,41	1,42	1,43	1,44				
Durchschnitt	1,28	1,28	1,28	1,28	1,28	1,28	1,28		1,28	1,39	1,41		1,41	1,42	1,42	1,42			0,14	19:25
Anzahl der Preisveränderungen bei NO: 8											Durchschnittliche Anzahl der Preisreaktionen bei NO: 4									

2.3. Preisniveau im Tages- und Wochenverlauf

Getrennt nach den verschiedenen Betreibergruppen kann man zuerst fragen, wie sich die Tagesdurchschnittspreise für Benzin und Diesel im Zeitablauf der Monate März bis Mai sowie September 2014 entwickelt haben. Beispielhaft wird dies für beide genannten Kraftstoffarten für die Region Hamburg gezeigt (Abbildung 2.3 und 2.4), die Tagesdurchschnittspreise für Leipzig, Köln und München befinden sich im Anhang (Abbildung 2.7-2.12). Typischerweise setzen Aral und Shell die jeweils höchsten durchschnittlichen Tagespreise. Jet und die Nicht-Oligopolisten liegen am unteren Ende des Preisspektrums, an den Standorten Leipzig, Köln und München unterbietet Jet im Durchschnitt noch die Außenseiter. Esso und Total liegen jeweils im Mittelfeld. Folgt man der gegenwärtigen Kartellrechtssprechung und schaut man daher auf das Fünferoligopol gegenüber den Nicht-Oligopolisten, liegen die Oligopolpreise deutlich höher; rekurriert man aber nur auf das 4er-Oligopol, vergrößert sich die Preisdifferenz umso mehr. In der Summe scheint es so zu sein, dass Jet aus der Preispolitik des Oligopols „ausgestiegen“ ist und mit den Nicht-Oligopolisten eine Niedrigpreisstrategie fährt, wenn nicht sogar das am preisaggressivste Verhalten zeigt.

Abbildung 2.3: Tagesdurchschnittspreise Diesel – Hamburg

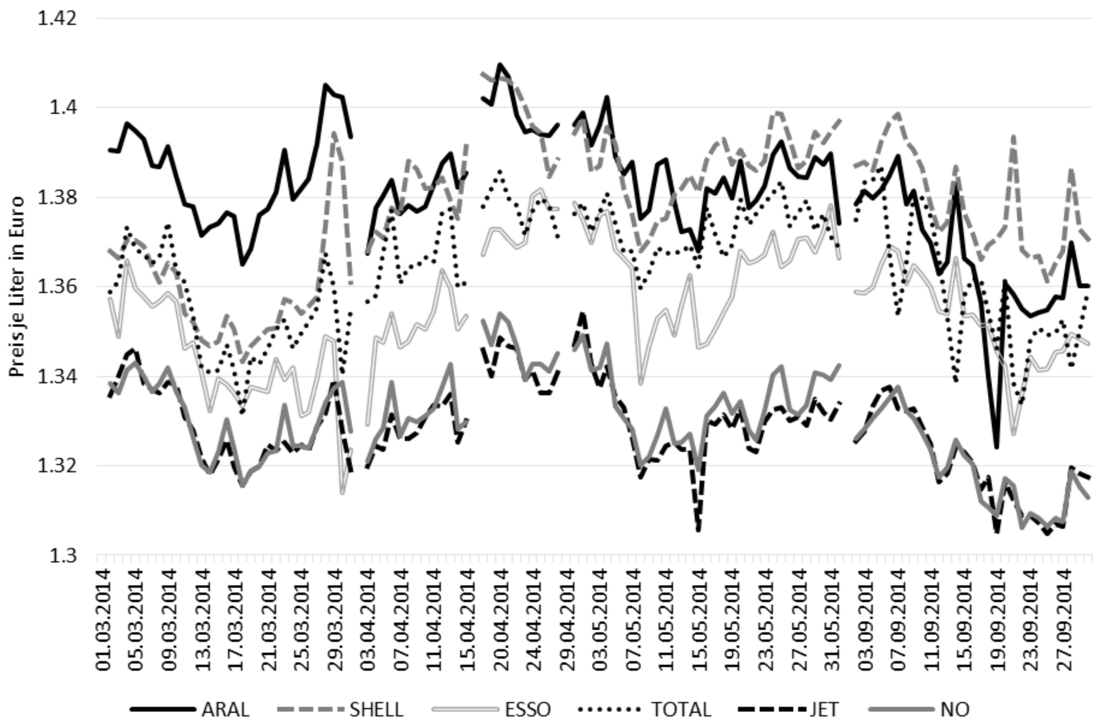
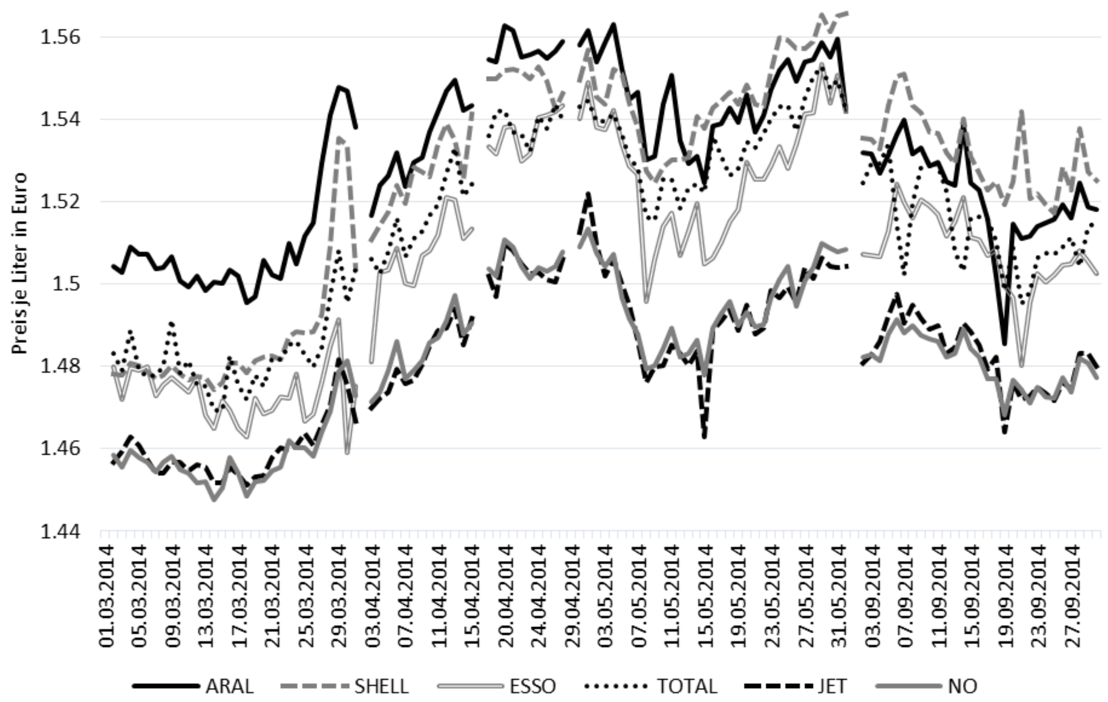


Abbildung 2.4: Tagesdurchschnittspreise Super E10 – Hamburg



Aufgrund der hohen Preisvolatilität führt eine alleinige Orientierung an den Tagesdurchschnittspreisen in die Irre. Für das tatsächliche Preisgeschehen sind die jeweiligen Durchschnittspreise über den Tag verteilt, differenziert nach den jeweiligen Wochentagen und Kraftstoffsorten, erhellender. Tabelle 2.4 und 2.5 sowie Abbildung 2.5 und 2.6 verdeutlichen die Marktverhältnisse in Hamburg (für die anderen untersuchten Regionen sei auf die Tabellen 2.19-2.24 sowie die Abbildung 2.13-2.18 des Anhangs verwiesen). Ähnlich der Vorgehensweise in der Sektoruntersuchung des Bundeskartellamtes (2011 S. 89-92 und Anhang S. 8-15) wurden in den Tabellen hohe Preise schwarz eingefärbt, und über grau geht es dann zu weißen, niedrigen Preisen.
Sowohl für die Dieselpreise in Hamburg (Abbildung 2.5) als auch für die übrigen Gebiete ist eindeutig erkennbar, dass um Mitternacht, unabhängig vom Wochentag und der Tankstellengruppe, die höchsten Preise gesetzt werden. Offensichtlich setzen Aral und Shell sowie mit Einschränkungen Total und Esso um 20 Uhr hohe Preise; Jet und die Außenseiter halten sich um 20 Uhr noch deutlich zurück (Tabelle 2.4). Abbildung 2.5 zeigt die zyklische Preisentwicklung grafisch eindrucksvoll: Von immer etwa gleich hohen Preisspitzen fallen die Preise im Tagesverlauf stetig auf die niedrigsten und über die Tage hinweg gleich bleibenden Tageswerte, wobei die Preisspitzen und -täler markenspezifisch ausgeprägt sind. Jet bzw. die Nicht-Oligopolisten setzen die geringsten Höchstpreise und bilden die niedrigsten Preissenken. Aral und Shell steigen auf ein hohes Preisniveau an und gehen relativ wenig nach unten, bevor sie am Abend die Preise wieder anheben.

Tabelle 2.4: Preisentwicklung Diesel im Tagesverlauf nach Wochentagen – Hamburg

Tag/Zeit	Aral	Shell	Esso	Jet	Total	NO	Oli4	Oli5
Mo. 0	1.445	1.437	1.412	1.378	1.412	1.383	1.435	1.427
Mo. 6	1.411	1.388	1.369	1.366	1.383	1.364	1.393	1.389
Mo. 12	1.336	1.341	1.327	1.313	1.330	1.314	1.336	1.333
Mo. 16	1.325	1.333	1.312	1.304	1.319	1.303	1.325	1.322
Mo. 18	1.325	1.332	1.310	1.302	1.314	1.302	1.324	1.321
Mo. 20	1.437	1.427	1.376	1.301	1.402	1.302	1.420	1.404
Di. 0	1.442	1.445	1.425	1.377	1.424	1.383	1.439	1.431
Di. 6	1.409	1.389	1.377	1.369	1.393	1.364	1.395	1.391
Di. 12	1.337	1.341	1.330	1.315	1.334	1.315	1.337	1.334
Di. 16	1.325	1.330	1.312	1.304	1.320	1.303	1.324	1.321
Di. 18	1.324	1.330	1.312	1.302	1.315	1.301	1.323	1.320
Di. 20	1.437	1.432	1.380	1.302	1.403	1.302	1.423	1.407
Mi. 0	1.443	1.444	1.433	1.378	1.428	1.382	1.441	1.432
Mi. 6	1.406	1.388	1.378	1.367	1.392	1.363	1.394	1.390
Mi. 12	1.337	1.339	1.329	1.315	1.337	1.316	1.336	1.333
Mi. 16	1.324	1.329	1.311	1.303	1.322	1.303	1.323	1.321
Mi. 18	1.323	1.328	1.310	1.300	1.317	1.301	1.322	1.319
Mi. 20	1.435	1.429	1.375	1.300	1.402	1.302	1.420	1.404
Do. 0	1.440	1.441	1.425	1.371	1.427	1.379	1.438	1.428
Do. 6	1.405	1.387	1.374	1.367	1.390	1.362	1.392	1.388
Do. 12	1.337	1.338	1.328	1.315	1.331	1.314	1.336	1.333
Do. 16	1.325	1.330	1.312	1.305	1.321	1.304	1.324	1.322
Do. 18	1.325	1.330	1.311	1.303	1.316	1.302	1.323	1.321
Do. 20	1.433	1.430	1.371	1.302	1.403	1.303	1.419	1.403
Fr. 0	1.438	1.442	1.422	1.376	1.427	1.382	1.436	1.428
Fr. 6	1.404	1.391	1.376	1.366	1.386	1.363	1.393	1.389
Fr. 12	1.341	1.340	1.332	1.316	1.336	1.318	1.338	1.336
Fr. 16	1.327	1.331	1.314	1.305	1.322	1.306	1.325	1.323
Fr. 18	1.325	1.330	1.312	1.302	1.319	1.303	1.324	1.321
Fr. 20	1.441	1.432	1.376	1.302	1.405	1.303	1.423	1.407
Sa. 0	1.445	1.442	1.424	1.376	1.429	1.382	1.440	1.432
Sa. 6	1.421	1.393	1.380	1.370	1.406	1.375	1.402	1.398
Sa. 12	1.341	1.342	1.334	1.315	1.341	1.316	1.340	1.337
Sa. 16	1.328	1.334	1.319	1.305	1.323	1.305	1.328	1.325
Sa. 18	1.327	1.334	1.318	1.303	1.321	1.305	1.327	1.324
Sa. 20	1.440	1.432	1.372	1.303	1.374	1.307	1.420	1.405
So. 0	1.446	1.442	1.412	1.377	1.409	1.384	1.437	1.429
So. 6	1.420	1.409	1.377	1.369	1.398	1.378	1.406	1.401
So. 12	1.355	1.349	1.336	1.325	1.337	1.325	1.348	1.345
So. 16	1.335	1.337	1.318	1.308	1.327	1.312	1.332	1.329
So. 18	1.334	1.336	1.316	1.306	1.325	1.311	1.331	1.328
So. 20	1.435	1.430	1.374	1.306	1.378	1.309	1.418	1.403

Tabelle 2.5: Preisentwicklung Super E10 im Tagesverlauf nach Wochentagen – Hamburg

Tag/Zeit	Aral	Shell	Esso	Jet	Total	NO	Oli4	Oli5
Mo. 0	1.586	1.577	1.557	1.530	1.561	1.530	1.577	1.571
Mo. 6	1.557	1.534	1.520	1.517	1.534	1.514	1.541	1.537
Mo. 12	1.487	1.488	1.480	1.465	1.481	1.465	1.486	1.483
Mo. 16	1.477	1.479	1.465	1.457	1.470	1.455	1.475	1.473
Mo. 18	1.476	1.478	1.464	1.456	1.466	1.454	1.474	1.472
Mo. 20	1.581	1.569	1.531	1.455	1.548	1.455	1.566	1.551
Di. 0	1.585	1.584	1.564	1.531	1.569	1.531	1.581	1.574
Di. 6	1.557	1.539	1.530	1.522	1.545	1.516	1.545	1.542
Di. 12	1.490	1.491	1.484	1.468	1.486	1.468	1.489	1.486
Di. 16	1.478	1.480	1.464	1.459	1.473	1.457	1.476	1.474
Di. 18	1.477	1.479	1.464	1.456	1.468	1.455	1.475	1.472
Di. 20	1.583	1.576	1.536	1.456	1.548	1.456	1.570	1.555
Mi. 0	1.588	1.584	1.573	1.531	1.570	1.531	1.583	1.576
Mi. 6	1.556	1.538	1.528	1.519	1.542	1.515	1.544	1.540
Mi. 12	1.488	1.487	1.481	1.467	1.486	1.468	1.487	1.484
Mi. 16	1.476	1.478	1.465	1.457	1.474	1.455	1.475	1.472
Mi. 18	1.475	1.477	1.463	1.454	1.469	1.454	1.473	1.471
Mi. 20	1.583	1.574	1.531	1.454	1.548	1.455	1.568	1.553
Do. 0	1.588	1.583	1.566	1.525	1.571	1.528	1.582	1.574
Do. 6	1.555	1.538	1.526	1.519	1.539	1.514	1.542	1.539
Do. 12	1.489	1.488	1.484	1.468	1.483	1.467	1.488	1.485
Do. 16	1.479	1.480	1.468	1.460	1.475	1.458	1.477	1.475
Do. 18	1.479	1.479	1.467	1.458	1.471	1.457	1.476	1.474
Do. 20	1.582	1.576	1.529	1.458	1.551	1.459	1.568	1.554
Fr. 0	1.586	1.585	1.568	1.531	1.573	1.533	1.582	1.575
Fr. 6	1.556	1.541	1.528	1.520	1.540	1.516	1.544	1.541
Fr. 12	1.492	1.490	1.485	1.469	1.487	1.470	1.489	1.487
Fr. 16	1.480	1.481	1.468	1.460	1.473	1.459	1.478	1.476
Fr. 18	1.479	1.481	1.467	1.458	1.471	1.457	1.477	1.475
Fr. 20	1.587	1.578	1.532	1.457	1.550	1.457	1.572	1.557
Sa. 0	1.592	1.586	1.570	1.532	1.574	1.533	1.585	1.578
Sa. 6	1.568	1.542	1.536	1.524	1.553	1.527	1.552	1.548
Sa. 12	1.493	1.491	1.486	1.468	1.492	1.467	1.491	1.488
Sa. 16	1.481	1.483	1.471	1.459	1.475	1.457	1.479	1.477
Sa. 18	1.480	1.482	1.470	1.457	1.474	1.457	1.478	1.476
Sa. 20	1.585	1.576	1.526	1.457	1.526	1.459	1.567	1.553
So. 0	1.590	1.584	1.558	1.530	1.561	1.533	1.581	1.574
So. 6	1.566	1.554	1.530	1.521	1.549	1.528	1.554	1.550
So. 12	1.506	1.498	1.487	1.477	1.488	1.474	1.499	1.496
So. 16	1.487	1.486	1.472	1.462	1.479	1.462	1.483	1.481
So. 18	1.486	1.485	1.470	1.460	1.478	1.462	1.482	1.479
So. 20	1.579	1.574	1.531	1.460	1.530	1.462	1.565	1.552

Weitgehend übereinstimmende Befunde ergeben sich für Super E10 in Hamburg (Tabelle 2.5 und Abbildung 2.6 sowie Tabelle 2.22-2.24 und Abbildung 2.16-2.18 für die anderen Regionen). Um Mitternacht gelten die höchsten Preise, bis abends um 18 Uhr gehen die Durchschnittspreise auf das niedrigste Niveau zurück. Aral, Shell und im geringeren Ausmaß Total und Esso heben nach 18.00 die Preise an, so dass sie um 20.00 preislich höher dastehen als Jet und die Nicht-Oligopolisten. Aus Abbildung 2.6 könnte man vielleicht etwas höhere Preisspitzen für Freitag- und Samstagnacht ablesen, wenn man sich auf Aral und Shell beschränkt.

Abbildung 2.5: Preisentwicklung Diesel nach Wochentagen – Hamburg

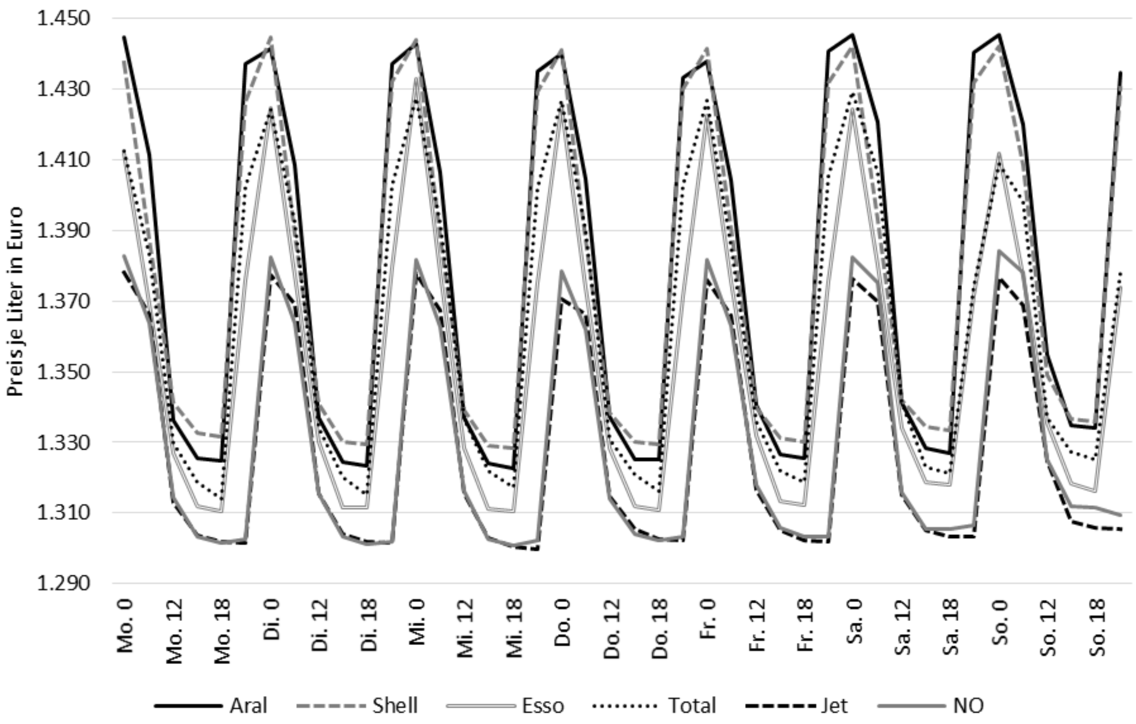
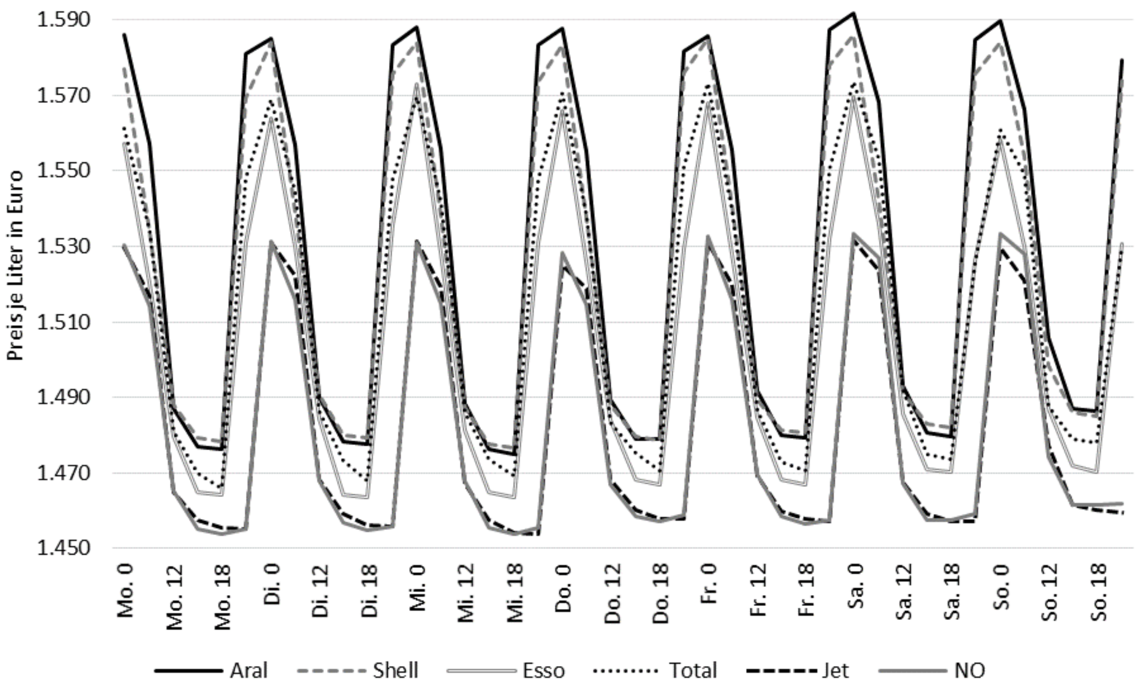


Abbildung 2.6: Preisentwicklung Super E10 nach Wochentagen – Hamburg



Blickt man zusammenfassend auf die Preishöhen, so scheinen Aral, Shell, Esso und Total eine Hochpreisstrategie zu fahren, wobei Esso und Total sich eher etwas preisgünstiger verhalten. Dagegen verlangen Jet und die Nicht-Oligopolisten niedrigere Preise. Im Tages- und Wochenverlauf verfolgen alle Tankstellen das gleiche Muster: Mit hohen Preisen in den Tag starten, die sukzessive im Tagesverlauf gesenkt werden und in den frühen Abendstunden das niedrigste Niveau erreichen. Das Vierer-Oligopol zieht nach 18.00 stark an und erreicht in der Nacht die hohen Preise, die für den nächsten Tag wieder als Startwert fungieren. Jet und die Außenseiter verhalten sich prinzipiell nach dem gleichen Muster, erhöhen die Preise abends und nachts jedoch nicht so stark bzw. später und beginnen am Folgemorgen auf dem gleichen Niveau. Wochentagsspezifische Besonderheiten sind analog zum Bundeskartellamt (2014, 2015) nicht zu erkennen, im Gegensatz zu den deutlichen Befunden für 2007-2010 (Bundeskartellamt 2011).

2.4. Preiserhöhungen und Preissenkungen

Preisveränderungen werden von einzelnen Tankstellen oder Betreibergruppen angestoßen. Wie häufig kommen Preiserhöhungen und -senkungen vor, zu welcher Uhrzeit und an welchen Tagen? Sind einzelne Marken insbesondere für die Preiserhöhungen verantwortlich, und in welche Maße folgen konkurrierende Marken diesem Preisverhalten (Parallelverhalten)? Tabelle 2.6 gibt für die vier Regionalmärkte Auskunft, wie oft zu welcher Tageszeit und an welchem Wochentag Preiseerhöhungen für Diesel stattfinden und um wieviel die Preise im Durchschnitt erhöht wurden. Im linken Teil der Tabelle 2.6 erkennt man deutlich, dass die Preiserhöhungen überwiegend ab 18,00 stattfinden. Laut Tabelle 2.7 sind dies etwa 90% aller Preiserhöhungen (schwarze Felder in Tabelle 2.6). Am seltensten finden diese Preisanpassungen nach oben am Nachmittag statt (weiße Felder). Hinsichtlich der einzelnen Wochentage gibt es keine Unterschiede – analog zum Bundeskartellamt 2014 und im Widerspruch zur Sektoruntersuchung 2007-2010 (Bundeskartellamt 2011). Rechts in Tabelle 2.6 wird ersichtlich, dass der Preis abends im Durchschnitt um etwa 8-9 ct. erhöht wird. Die geringsten, jedoch seltenen Preiserhöhungen finden für Diesel eher montags und dienstags statt. Durchschnittlich lagen die Preiserhöhungen zwischen 7,5 ct. (Leipzig) und 8,7 ct. (Köln), für 2007-10 bei 4-5 ct. (Bundeskartellamt 2011, Anhang, S. 16-23). Je Tag werden in München pro Tankstelle durchschnittlich 1,06-mal die Preise erhöht, in Leipzig dagegen 1,23-mal, Hamburg/Köln liegen dazwischen. In der Sektoruntersuchung war dies zwischen 0,3 und 0,5-mal der Fall. Die Preise werden nicht nur stärker erhöht, sondern die Anzahl der Anhebungen hat sich in etwa auch verdreifacht.

Tabelle 2.6: Preiserhöhungen Diesel nach Wochentagen – Anzahl absolut & durchschnittliche Höhe

Wochentag	Zeit	HH	K	L	M	HH	K	L	M
Montag	00-06Uhr	114	85	54	74	0.042	0.056	0.041	0.039
Montag	06-12Uhr	146	189	71	192	0.026	0.031	0.029	0.024
Montag	12-18Uhr	56	79	18	47	0.020	0.055	0.028	0.021
Montag	18-24Uhr	2270	1963	1157	2285	0.091	0.092	0.082	0.084
Dienstag	00-06Uhr	114	101	112	92	0.054	0.062	0.045	0.042
Dienstag	06-12Uhr	136	220	124	219	0.024	0.033	0.033	0.028
Dienstag	12-18Uhr	55	71	16	43	0.023	0.065	0.011	0.013
Dienstag	18-24Uhr	2298	1999	1115	2319	0.092	0.092	0.079	0.085
Mittwoch	00-06Uhr	88	63	51	65	0.058	0.071	0.042	0.042
Mittwoch	06-12Uhr	124	192	94	197	0.027	0.032	0.029	0.028
Mittwoch	12-18Uhr	70	87	12	48	0.040	0.069	0.038	0.037
Mittwoch	18-24Uhr	2178	1883	1044	2202	0.090	0.092	0.079	0.083
Donnerstag	00-06Uhr	162	97	57	79	0.052	0.066	0.061	0.044
Donnerstag	06-12Uhr	122	194	70	208	0.033	0.037	0.032	0.030
Donnerstag	12-18Uhr	66	83	24	70	0.035	0.067	0.045	0.067
Donnerstag	18-24Uhr	2236	1927	1114	2267	0.092	0.093	0.081	0.084
Freitag	00-06Uhr	104	67	47	48	0.055	0.072	0.055	0.037
Freitag	06-12Uhr	111	199	88	178	0.030	0.033	0.028	0.027
Freitag	12-18Uhr	67	90	75	38	0.030	0.061	0.016	0.034
Freitag	18-24Uhr	2253	1938	1108	2289	0.093	0.095	0.084	0.084
Samstag	00-06Uhr	91	68	52	36	0.057	0.080	0.060	0.042
Samstag	06-12Uhr	57	86	85	88	0.036	0.057	0.028	0.037
Samstag	12-18Uhr	57	66	57	21	0.037	0.082	0.012	0.021
Samstag	18-24Uhr	2327	1945	1171	2352	0.091	0.095	0.083	0.079
Sonntag	00-06Uhr	37	34	42	9	0.055	0.078	0.046	0.056
Sonntag	06-12Uhr	93	67	62	55	0.038	0.040	0.022	0.035
Sonntag	12-18Uhr	57	55	50	19	0.032	0.087	0.015	0.039
Sonntag	18-24Uhr	2272	1920	1160	2217	0.089	0.090	0.081	0.076

Tabelle 2.7: Preiserhöhungen Diesel – Anzahl absolut und in Prozent

	Hamburg	Köln	Leipzig	München	Summe
00-06 Uhr	710	515	415	403	2.043
06-12 Uhr	789	1.147	594	1.137	3.667
12-18 Uhr	428	531	252	286	1.497
18-24 Uhr	15.834	13.575	7.869	15.931	53.209
Summe	17.761	15.768	9.130	17.757	60.416
Prozentualer Anteil					
00-06 Uhr	4%	3%	5%	2%	3%
06-12 Uhr	4%	7%	7%	6%	6%
12-18 Uhr	2%	3%	3%	2%	2%
18-24 Uhr	89%	86%	86%	90%	88%
Summe	100%	100%	100%	100%	100%

Die Tabelle 2.8 und 2.9 für Super E10 bestätigen die bisherigen Ergebnisse. Gleiches gilt für die Preisveränderungen pro Tankstelle: Täglich werden die Preise durchschnittlich 1,1-mal angehoben und dabei je nach Region im Mittel zwischen 0,078 und 0,084 C/L erhöht[5].

Tabelle 2.8: Preiserhöhungen E10 nach Wochentagen – Anzahl absolut & durchschnittliche Höhe

Wochentag	Zeit	HH	K	L	M	HH	K	L	M
Montag	00-06Uhr	96	91	13	55	0.041	0.054	0.023	0.042
Montag	06-12Uhr	118	176	43	159	0.027	0.031	0.031	0.022
Montag	12-18Uhr	51	70	18	40	0.019	0.059	0.021	0.020
Montag	18-24Uhr	2229	1923	1046	2228	0.085	0.088	0.080	0.083
Dienstag	00-06Uhr	100	98	5	73	0.048	0.060	0.028	0.042
Dienstag	06-12Uhr	132	204	64	174	0.025	0.033	0.031	0.029
Dienstag	12-18Uhr	53	69	23	27	0.018	0.064	0.011	0.014
Dienstag	18-24Uhr	2247	1938	1048	2253	0.087	0.088	0.079	0.085
Mittwoch	00-06Uhr	68	64	4	52	0.057	0.064	0.025	0.044
Mittwoch	06-12Uhr	114	181	53	153	0.026	0.032	0.029	0.028
Mittwoch	12-18Uhr	67	78	12	45	0.043	0.076	0.035	0.040
Mittwoch	18-24Uhr	2116	1838	985	2135	0.087	0.090	0.079	0.085
Donnerstag	00-06Uhr	155	95	10	66	0.049	0.063	0.045	0.049
Donnerstag	06-12Uhr	116	188	54	178	0.035	0.037	0.040	0.032
Donnerstag	12-18Uhr	79	84	26	75	0.031	0.063	0.038	0.056
Donnerstag	18-24Uhr	2158	1893	1039	2208	0.088	0.090	0.080	0.084
Freitag	00-06Uhr	89	67	5	35	0.051	0.066	0.036	0.041
Freitag	06-12Uhr	117	177	57	135	0.030	0.035	0.030	0.025
Freitag	12-18Uhr	75	89	29	35	0.029	0.060	0.024	0.034
Freitag	18-24Uhr	2187	1885	1039	2227	0.090	0.091	0.084	0.083
Samstag	00-06Uhr	76	68	9	33	0.055	0.074	0.066	0.042
Samstag	06-12Uhr	50	82	43	66	0.037	0.043	0.038	0.035
Samstag	12-18Uhr	57	66	9	21	0.032	0.076	0.027	0.024
Samstag	18-24Uhr	2287	1924	1106	2293	0.086	0.091	0.082	0.079
Sonntag	00-06Uhr	27	35	3	9	0.058	0.073	0.093	0.060
Sonntag	06-12Uhr	77	71	10	34	0.038	0.035	0.029	0.033
Sonntag	12-18Uhr	60	55	10	23	0.028	0.082	0.021	0.044
Sonntag	18-24Uhr	2242	1890	1095	2154	0.085	0.085	0.081	0.077

[5] In den Jahren 2007 bis 2010 entsprachen die Werte des Benzinmarktes denen des Diesels (Bundeskartellamt 2011, Anhang S. 16-23).

Tabelle 2.9: Preiserhöhungen Super E10 – Anzahl absolut und in Prozent

	Hamburg	Köln	Leipzig	München	Summe
00-06 Uhr	611	518	49	323	1.501
06-12 Uhr	724	1079	324	899	3.026
12-18 Uhr	442	511	127	266	1.346
18-24 Uhr	15.466	13.291	7.358	15.498	51.613
Summe	17.243	15.399	7.858	16.986	57.486
Prozentualer Anteil					
00-06 Uhr	4%	3%	1%	2%	3%
06-12 Uhr	4%	7%	4%	5%	5%
12-18 Uhr	3%	3%	2%	2%	2%
18-24 Uhr	90%	86%	94%	91%	90%
Summe	100%	100%	100%	100%	100%

Korrespondierend zu den Preiserhöhungen finden in beiden Kraftstoffmärkten etwa die Hälfte aller Preissenkungen zwischen 6 Uhr und mittags statt (Tabelle 2.10 bis 2.12). Die umfänglicheren Preissenkungen finden bei Diesel in den frühen Morgenstunden (vor 6 Uhr) statt, bei Superbenzin gibt es keine eindeutigen Ergebnisse. Im Vergleich zu den Werten der Sektoruntersuchung (Bundeskartellamt 2011, Anhang S. 16-23) hat sich auch die Anzahl der Preissenkungen in etwa verdreifacht und das Ausmaß (-0,02 bis -0,031 C/L) erhöht.

Tabelle 2.10: Preissenkungen Diesel – Anzahl absolut und in Prozent

	Hamburg	Köln	Leipzig	München	Summe
00-06 Uhr	12.203	9.251	5.452	9.708	36.614
06-12 Uhr	29.509	24.863	14.424	24.480	93.276
12-18 Uhr	11.754	12.084	10.764	10.689	45.291
18-24 Uhr	772	4.52	1.269	354	2.847
Summe	54.238	46.650	31.909	45.231	178.028
Prozentualer Anteil					
00-06 Uhr	22%	20%	17%	21%	21%
06-12 Uhr	54%	53%	45%	54%	52%
12-18 Uhr	22%	26%	34%	24%	25%
18-24 Uhr	1%	1%	4%	1%	2%
Summe	100%	100%	100%	100%	100%

Tabelle 2.11: Preissenkungen Diesel nach Wochentagen – Anzahl absolut & durchschnittliche Höhe

Wochentag	Zeit	HH	K	L	M	HH	K	L	M
Montag	00-06Uhr	1888	1463	844	1565	-0.035	-0.035	-0.028	-0.036
Montag	06-12Uhr	4192	3606	1942	3660	-0.028	-0.031	-0.022	-0.030
Montag	12-18Uhr	1542	1627	1306	1593	-0.017	-0.019	-0.015	-0.021
Montag	18-24Uhr	96	47	193	44	-0.023	-0.022	-0.032	-0.024
Dienstag	00-06Uhr	1995	1620	884	1632	-0.035	-0.036	-0.031	-0.037
Dienstag	06-12Uhr	4521	3672	2059	3719	-0.026	-0.028	-0.019	-0.027
Dienstag	12-18Uhr	1775	2025	1416	2006	-0.017	-0.018	-0.015	-0.020
Dienstag	18-24Uhr	83	54	168	41	-0.024	-0.018	-0.027	-0.019
Mittwoch	00-06Uhr	1842	1575	781	1409	-0.035	-0.034	-0.031	-0.040
Mittwoch	06-12Uhr	4314	3500	1876	3605	-0.025	-0.028	-0.019	-0.028
Mittwoch	12-18Uhr	1843	1912	1438	1778	-0.017	-0.019	-0.016	-0.021
Mittwoch	18-24Uhr	129	72	169	56	-0.030	-0.030	-0.031	-0.034
Donnerstag	00-06Uhr	1994	1497	837	1544	-0.036	-0.036	-0.032	-0.037
Donnerstag	06-12Uhr	4253	3355	1943	3755	-0.027	-0.030	-0.021	-0.029
Donnerstag	12-18Uhr	1565	1886	1409	1596	-0.018	-0.020	-0.016	-0.021
Donnerstag	18-24Uhr	140	94	192	99	-0.023	-0.025	-0.031	-0.022
Freitag	00-06Uhr	1869	1539	833	1504	-0.037	-0.036	-0.033	-0.038
Freitag	06-12Uhr	4161	3437	1962	3411	-0.026	-0.030	-0.019	-0.030
Freitag	12-18Uhr	1865	2027	1589	1718	-0.017	-0.019	-0.017	-0.021
Freitag	18-24Uhr	133	75	202	48	-0.031	-0.029	-0.028	-0.031
Samstag	00-06Uhr	1439	890	658	1109	-0.038	-0.037	-0.031	-0.039
Samstag	06-12Uhr	4292	3897	2364	3370	-0.031	-0.036	-0.022	-0.034
Samstag	12-18Uhr	1546	1255	2122	1059	-0.019	-0.020	-0.014	-0.026
Samstag	18-24Uhr	96	58	200	41	-0.029	-0.022	-0.027	-0.020
Sonntag	00-06Uhr	1176	667	615	945	-0.037	-0.034	-0.026	-0.037
Sonntag	06-12Uhr	3776	3396	2278	2960	-0.033	-0.035	-0.022	-0.035
Sonntag	12-18Uhr	1618	1352	1484	939	-0.023	-0.025	-0.016	-0.034
Sonntag	18-24Uhr	95	52	145	25	-0.026	-0.025	-0.030	-0.018

Tabelle 2.12: Preissenkungen Super E10 – Anzahl absolut und in Prozent

	Hamburg	Köln	Leipzig	München	Summe
00-06 Uhr	11.888	8.879	5.057	9.074	34.898
06-12 Uhr	28.425	24.449	13.798	23.182	89.854
12-18 Uhr	10.667	12.099	10.054	9.506	42.326
18-24 Uhr	693	361	899	269	2.222
Summe	51.673	45.788	29.808	42.031	169.300
Prozentualer Anteil					
00-06 Uhr	22%	20%	17%	21%	21%
06-12 Uhr	54%	53%	45%	54%	53%
12-18 Uhr	22%	26%	34%	24%	25%
18-24 Uhr	1%	1%	4%	1%	1%
Summe	100%	100%	100%	100%	100%

Tabelle 2.13: Preissenkungen E10 nach Wochentagen – Anzahl absolut & durchschnittliche Höhe

Wochentag	Zeit	HH	K	L	M	HH	K	L	M
Montag	00-06Uhr	1821	1426	776	1467	-0.032	-0.031	-0.026	-0.035
Montag	06-12Uhr	4025	3555	1877	3502	-0.027	-0.029	-0.022	-0.030
Montag	12-18Uhr	1390	1609	1233	1483	-0.017	-0.019	-0.015	-0.021
Montag	18-24Uhr	77	31	98	38	-0.024	-0.024	-0.016	-0.024
Dienstag	00-06Uhr	1932	1554	757	1548	-0.030	-0.031	-0.025	-0.034
Dienstag	06-12Uhr	4350	3566	1979	3465	-0.026	-0.027	-0.020	-0.030
Dienstag	12-18Uhr	1646	2084	1408	1827	-0.018	-0.018	-0.016	-0.020
Dienstag	18-24Uhr	90	39	121	35	-0.021	-0.019	-0.017	-0.021
Mittwoch	00-06Uhr	1800	1491	762	1302	-0.030	-0.030	-0.026	-0.037
Mittwoch	06-12Uhr	4102	3450	1724	3415	-0.025	-0.028	-0.020	-0.030
Mittwoch	12-18Uhr	1656	1949	1354	1499	-0.018	-0.019	-0.016	-0.023
Mittwoch	18-24Uhr	131	61	118	39	-0.029	-0.031	-0.019	-0.045
Donnerstag	00-06Uhr	1965	1407	756	1402	-0.032	-0.034	-0.027	-0.036
Donnerstag	06-12Uhr	4115	3406	1899	3550	-0.027	-0.028	-0.022	-0.031
Donnerstag	12-18Uhr	1402	1974	1352	1384	-0.018	-0.019	-0.016	-0.023
Donnerstag	18-24Uhr	95	69	149	64	-0.026	-0.027	-0.015	-0.026
Freitag	00-06Uhr	1868	1512	803	1422	-0.033	-0.032	-0.029	-0.036
Freitag	06-12Uhr	3977	3333	1828	3202	-0.027	-0.029	-0.022	-0.031
Freitag	12-18Uhr	1627	1966	1392	1524	-0.017	-0.019	-0.016	-0.022
Freitag	18-24Uhr	119	60	163	51	-0.032	-0.030	-0.017	-0.031
Samstag	00-06Uhr	1391	874	629	1046	-0.033	-0.034	-0.026	-0.037
Samstag	06-12Uhr	4180	3877	2293	3202	-0.031	-0.034	-0.022	-0.035
Samstag	12-18Uhr	1403	1240	1938	934	-0.019	-0.021	-0.015	-0.029
Samstag	18-24Uhr	86	51	152	28	-0.028	-0.024	-0.019	-0.025
Sonntag	00-06Uhr	1111	615	574	887	-0.036	-0.031	-0.025	-0.035
Sonntag	06-12Uhr	3676	3262	2198	2846	-0.032	-0.034	-0.022	-0.036
Sonntag	12-18Uhr	1543	1277	1377	855	-0.023	-0.026	-0.017	-0.037
Sonntag	18-24Uhr	95	50	98	14	-0.023	-0.024	-0.021	-0.029

Die Tabellen 2.14-2.16 beschreiben das durchschnittliche Preiserhöhungsverhalten in den vier Regionen nach 18 Uhr.[6] Der ersten flächendeckenden Preiserhöhung (mehr als 50% aller Tankstellen der jeweiligen Marke in der jeweiligen Region erhöhen zeitgleich den Preis) wird die durchschnittliche Reaktion der anderen Oligopolisten sowie der Außenseiterkonkurrenz bis Mitternacht gegenüber gestellt. Preisreaktionen werden als Nettogrößen angegeben, indem bei den jeweiligen Tankstellen Preiserhöhungen und vereinzelte Preissenkungen saldiert werden. Beginnen Marken gleichzeitig eine Preiserhöhung, wird diese Sequenz beiden „Ereignis"-kategorien zugeschrieben (6 Fälle).

Anhand der Tabelle 2.14 für Preiserhöhungen von Aral wird die Vorgehensweise deutlich. Spalte 2 bezieht sich auf die Region Hamburg mit Diesel, in der in 60 Fällen Aral als erstes Unternehmen die Preise erhöht. Die Preiserhöhungsrunden beginnen im Durchschnitt um 18.59 und führen zu

[6] Da fast 90% aller Preiserhöhungen nach 18 Uhr stattfinden (siehe Tab. 7 und 8), wird der Analysezeitraum auf 18 bis 24 Uhr eingeschränkt.

durchschnittlich 11,19 ct. höheren Preisen. Jedoch steigen die Preise insgesamt an den Aral-Tankstellen bis zum Ende des Tages durchschnittlich nur um 8,97 ct. Die betroffenen Tankstellen führen insgesamt 1,06 Preiserhöhungen durch. Shell reagiert erstmals 28 min später und setzt netto den Preis bis Mitternacht um 9,23 ct. hoch. Die Preisbewegungen von Shell beruhen auf durchschnittlich 1,12 Preisänderungen je Tankstelle. Esso folgt erstmals innerhalb von 33 min Aral und setzt im Mittel den Preis um 7,85 ct. bis 24 Uhr hoch. Total zieht in Hamburg im Durchschnitt nach 1 h und 11 min erstmalig nach, erhöht hier im Durchschnitt um 10,82 ct. (vermutlich liegt der Ausgangspreis bei Total niedriger, siehe Abbildung 2.5) und durchschnittlich ändert jede Totalstation einmal den Preis bis Mitternacht. Jet folgt bis Mitternacht der Preiserhöhung um 7,58 ct., macht also die Preiserhöhungen bis auf etwa 1,5 ct. mit, beginnt damit aber erst etwas mehr als 2,5 h später. Die Nicht-Oligopolisten reagieren im Vergleich zu Jet deutlich schneller (im Durchschnitt nach 1 h erstmals) und gehen bis Ende des Tages um ca. 8,5 ct. nach oben. Im Schnitt werden diese Preisänderungen nur von 0,89 Tankstellen ihrer Gruppe vollzogen. Spalten 3-5 beschreibt das Ausmaß der Dieselpreiserhöhungen von Aral in Köln, Leipzig und München und verdeutlicht die Reaktion der Wettbewerber. Gleiches wird in Spalten 6-9 für Super E10 anhand der vier Regionen dargestellt. Zusammenfassend zeigt sich, dass Aral die Preiserhöhungen im Durchschnitt zwischen 18.30 und 19.00 startet, zunächst etwa um 9-10 ct. erhöht, bis Mitternacht liegen die tatsächlichen Preiserhöhungen lediglich zwischen 6,37 und 8,97 ct. und meist ändert jede Tankstelle mehr als einmal den Preis. Shell reagiert frühestens nach einer knappen halben Stunde und mit Gesamtpreiserhöhungen zwischen durchschnittlich 8,55 bis 11,21 ct. Esso zieht meistens nach etwa einer Stunde mit Ausnahme in Hamburg nach, wo sich die Erstreaktionszeit auf eine halbe Stunde verringert. Bei Esso verändern die Tankstellen ihre Preise häufiger (zwischen 1,18 und 1,43) und die Erhöhungen fallen schwächer aus (etwa 8 ct.). Total erhöht in etwa um 10 ct. nach ca. 1,5 h. Jet benötigt zwischen 2,5 und 3 h für eine Erstreaktion und verlangt zwischen 6,5 und 7,5 ct. höhere Preise. Die Außenseiter (NO) reagieren deutlich schneller (zwischen einer halben Stunde und 1 h 51 min) als Jet, jedoch mit deutlich selteneren Preisänderungen je Tankstelle (in etwa 0,9 zu 1). In den vier Regionen beginnt Aral im Durchschnitt an 60 Tagen die Preiserhöhungen, jeweils bei Diesel und Benzin.

Tabelle 2.14: Preiserhöhungen Aral – Reaktion Wettbewerber

Kraftstoff		Diesel				Super E10			
Region		HH	K	L	M	HH	K	L	M
Aktion									
Aral	Start ↑	18:58:54	18:31:02	18:32:22	18:31:31	18:58:54	18:31:02	18:32:22	18:31:31
	Erste +	11,19	9,77	8,55	9,17	10,21	9,01	7,83	9,01
	Insges. +	8,97	8,88	6,82	8,50	8,42	8,23	6,37	8,33
	Anzahl +	1,06	1,05	1,30	1,07	1,04	1,05	1,29	1,06
Reaktionen									
Shell	Insges. +	9,23	10,99	10,97	11,21	8,55	10,45	10,24	11,16
	Zeit	00:28:16	00:26:26	00:27:09	00:28:26	00:28:13	00:26:26	00:27:09	00:28:26
	Anzahl +	1,12	0,95	0,95	0,98	1,12	0,95	0,97	0,95
Esso	Insges. +	7,85	8,53	7,76	8,40	7,90	8,80	6,88	8,22
	Zeit	00:33:11	01:01:47	01:03:06	01:00:05	00:33:17	01:01:47	01:03:06	01:00:07
	Anzahl +	1,29	1,41	1,37	1,43	1,18	1,25	1,39	1,41
Total	Insges. +	10,82	10,08	9,61	10,51	9,93	9,53	8,73	9,76
	Zeit	01:11:31	01:38:50	01:39:13	01:39:04	01:11:31	01:38:50	01:39:13	01:39:04
	Anzahl +	1,00	1,05	1,00	1,00	1,00	1,02	1,00	1,00
Jet	Insges. +	7,58	6,87	6,49	6,76	7,51	6,97	6,78	6,97
	Zeit	02:34:26	03:01:22	03:00:09	03:01:43	02:34:27	03:01:22	02:57:40	03:01:43
	Anzahl +	1,03	1,02	1,01	1,02	1,04	1,01	1,01	1,02
N0	Insges. +	8,43	9,43	7,04	8,08	8,09	8,89	7,46	7,80
	Zeit	00:59:28	01:02:49	00:20:23	00:15:45	01:00:27	01:05:11	01:51:38	00:15:42
	Anzahl +	0,89	0,88	1,33	0,79	0,90	0,88	1,03	0,85
Anzahl		60	62	59	61	60	62	59	61

Beginnt Shell mit den Preiserhöhungen, was ebenfalls an ungefähr 60 Tagen vorkommt, finden die Preiserhöhungen unmittelbar nach 18.00 statt (Tabelle 2.15). In der ersten Welle erhöht Shell um ca. 10 ct., was im Laufe des Abends um etwa 0,3 ct. zurückgenommen wird. Jede Shell-Tankstelle verändert etwa einmal am Abend den Preis. Aral zieht etwa nach 5 min nach, bleibt aber in seiner Erhöhung um etwa 2 ct. zurück. Esso liegt in den Größenordnungen sehr nahe bei Shell, jedoch etwa eine Stunde später. Total erhöht sogar etwas mehr als Shell, beginnt diesen Prozess jedoch erst nach einer Stunde bzw. bis zu eineinhalb Stunden später. Jet geht die Preiserhöhung von Shell zu etwa 2/3 mit und benötigt für erste Reaktion 2,5 bis 3 h. Die Nicht-Oligopolisten kommen fast an das Preiserhöhungsausmaß von Shell heran und benötigen im Durchschnitt für die erste Reaktion zwischen einer Viertelstunde und zwei Stunden.

Tabelle 2.15: Preiserhöhungen Shell – Reaktion Wettbewerber

Kraftstoff		Diesel				Super E10			
Region		HH	K	L	M	HH	K	L	M
Aktion									
Shell	Start ↑	18:02:10	18:02:14	18:03:50	18:02:12	18:02:10	18:02:14	18:03:50	18:02:12
	Erste +	10,79	9,94	9,26	8,83	10,37	9,80	9,66	9,02
	Insges. +	10,44	9,64	8,99	8,69	10,00	9,53	9,37	8,88
	Anzahl +	1,07	1,04	1,05	1,02	1,06	1,04	1,06	1,01
Reaktionen									
Aral	Insges. +	9,34	9,39	6,66	7,34	9,11	9,19	6,84	7,76
	Zeit	00:06:33	00:05:31	00:05:39	00:05:26	00:06:33	00:05:31	00:05:39	00:05:26
	Anzahl +	1,24	0,99	1,28	1,12	1,24	0,99	1,27	1,12
Esso	Insges. +	9,54	9,24	8,81	8,67	9,62	9,30	9,06	8,96
	Zeit	01:09:35	01:06:09	01:00:59	01:04:34	01:09:17	01:06:09	01:00:59	01:04:34
	Anzahl +	1,08	1,26	1,10	1,21	1,07	1,20	1,10	1,18
Total	Insges. +	9,79	9,93	9,38	9,63	9,53	9,68	9,16	9,43
	Zeit	01:36:39	01:36:09	01:32:49	01:35:58	01:36:39	01:36:09	01:32:49	01:35:58
	Anzahl +	1,00	1,00	1,00	0,97	1,00	1,00	1,00	0,98
Jet	Insges. +	6,65	6,17	5,63	5,50	6,44	6,21	6,01	5,88
	Zeit	02:59:44	02:52:59	02:54:34	03:01:52	02:59:44	02:56:22	02:56:43	03:01:52
	Anzahl +	1,11	1,08	1,13	1,12	1,11	1,08	1,12	1,12
N0	Insges. +	8,48	8,98	7,82	7,15	7,99	8,60	8,16	7,50
	Zeit	01:18:41	01:00:39	00:23:17	00:08:29	01:19:57	00:59:47	01:47:32	00:08:31
	Anzahl +	0,88	0,91	1,16	0,81	0,88	0,91	1,01	0,87
Anzahl		57	57	62	58	57	57	62	58

Erste flächendeckende Preiserhöhungen von Esso gibt es lediglich in drei Regionen für die beiden Kraftstoffarten nur zwei- bis dreimal (Tabelle 2.16). Sie beginnen sieben bis acht Minuten nach 19 Uhr und liegen bei 8-9 ct. Am Ende des Abends fallen ihre Preiserhöhungen insgesamt um etwa 2 ct. geringer aus; die Preisveränderungen werden im Durchschnitt durch 1,38 bis 1,9 Preisbewegungen je Tankstelle induziert. Aral zieht schwächer nach, etwa 4-6 ct., aber dafür beginnend innerhalb von 10 min. Die geringen Preiserhöhungen von Aral können natürlich auch an dem meist höheren Ausgangspreisniveau von Aral liegen (vgl. Abbildung 2.5 und 2.5). Shell reagiert mit Preiserhöhungen von ca. 6 bis 12 ct., nach etwa 30-40 min. Total setzt etwas stärker als Esso die Preise hoch und beginnt diesen Prozess nach 20-30 min. 7-8 ct. mehr verlangt Jet, beginnend genau zwei Stunden und 10 min. Die Nicht-Oligopolisten reagieren auch hier stärker und schneller als Jet.

Zusammenfassend gilt, dass meistens Aral oder Shell die Preiserhöhungen starten, meist in etwa um 10 ct.; im Laufe der Nacht „muss“ der Preiserhöher aber wieder etwas zurückgehen. Anscheinend ändert jede Tankstelle etwas mehr als einmal am Abend den Preis. Esso ist nur sehr selten der Preistreiber und dann erst nach Beginn der „heute“-Nachrichten. Ist Aral in der Rolle des Reagierenden, reagiert es sehr schnell, Shell benötigt länger. Total und Esso als Reagierende können durchaus auch „überschießend“ reagieren, was vermutlich am niedrigeren Ausgangsniveau liegt;

sie beginnen ihre Preisanpassungen nach etwa 1-1,5 h. Jet geht nur moderat auf die Preiserhöhungen ein und lässt sich durchaus 2-2,5 h Zeit. Die Außenseiter erhöhen auf jeden Fall stärker als Jet und beginnen damit deutlich früher.

Tabelle 2.16: Preiserhöhungen Esso – Reaktion Wettbewerber

Kraftstoff		Diesel			Super E10		
Region		HH	K	M	HH	K	M
Aktion							
Esso	Start ↑	19:08:23	19:07:09	19:07:09	19:08:23	19:07:09	19:07:09
	Erste +	9,68	8,90	8,46	9,88	8,29	8,88
	Insgesamt +	6,99	8,15	7,68	7,39	7,39	7,13
	Anzahl +	1,58	1,77	1,88	1,38	1,68	1,90
Reaktionen							
Aral	Insgesamt +	6,87	4,18	5,10	6,52	3,70	4,77
	Zeit	00:05:44	00:08:13	00:08:13	00:05:44	00:08:13	00:08:13
	Anzahl +	0,63	0,54	0,53	0,61	0,54	0,52
Shell	Insgesamt +	13,08	6,33	12,16	12,25	6,59	11,92
	Zeit	00:27:35	00:41:10	00:41:10	00:27:35	00:41:10	00:41:10
	Anzahl +	0,54	0,64	0,67	0,54	0,65	0,58
Total	Insgesamt +	13,67	9,86	13,00	11,67	9,02	11,00
	Zeit	00:27:17	00:20:55	00:20:55	00:27:17	00:20:55	00:20:55
	Anzahl +	1,00	1,17	1,00	1,00	1,08	1,00
Jet	Insgesamt +	7,94	7,33	7,86	8,14	7,22	7,95
	Zeit	02:10:52	02:10:31	02:10:31	02:10:52	02:10:31	02:10:31
	Anzahl +	1,09	1,00	1,00	1,09	1,00	1,00
NO	Insgesamt +	9,58	9,78	7,41	9,18	8,86	7,12
	Zeit	00:58:19	00:09:19	00:47:15	01:02:01	00:09:19	00:47:15
	Anzahl +	0,90	0,94	0,53	0,89	0,94	0,58
Anzahl		3	2	2	3	2	2

Die deskriptive Auswertung kann noch erweitert werden, indem für andere Einflussfaktoren auf die Höhe der Preiserhöhungen kontrolliert wird.

Tabelle 2.25 im Anhang gibt die deskriptiven Werte im Anhang wieder, wenn man sich einerseits auf die 452 Fälle konzentriert, bei denen Aral flächendeckend nach 18 Uhr als Erster die Preise erhöht. Die erste Preiserhöhung beträgt durchschnittlich 9,4 ct. (Aktion Aral), die jedoch bis Mitternacht nur auf das Preiserhöhungsausmaß 8,1 durchgehalten werden kann. In diesen Abendstunden erhöht nachfolgend Shell stärker um 10,4 ct., die Nicht-Oligopolisten in etwa gleich (8,2 ct.) und Jet nur um 7 ct. Auffällig ist, dass Shell in seiner Reaktion am stärksten variiert (Standardabweichung 3,5 ct.) sowie am weitesten nach unten (-3,25 ct.) und nach oben (16 ct.) abweicht. Die durchschnittlichen Preise um 18 Uhr für Diesel sowie Super E10 liegen bei Jet und den Nicht-Oligopolisten etwa 2 ct. unter den nahezu gleich hohen Durchschnittspreisen von Aral und Shell. 31% der betrachten Preiserhöhungsrunden liegen am Wochenende bzw. an einem Feiertag, nur 8% der Runden wurden an Ferientagen durchgeführt, bezogen auf das jeweilige Bundesland. Der Marktanteil des 4er-Oligopols schwankt zwischen 45 und 61%, bei Hinzurechnung von Jet steigt er auf Minimum 50 und Maximum 70%. Der durchschnittliche Großhandelspreis für Diesel beträgt 126,13 ct. und für Super E10 141.21 ct. Dieser ändert sich im betrachteten Zeitraum kaum (Änderung Handelspreis Diesel -0,05 ct.; Änderung Handelspreis Super E10-0,01 ct.).

Andererseits gilt für die 462 Fälle (Tabelle 2.26 im Anhang), bei denen Shell die Preiserhöhungsrunde flächendeckend ab 18 Uhr beginnt, dass Shell mit seinem „Erstschlag" durchschnittlich um 9,7 ct. erhöht, was nur geringfügig bis Mitternacht auf 9,4 ct. nach unten korrigiert wird. Aral, Jet und die Außenseiter bleiben im Verlauf des Abends mit jeweils 8,2, 6 und 8,1 ct. deutlich drunter. Wiederum gilt, dass in Bezug auf die finale Preiserhöhung Shell am stärksten streut (Standardabweichung 3,2 ct.) bzw. am weitesten nach oben abweicht. Die durchschnittlichen Ausgangspreise um 18 Uhr liegen bei Diesel zwischen 132,09 ct. (Jet) und 135,34 ct. (Shell) sowie bei Super E10 zwischen 147,66 ct. (Jet) und 150,46 ct. (Aral).

Die Tabelle 2.17 zeigt OLS-Schätzungen für das Ausmaß an Preisreaktionen der Marken Shell, Jet bzw. der Nicht-Oligopolisten auf eine vorangegangene Preiserhöhungsaktion von Aral nach 18 Uhr. Als weitere erklärende Variablen werden die Kraftstoffsorte (Diesel/Super E10), Wochenende/unter der Woche, Wochentage, Regionen, Marktanteile des 4er- bzw. 5er-Oligopols, der durchschnittlichen Preise einer Marke um 18 Uhr, die Bruttoraffineriepreise[7] und die Änderungsrate des Bruttoraffineriepreises miteinbezogen.

Die Modelle (1) bis (5) in Tabelle 2.17 beziehen sich somit auf die 452 Fälle, in denen Aral als erstes Unternehmen flächendeckende Preiserhöhungen in einer Region durchführt, und sie beschreiben, wie sich die Preise aller Shell-Tankstellen im Vergleich zu denen von Aral entwickeln. Diese Schätzungen deuten darauf hin, dass eine Preiserhöhung von Aral in Höhe von 1 ct. mit einer Preiserhöhung von Shell zwischen 1 und 1,3 ct. bis 24 Uhr einhergeht. Diese Punktschätzungen sind alle auf dem 0,1-Prozentlevel von Null verschieden. In den Spezifikationen (1) - (4) sind die Koeffizienten für Super E10 gegenüber Diesel, für den „Startpreis" von Shell um 18 Uhr, für Wochenenden und für die Wochentage (Basis ist Montag) meist nur insignifikant. Hingegen fallen die Preisreaktionen von Shell in Schulferien etwa 4 ct. geringer aus, da die Ausgangspreise an diesen Tagen eventuell höher sind. Kontrolliert man für Köln, Leipzig und München im Vergleich zu Hamburg, dann werden signifikante, regionale Unterschiede deutlich. Ein einprozentiger Marktanteilszuwachs des 4er-Oligopols erhöht schwach signifikant den Preis von Shell um 0,5 ct. (Modell 4). Erweitert man das 4er-Oligopol um Jet, fallen die Preissteigerungen jedoch um 0,5 ct. geringer aus. Insofern scheint Jet einen preissenkenden Effekt auszuüben. Im Modell 5 weisen die Koeffizienten ähnliche Werte auf, jedoch bewirkt ein 1 ct. höherer Ausgangspreis der Marke Shell hier ein um 0,3 ct. geringere Preiserhöhung bei dieser (5 Prozentniveau signifikant). Auch ein leicht signifikanter Einfluss der Kraftstoffsorte ist erkennbar.

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[7] Die Daten stammen von dem Preis-Informationsdienst O.M.R. OIL MARKET REPORT. Bruttopreis in Cent pro Liter als Durchschnitt aus Tageshöchst- und Tagestiefstpreis.

Tabelle 2.17: Preisänderungen von Shell/Jet/Nicht-Oligopolisten nach Preiserhöhungsrunde von Aral [OLS-Regressionen]

	(1) Shell	(2) Shell	(3) Shell	(4) Shell	(5) Shell	(6) Jet	(7) Jet	(8) Jet	(9) Jet	(10) Jet	(11) NO	(12) NO	(13) NO	(14) NO	(15) NO
Aral	0.976***	0.970***	1.280***	1.296***	1.160***	0.359***	0.357***	0.411***	0.397***	0.205***	0.352***	0.356***	0.293***	0.312***	0.248***
	(0.0701)	(0.0695)	(0.0791)	(0.0806)	(0.0875)	(0.0278)	(0.0275)	(0.0309)	(0.0316)	(0.0313)	(0.0238)	(0.0236)	(0.0387)	(0.0396)	(0.0395)
E10	-0.981	-1.032	0.924	0.416	-2.627*	1.854***	1.872***	1.771***	2.152***	-0.604	1.280**	1.269**	0.673	-0.0929	-0.966*
	(1.199)	(1.166)	(1.050)	(1.115)	(1.118)	(0.365)	(0.364)	(0.386)	(0.385)	(0.340)	(0.407)	(0.408)	(0.370)	(0.375)	(0.387)
Shell 18Uhr	0.0663	0.0698	-0.0591	-0.0226	-0.276*										
	(0.0845)	(0.0820)	(0.0746)	(0.0791)	(0.133)										
Jet 18Uhr						-0.107***	-0.108***	-0.0996***	-0.126***	-0.466***					
						(0.0255)	(0.0254)	(0.0271)	(0.0268)	(0.0376)					
NO 18Uhr											-0.092***	-0.091***	-0.0516*	0.00219	-0.132**
											(0.0259)	(0.0259)	(0.0243)	(0.0248)	(0.0503)
Ferien	-4.492***	-4.474***	-3.372***	-3.619***	-3.798***	-0.256*	-0.241*	-0.308*	-0.118	-0.162	-0.835***	-0.830***	-0.718***	-0.938***	-1.011***
	(0.525)	(0.534)	(0.501)	(0.475)	(0.449)	(0.107)	(0.113)	(0.129)	(0.120)	(0.100)	(0.117)	(0.118)	(0.134)	(0.143)	(0.138)
Wochenende§	0.0594					-0.0713					-0.386**				
	(0.297)					(0.0912)					(0.118)				
Dienstag		-0.0444	-0.0649	-0.0312	-0.0433		-0.127	-0.0982	-0.118	-0.158		0.281	0.278	0.307	0.310
		(0.450)	(0.398)	(0.406)	(0.410)		(0.162)	(0.157)	(0.163)	(0.142)		(0.220)	(0.193)	(0.199)	(0.195)
Mittwoch		-0.146	-0.352	-0.316	-0.256		-0.150	-0.140	-0.168	-0.177		0.0749	0.0841	0.112	0.144
		(0.468)	(0.408)	(0.414)	(0.400)		(0.170)	(0.163)	(0.169)	(0.147)		(0.230)	(0.207)	(0.214)	(0.207)
Donnerstag		-0.969	-1.183*	-1.119*	-0.919		-0.510**	-0.479**	-0.521**	-0.448**		0.0612	0.0689	0.123	0.217
		(0.518)	(0.472)	(0.477)	(0.470)		(0.174)	(0.171)	(0.174)	(0.149)		(0.215)	(0.196)	(0.203)	(0.190)
Freitag		0.257	0.0768	0.103	0.233		-0.0732	-0.0687	-0.0884	-0.199		0.104	0.127	0.147	0.196
		(0.459)	(0.423)	(0.425)	(0.455)		(0.184)	(0.177)	(0.182)	(0.156)		(0.232)	(0.213)	(0.219)	(0.196)
Samstag		0.346	0.322	0.337	0.350		-0.160	-0.146	-0.157	-0.309*		-0.289	-0.274	-0.266	-0.250
		(0.464)	(0.414)	(0.414)	(0.417)		(0.176)	(0.168)	(0.173)	(0.151)		(0.243)	(0.217)	(0.221)	(0.215)
Sonntag		-0.447	-0.296	-0.301	-0.203		-0.299	-0.270	-0.275	-0.386**		-0.255	-0.294	-0.318	-0.253
		(0.526)	(0.490)	(0.489)	(0.489)		(0.166)	(0.158)	(0.166)	(0.144)		(0.231)	(0.211)	(0.214)	(0.208)
Köln			1.213**					-0.517***					0.882***		
			(0.437)					(0.125)					(0.113)		
Leipzig			3.541***					0.104					-0.370		
			(0.490)					(0.156)					(0.232)		
München			2.004***					-0.479***					-0.210		
			(0.415)					(0.116)					(0.120)		
Anteil Oli4				0.473*	0.333				0.177**	-0.0409				0.256**	0.110
				(0.191)	(0.173)				(0.0635)	(0.0598)				(0.0872)	(0.0891)
Anteil Oli5				-0.522**	-0.377**				-0.156**	0.0481				-0.160*	-0.0354
				(0.160)	(0.145)				(0.0537)	(0.0506)				(0.0776)	(0.0781)
Handelspreis~					0.438**					0.505***					0.184***
					(0.148)					(0.0396)					(0.0529)
Änderung Handelspreis#					-0.770*					-0.0927					-0.262
					(0.352)					(0.130)					(0.166)
Konstante	-5.944	-6.209	6.710	10.08	-11.55	17.99***	18.34***	16.98***	20.43***	2.102	17.64***	17.38***	12.62***	1.515	-3.466
	(11.42)	(11.13)	(9.940)	(10.36)	(9.638)	(3.445)	(3.458)	(3.601)	(3.713)	(3.108)	(3.451)	(3.464)	(3.227)	(3.416)	(3.177)
Beobachtungen	452	452	452	452	452	452	452	452	452	452	452	452	452	452	452
Korrigiertes R^2	0.348	0.353	0.446	0.441	0.455	0.380	0.389	0.441	0.400	0.568	0.313	0.309	0.434	0.395	0.410

Robuste Standardfehler in Klammern; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; für alle Spezifikationen ergibt sich für *"Prob > F"* ein Wert von Null; §Samstage, Sonntage und gesetzliche Feiertage; ~Großhandelspreis in der jeweiligen Region; #Änderungsrate Großhandelspreis im Vgl. zum Vortag in der Region in Prozent

Des Weiteren fallen die Reaktionen von Shell bei einem größeren Großhandelspreis stärker aus. Alle fünf Modelle sind insgesamt ökonometrisch signifikant. Die Preisanpassungen von Shell sind in hohem Maße gleichgerichtet zu Aral, teilweise gehen sie über das Preisänderungsvolumen bei Aral hinaus. Dieses Ergebnis (und jedes Folgeergebnis) ist nur partiell kausal interpretierbar, da zwar laut Tabelle 2.14 Aral mit erheblichen Preiserhöhungen nach 18 Uhr startet, aber die hier gemessenen Preisanpassungen sich jeweils auf die Zeiträume zwischen der früh am Abend stattfindenden Preiserhöhung bis Mitternacht beziehen. Insofern kann man nicht ausschließen, dass Preisanpassungen von Aral auch als Reaktion auf Preisänderungen von Shell anzusehen sind.

Die Modelle (6) bis (10) in Tabelle 2.17 analysieren die abendlichen Preiserhöhungen von Jet, falls Aral als Erster flächendeckend am Abend den Preis erhöht hat. Eine Preissteigerung von 1 ct. bei Aral geht meist mit ca. 0,4 ct. bei Jet einher (signifikant auf 1 Tausend-Level). Ein 1 ct. höherer Jet-Preis um 18 Uhr vermindert die Preiserhöhung überwiegend um 0,1 ct., ebenfalls mit sehr geringer Irrtumswahrscheinlichkeit kann die Hypothese der nicht von Null verschiedenen Koeffizienten hier abgelehnt werden. Darüber hinaus erhöht ceteris paribus Jet bei Super E10 um 1,8 bis 2,1 ct. stärker als bei Diesel (höchstes Signifikanzlevel). Ferien haben nur in den Modellen (6) bis (8) einen schwach signifikanten Einfluss von -0,25 bis -0,3 ct. Am Donnerstag fallen die Preise im Vergleich zu Montag um 0,5 ct. geringer aus und nur im umfassendsten Schätzmodell (10) gibt es noch einen auf dem 5-Prozentniveau signifikanten, preisdämpfenden Effekt des Sonntags in Höhe von etwa 0,4 ct. Im Vergleich zu Hamburg finden signifikant um 0,4 bis 0,5 ct. geringere Preiserhöhungen in Köln und München statt, aber nicht in Leipzig. Der Verstärkungseffekt bei Preiserhöhungen fällt bei Berücksichtigung des 4er-Oligopolsmarktanteils um 0,18 höher und beim 5-er-Oligopol um 0,16 ct. geringer aus, allerdings mit einer einprozentigen Irrtumswahrscheinlichkeit und solange man nicht für den Großhandelspreis kontrolliert. Jet scheint signifikant auf die Großhandelspreise zu reagieren, da ein um 1 ct. höherer Großhandelspreis mit 0,5 ct. höheren Tankstellenpreisen korreliert. Zwischen 0,38 und 0,57% der Varianz können durch die genannten Modelle erklärt werden, die in ihrer Gesamtheit hochgradig abgesichert sind.

Die Nicht-Oligopolisten setzen die Preise bis Mitternacht um etwa 0,25-0,36 ct. hoch, während Aral mit einer 1 ct.-Preiserhöhung beginnt (hoch signifikant; vgl. Tabelle 2.17, Modelle (11)-(15)). Ein um 1 ct. höherer Startpreis um 18 Uhr der Nicht- Oligopolisten mindert fast immer die abendliche Preiserhöhung um 0,05 bis 0,1 ct., aber mit unterschiedlicher statistischer Absicherung. Für E10 gibt es nur nach dem letzten Schätzmodell einen um etwa 1 ct. niedrigeren Preis im Vergleich zu Diesel (5%-Level signifikant), bei zwei der anderen vier Schätzmodelle sind die Preiserhöhungen um 1,3 ct. höher und auf dem 1 Prozentniveau signifikant. Ferientage mindern die Preiserhöhung um 0,8 bis 1 ct. An Wochenenden und an Feiertagen erhöhen die Nicht-Oligopolisten um ca. 0,4 ct. weniger die Preise. Wochentage spielen in allen Schätzungen, die diese Dummy-Variable aufnehmen, keine Rolle. Nicht an die fünf Oligopolisten gebundene Tankstellen in Köln erhöhen bis Mitternacht um ca. 0,8 ct. mehr die Preise als die der anderen drei Regionen. Höhere Marktanteile im 4er-Oligopol korrelieren mit um etwa 0,3 ct. höheren Preisen der Nicht-Oligopolisten. Steigende Marktanteile bei dem 5er-Oligopol, die sich ja nur durch die Berücksichtigung von Jet unterscheiden, lassen die Preiserhöhungen am Abend um 0,2 ct. zurückbleiben (jedoch schwächer statistisch abgesichert). Ein um 1 ct. höherer Handelspreis korreliert mit 0,18 ct. höheren Preisen der Nicht-Oligopolisten am Abend. Alle Modelle sind statistisch sehr gut abgesichert und erklären zwischen 30 und 44% der Varianz in den Preiserhöhungen der Außenseiter.

Mit Hilfe der Tabelle 2.18 verschiebt sich der Blick auf anfängliche Preiserhöhungen, die von Shell ausgehen. Jeweils hochgradig signifikant korreliert eine Preiserhöhung von Shell in Höhe von einem 1 ct. mit einer Preiserhöhung bis Mitternacht in Höhe von etwa 0,2 ct. bei Aral, 0,03 bis 0,04 ct. bei Jet und 0,2 ct. bei den Nicht-Oligopolisten. Bei Aral deuten zwei Schätzungen auf 0,4 ct. geringere Preiserhöhungen (1% signifikant) hin, wenn der Preis um 18 Uhr um 1 ct. höher liegt. Hoch signifikant ist bei Jet ein 1 ct. höherer Startpreis um 18 Uhr mit einer um 0,3 bis 0,4 ct. geringeren Preiserhöhung korreliert. Bei den Nicht-Oligopolisten bewegt sich dieser Koeffizient zwischen -0,2 bis -0,3 ct. Bei Aral und Jet kommt es zu drastischen Preiserhöhungen bei E10 im Vergleich zu Diesel in Höhe von 3,3 bis 6,4 ct.; bei den Nicht-Oligopolisten sind sie um 3-4 ct. höher (hoch signifikant). Wochenenden und Feiertage sowie Ferientage spielen nur bei Aral eine Rolle und lassen die Preiserhöhungen c.p. größer ausfallen. Leicht signifikante Wochentagseffekte treten bei den drei Akteuren nur vereinzelt und an unterschiedlichen Tagen auf. An den Standorten Leipzig und München sind die Preisreaktionen bei Aral signifikant um 1 bis 2 ct. geringer als in Hamburg, und bei den Nicht-Oligopolisten in allen drei Regionen zwischen 0,3 und 1,1 ct. höher, jedoch unterschiedlich abgesichert. Die Marktanteile korrelieren nur bei den Nicht-Oligopolisten mit den bereits bekannten Zusammenhängen, wonach Preisanpassungen bei hohen Marktanteilen nach der 4er-Abgrenzung höher sowie nach der 5-er-Abgrenzung niedriger sind. Die Großhandelspreise haben bei Aral schwach signifikante geringe negative (-0,2 ct.), und den Nicht-Oligopolisten hoch signifikante geringe positive Effekte (0,2 ct.). Die Modelle für Aral und für die Außenseiter können für Preiserhöhungen von Shell relativ viel an Varianz erklären, dies trifft nicht für die Preiserhöhungen von Jet zu. Insgesamt sind aber alle Modelle gut abgesichert.

Tabelle 2.18: Preisänderungen von Aral/Jet/Nicht-Oligopolisten nach Preiserhöhungsrunde von Shell [OLS-Regressionen]

	(1) Aral	(2) Aral	(3) Aral	(4) Aral	(5) Aral	(6) Jet	(7) Jet	(8) Jet	(9) Jet	(10) Jet	(11) NO	(12) NO	(13) NO	(14) NO	(15) NO
Shell	0.207***	0.205***	0.177***	0.173***	0.186***	0.0351*	0.0387**	0.0335*	0.0359*	0.0308*	0.238***	0.240***	0.244***	0.233***	0.224***
	(0.0223)	(0.0221)	(0.0170)	(0.0169)	(0.0175)	(0.0150)	(0.0148)	(0.0150)	(0.0150)	(0.0150)	(0.0182)	(0.0175)	(0.0185)	(0.0185)	(0.0186)
E10	6.399***	6.260***	2.189*	1.316	3.258**	5.366***	5.775***	5.417***	5.549***	5.529***	4.454***	4.276***	4.686***	3.111***	1.146
	(0.656)	(0.667)	(0.927)	(0.774)	(1.087)	(0.580)	(0.595)	(0.720)	(0.702)	(0.924)	(0.374)	(0.369)	(0.595)	(0.506)	(0.689)
Aral 18Uhr	-0.408***	-0.399***	-0.138*	-0.0815	0.0196										
	(0.0406)	(0.0415)	(0.0590)	(0.0490)	(0.0608)										
Jet 18Uhr						-0.335***	-0.361***	-0.338***	-0.347***	-0.395***					
						(0.0369)	(0.0379)	(0.0461)	(0.0449)	(0.0547)					
NO 18Uhr											-0.292***	-0.280***	-0.307***	-0.205***	-0.291***
											(0.0236)	(0.0234)	(0.0391)	(0.0334)	(0.0363)
Ferien	0.621**	0.642***	0.247*	0.218	0.333**	0.277	0.263	0.260	0.246	0.236	0.258**	0.201*	0.131	0.100	-0.0277
	(0.190)	(0.191)	(0.115)	(0.121)	(0.128)	(0.172)	(0.161)	(0.165)	(0.166)	(0.174)	(0.0909)	(0.0930)	(0.0797)	(0.0822)	(0.0851)
Wochenende§	0.451***					-0.200					-0.0662				
	(0.134)					(0.124)					(0.0856)				
Dienstag		0.439*	0.283	0.253	0.277		0.139	0.127	0.131	0.0329		-0.0681	-0.0575	-0.107	-0.127
		(0.219)	(0.173)	(0.171)	(0.174)		(0.151)	(0.150)	(0.151)	(0.144)		(0.181)	(0.171)	(0.175)	(0.167)
Mittwoch		0.116	0.0158	0.0151	0.0247		-0.956**	-0.963**	-0.964**	-1.021**		-0.164	-0.169	-0.188	-0.174
		(0.228)	(0.183)	(0.183)	(0.186)		(0.328)	(0.329)	(0.329)	(0.311)		(0.148)	(0.128)	(0.139)	(0.133)
Donnerstag		0.177	0.104	0.0868	0.0916		-0.114	-0.124	-0.121	-0.0679		-0.302	-0.294	-0.351*	-0.341*
		(0.276)	(0.223)	(0.219)	(0.225)		(0.178)	(0.177)	(0.178)	(0.181)		(0.169)	(0.164)	(0.166)	(0.154)
Freitag		0.315	0.109	0.0746	0.0639		-0.594**	-0.608**	-0.602**	-0.499*		0.0379	0.0580	0.00986	-0.00718
		(0.221)	(0.168)	(0.168)	(0.169)		(0.197)	(0.199)	(0.199)	(0.207)		(0.146)	(0.128)	(0.138)	(0.134)
Samstag		0.614**	0.378*	0.342	0.371*		-0.232	-0.243	-0.240	-0.293*		-0.0792	-0.0650	-0.115	-0.157
		(0.230)	(0.180)	(0.179)	(0.181)		(0.145)	(0.146)	(0.147)	(0.143)		(0.146)	(0.127)	(0.135)	(0.129)
Sonntag		0.574*	0.147	0.0697	0.0545		0.263*	0.231	0.243*	0.222		-0.372*	-0.323*	-0.477**	-0.458**
		(0.240)	(0.203)	(0.198)	(0.200)		(0.117)	(0.123)	(0.123)	(0.119)		(0.154)	(0.146)	(0.155)	(0.148)
Köln			0.379*					-0.143					1.053***		
			(0.191)					(0.173)					(0.0933)		
Leipzig			-2.046***					-0.139					0.617***		
			(0.229)					(0.193)					(0.180)		
München			-1.158***					-0.274					0.341*		
			(0.187)					(0.204)					(0.165)		
Anteil Oli4				0.0452	0.114				0.0662	0.0399				0.421***	0.310***
				(0.0722)	(0.0783)				(0.0902)	(0.0916)				(0.0613)	(0.0643)
Anteil Oli5				0.0791	0.0158				-0.0484	-0.0278				-0.333***	-0.236***
				(0.0593)	(0.0657)				(0.0726)	(0.0746)				(0.0505)	(0.0539)
Handelspreis~					-0.217**					0.0502					0.202***
					(0.0748)					(0.0721)					(0.0523)
Änderung Handelspreis#					0.306					-1.123***					-0.179
					(0.202)					(0.296)					(0.225)
Konstante	60.91***	59.56***	25.56**	10.05	23.99**	49.91***	53.47***	50.64***	51.02***	51.21***	44.54***	43.12***	46.08***	31.05***	16.83**
	(5.465)	(5.567)	(7.755)	(6.997)	(9.083)	(4.833)	(4.969)	(5.970)	(6.259)	(7.524)	(3.132)	(3.111)	(5.041)	(4.799)	(5.720)
Beobachtungen	462	462	462	462	462	462	462	462	462	462	462	462	462	462	462
Korrigiertes R^2	0.250	0.249	0.552	0.550	0.555	0.152	0.209	0.207	0.207	0.251	0.489	0.494	0.576	0.531	0.543

Robuste Standardfehler in Klammern; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; für alle Spezifikationen ergibt sich für *"Prob > F"* ein Wert von Null; §Samstage, Sonntage und gesetzliche Feiertage; ~Großhandelspreis in der jeweiligen Region; #Änderungsrate Großhandelspreis im Vgl. zum Vortag in der Region in Prozent

Für die im Rahmen dieses Aufsatzes relevante Frage der Bedeutung des Binnen- und Außenwettbewerbs machen diese Schätzungen deutlich, dass Shell sehr stark im Gleichklang mit Aral seine Preise am Abend erhöht, wenn Aral die Preiserhöhung beginnt. Bei zunehmender Kontrolle für andere Einflussfaktoren sogar bis zu dem 1,4-Fachen. Jet verhält sich ebenfalls parallel, allerdings nur in etwa mit dem Faktor 0,4. Die Außenseiter als Nicht-Oligopolisten verhalten sich ebenfalls parallel, aber kaum schwächer als Jet. In gleiche Richtung deutet der „Vorzeichenwechsel" in der Tabelle 2.17 hin, wonach hohe Marktanteile des 4er-Oligopols mit höheren Preisen und bei ergänzender Berücksichtigung von Jet im 5er-Oligopol mit geringeren Preisen verbunden ist; dies ist ein Indiz dafür, dass Jet die Rolle des preissenkenden „Hechts im Karpfenteich" wahrnimmt. Insofern werden die deskriptiven Analysen ohne Kontrolle für andere Einflussgrößen voll bestätigt. Für die Analyse der Preise, die auf Preiserhöhungen von Shell zurückgehen, verändert sich das Bild. Zwar bleiben die Werte für die Nicht-Oligopolisten weitgehend gleich, aber bei Aral und Jet fallen die Korrelationen deutlich geringer aus. Insofern würde man aus diesen Schätzungen schließen, dass hier das Ausmaß an Parallelverhalten bei Aral und Jet zu Shell deutlich geringer ausfällt, was im Widerspruch zu der vorausgehenden univariaten, deskriptiven Analysen steht. Aus der Tabelle 2.17 ergab sich jedoch, dass bei einer von Aral ausgehenden Preiserhöhungsrunde Aral im Laufe des Abends die anfängliche Preiserhöhung von 9,4 ct. wieder um 1,3 ct. zurücknehmen muss und Shell in seiner Reaktion durchschnittlich deutlich stärker, aber mit erheblicher Streuung reagiert. Bei einer von Shell initiierten Preiserhöhungsrunde hält Shell die zuerst „ausgerufenen" 9,7 ct. bis auf -0,3 ct., jedoch mit deutlich größerer Streuung. Insofern kann der vertiefte Blick mit Mikrodaten auch hier zeigen, dass der auf aggregierte Ebene abgeleitete Befund symmetrischer Preisreaktionsmuster bei Aral oder Shell als Reaktion auf Preiserhöhungsrunden des anderen sich nur sehr deutlich für Shell als Reaktion auf Aral bestätigt; Aral in Reaktion auf Shell fällt deutlich schwächer aus und ist weitaus schlechter abgesichert. Insofern schwächt sich bei Verwendung vom Mikrodaten das feste Bild eines fehlenden Binnenwettbewerbs von Aral in Bezug auf Shell etwas ab.

2.5. Fazit

Die Frage der Marktbeherrschung im Tankstellenmarkt ist rechtlich und ökonomisch umstritten. Insbesondere stellt sich die Frage, ob es in dem Oligopol mit Aral, Shell, Esso, Total und Jet zu keinem Binnenwettbewerb kommt bzw. dieses Oligopol wirksam Außenseiterwettbewerb ausgesetzt ist. Zwar sprechen die Strukturmerkmale in diesem Markt unstreitig für Marktbeherrschung, aber das hochgradig volatile Preissetzungsverhalten wird unterschiedlich bewertet. Vereinfachend gesehen wird einerseits alleine aus der Volatilität der Preise auf wirksamen Wettbewerb geschlossen (Oberlandesgericht Düsseldorf 2010), andererseits indizieren die wöchentlichen und tageszeitlichen Schwankungen der Preise sowie das gleichförmige Verhalten bei Preiserhöhungen ein starkes Parallelverhalten (Bundesgerichtshof 2011). Es zeichnet sich ab, dass im Tagesverlauf die Anreize überwiegen, Preise nach unten zu ziehen, aber ab 18 Uhr bzw. im weiteren Verlauf des Abends gemeinsam die Preise nach oben zu setzen, meist auf das morgendliche hohe Preisniveau; in den Abendstunden werden tendenziell Preise entsprechend der Großhandelspreise plus etwa 5-6 ct. pro Liter als Deckungsbeitrag für Transport und Tankstellenvertrieb erreicht.

Neuartige Daten aus dem Jahr 2014, die auf die Markttransparenzstelle zurückgehen, deuten auf folgende Befunde hin:

- Aral und Shell scheinen eine Hochpreisstrategie zu verfolgen, Esso und Total bleiben etwas dahinter. Jet und die Nicht-Oligopolisten setzen tendenziell niedrige Preise. Im Tagesverlauf starten alle Tankstellen morgens mit hohen Preisen, die sukzessive im Laufe des Tages gesenkt werden. In den frühen Abendstunden wird das niedrigste Niveau erreichet. Das Vierer-Oligopol erhöht nach 18.00 stark und erreicht spätestens zu Mitternacht die höchsten Preise, die wiederum mit den morgendlichen Preisen des abgelaufenen Tages übereinstimmen. Diese hohen Preise werden bis zum Folgemorgen durchgehalten, danach beginnt der Zyklus von vorne. Jet und die Außenseiter erzeugen prinzipiell das gleiche Muster, gehen jedoch abends deutlich später und nicht so stark nach oben (Jet) oder kaum später und stärker nach oben (Außenseiter). Wie bereits die Auswertungen des Bundeskartellamtes für 2014 und 2015 zeigen, gibt es keine wochentagsspezifischen Muster, im Gegensatz zu 2007-2010 (Bundeskartellamt 2011, 2014 und 2015).
- Die Preiserhöhungen finden weit überwiegend abends zwischen 18 und 24 Uhr statt, unabhängig von der Kraftstoffsorte oder der untersuchten Region; auch quantitativ gesehen sind sie in dieser Zeit besonders hoch. Preissenkungen gibt es meist zwischen 6 und 12 Uhr. Im Vergleich zu Ende der 2000er Jahre hat sich die Anzahl der Preissenkungen und -erhöhungen verdreifacht, Wochentagseffekte gibt es keine mehr. Bei Diesel geht die Preisbewegung am Morgen früher los.
- Meistens starten Aral (ca. 18.30) oder Shell (ca. 18.05) mit Preiserhöhungen, etwa in Höhe von 10 ct. Im Laufe des Abends bzw. Nacht „muss" der Preiserhöher wieder etwas herunter. Esso ist nur dreimal als „Preistreiber" aufgetreten, knapp nach 19.00. Aral reagiert sehr schnell auf Preiserhöhungen von Shell (ca. 5 min), Shell wartet ca. 25 min. Total und Esso können durchaus über die Preiserhöhungsniveaus der Agierenden hinausgehen, beide fangen mit ihren Preisanpassungen nach etwa 1-1,5 h an. Jet steigt nur moderat auf die Preiserhöhungen der anderen ein und wartet 2-2,5 h. Die Außenseiter erhöhen stärker und früher als Jet.
- Kontrolliert man für andere Einflussfaktoren auf das Preiserhöhungsausmaß fällt auf, dass Shell gleich stark zu Aral die Preise erhöht, unter Umständen sogar stärker. Jet verhält sich ebenfalls parallel zu Aral aber deutlich schwächer (Faktor 0,4). Die Nicht-Oligopolisten zeigen sehr ähnlich Muster wie Jet. Bei von Shell ausgehenden Preiserhöhungen bleibt das Gesagte

für die Nicht-Oligopolisten bestehen, jedoch bei Aral und Jet gibt es deutliche geringere Gleichläufe. Insofern schwächt sich bei Verwendung vom Mikrodaten das feste Bild eines fehlenden Binnenwettbewerbs von Aral in Bezug auf Shell etwas ab.

Zusammenfassend kann man sagen, dass Jet sich weitaus eher als Außenseiter verhält und relativ wenig parallel zu den vier Anderen Preise setzt. Teilweise lehnen sich die Nicht-Oligopolisten stärker an die 4er-Oligopolisten an als Jet. Shell reagiert stark auf Aral, aber Aral relativ wenig auf Shell, wenn man wie wir regionale Mikrodaten verwendet. Auf der aggregierten Regionsebene besteht eine deutliche wechselseitige Reaktionsverbundenheit. Eine endgültige Bewertung dieses Zusammenhangs ist erst möglich, wenn man die Reaktionsverbundenheit der einzelnen Tankstelle erfasst, was methodisch und datentechnisch viel schwieriger ist als unser Vorgehen, bei dem wir das Agieren und Reagieren der einzelnen Marken aus dem durchschnittlichen Verhalten der einzelnen Marken als Folge einer flächendeckenden Aktion einer anderen abgebildet haben. Auf jeden Fall bleibt das Parallelerhalten, dass alle Anbieter relativ gemeinsam im Lauf des Abends die Preise erhöhen, häufig auf die Tageshöchstpreise während der Nacht zurückkehren und im Tagesverlauf gleichförmig Preise herabsetzen. Ferner sind die stabilen, jedoch markenspezifisch unterschiedlichen Preiserhöhungsmuster ein deutliches Zeichen für Parallelverhalten. Insofern spricht vieles für eine Einschlägigkeit des § 18, V GWB. Jedoch kann die Marktbeherrschungsvermutung des § 18, VI GWB nur so angewandt werden, dass Jet nicht als Oligopolzugehöriger angesehen wird. Diese wettbewerbsrechtliche Verschiebung bringt die Kartellbehörde in die Beweislast. Natürlich stehen die Schlussfolgerungen auch unter dem Fragezeichen, ob die Marktverhältnisse auch noch aktuell gelten. Indiz für das Fortgelten unserer Befunde ist, dass sie mindestens zu wesentlichen Teilen im Einklang mit den Erkenntnissen des Bundeskartellamtes (2011) von 2007 bis 2010 bzw. in einer breiteren regionalen Abgrenzung für 2014/2015 stehen (Bundeskartellamtes 2014, 2015).

Dieser Aufsatz zielt darauf ab, die Schlussfolgerungen des Kartellamtes aus 2007 bis 2010 in Bezug auf Binnen- und Außenwettbewerb im Kraftstoffmarkt mit jüngeren Daten zu überprüfen. Insofern wurde seine methodische Vorgehensweise, insbesondere bei der Beschränkung auf die vier Metropolregionen und in der Deskription, übernommen. Bei der räumlichen Marktabgrenzung ist sicherlich zu vermuten, dass nicht alle Tankstellen in der jeweiligen Metropolregion zueinander im Wettbewerb stehen. Bei einer kleinräumigeren Marktabgrenzung (Neukirch und Wein 2016) zeigen sich ähnliche zyklische Muster, die jedoch in ihrer Stärke abnehmen. Möglicherweise wird also bei einer zu großräumigen Marktabgrenzung die Wettbewerbsintensität überschätzt. Ähnliches gilt beim Vergleich der deskriptiven Analyse mit den multivariaten Schätzungen: Die Kontrolle für andere preiserhöhende Faktoren vermindert deutlich die Höhe, mit der im Binnen- und Außenwettbewerb auf flächendeckende Preiserhöhungen der Konkurrenten eingestiegen wird. Im Vergleich zu den jüngsten ökonometrischen, eher skeptischen Analysen der Wirkungen der Markttransparenzstelle Kraftstoffe kommen wir zu einer zweigeteilten Bewertung:

Einerseits hat die Einführung der Markttransparenzstelle nicht dazu geführt, die hohe innertägliche Preisvolatilität zu begrenzen, bzw. sie sogar verstärkt; andererseits scheinen wochentagsspezifische und ferienbedingte Preiserhöhungen keine Rolle mehr zu spielen. Die Wirkungen der Markttransparenzstelle lassen sich wohl nur umfassend bewerten, wenn man auch das Auf und Ab der Benzinpreise innerhalb des Tages mit in den Blick nimmt, was mit den sekundengenauen Daten der Markttransparenzstelle für Gütermärkte in geradezu einzigartigen Weise möglich ist.

Anhang

Abbildung 2.7: Tagesdurchschnittspreise Diesel – Köln

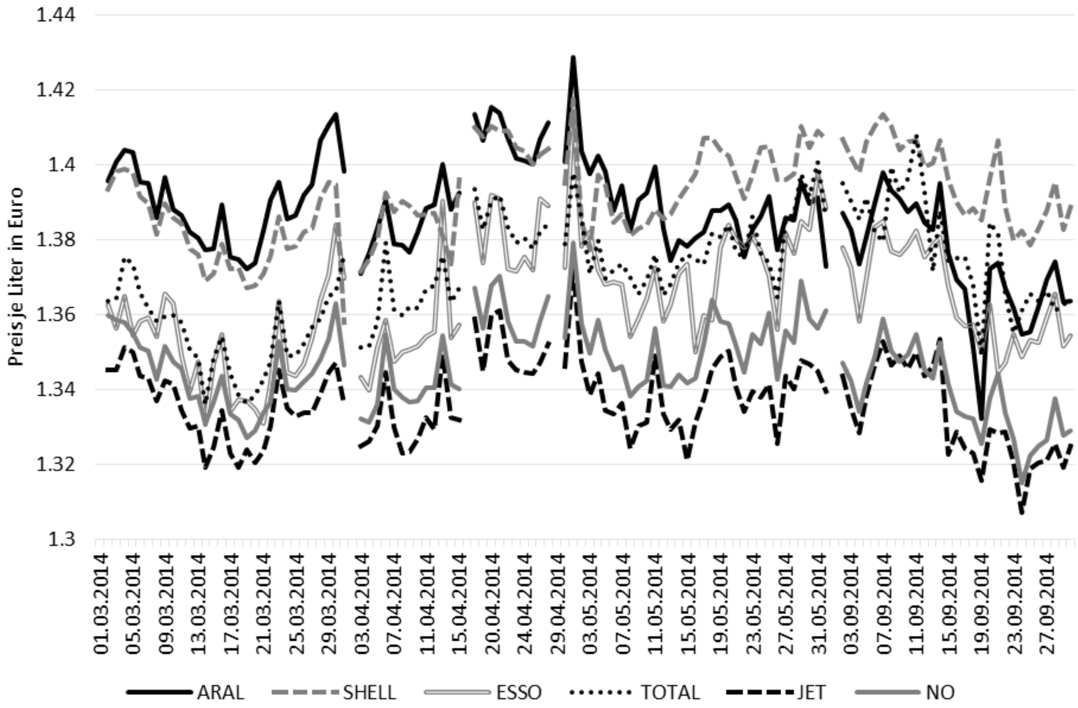

Abbildung 2.8: Tagesdurchschnittspreise Diesel – Leipzig

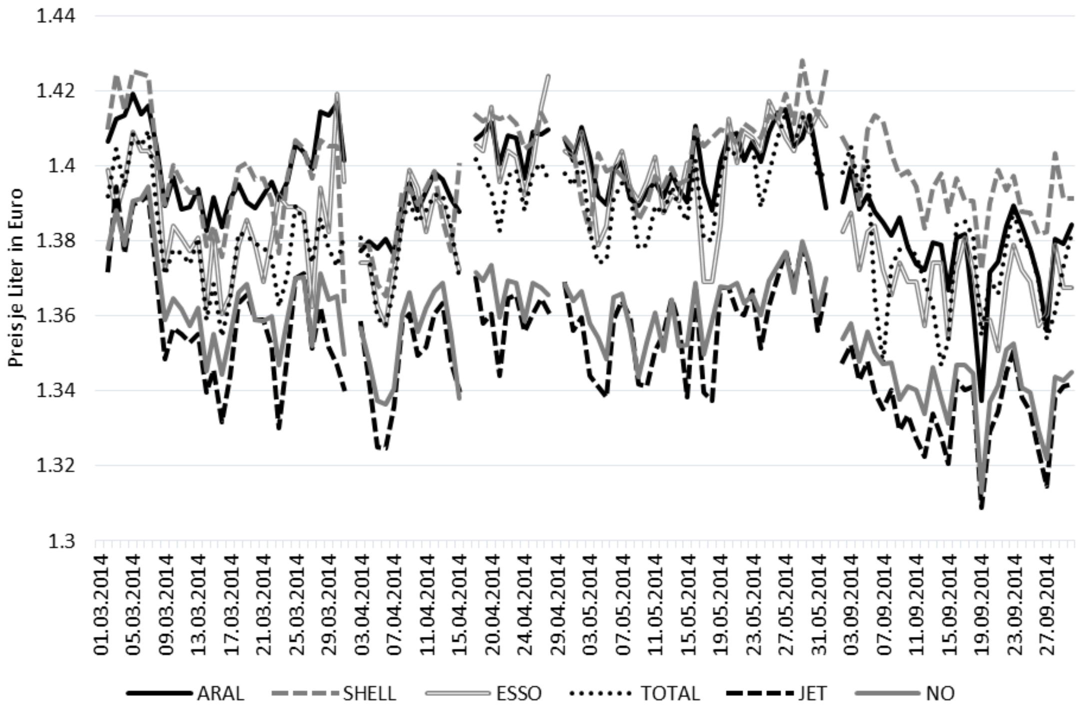

Abbildung 2.9: Tagesdurchschnittspreise Diesel – München

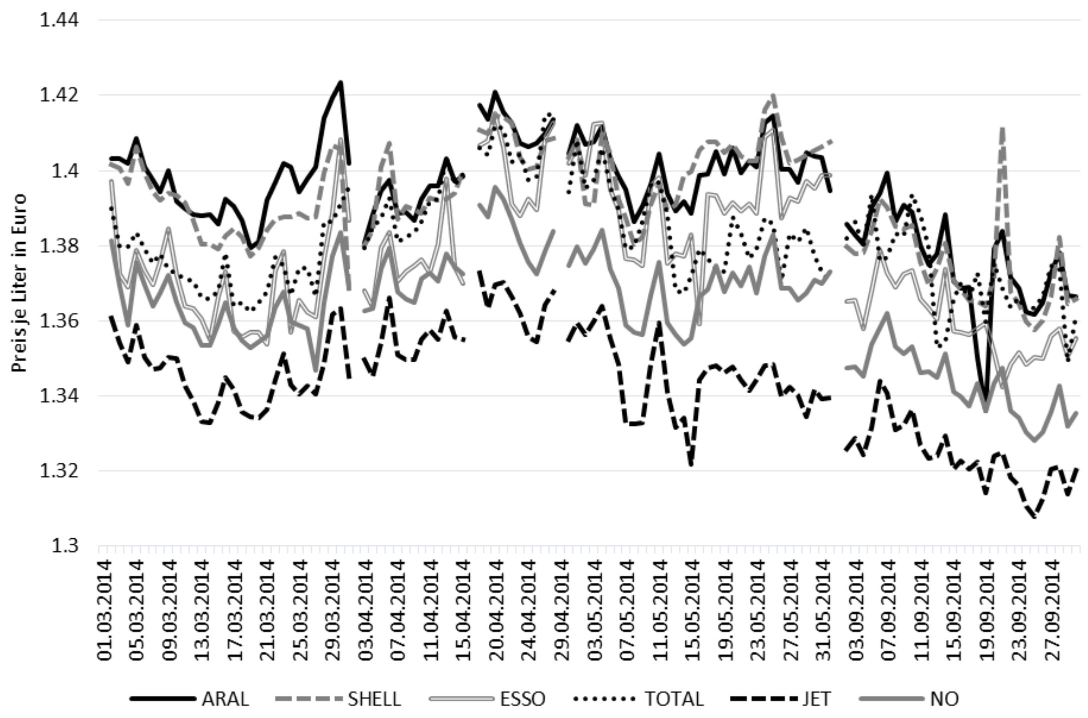

Abbildung 2.10: Tagesdurchschnittspreise Super E10 – Köln

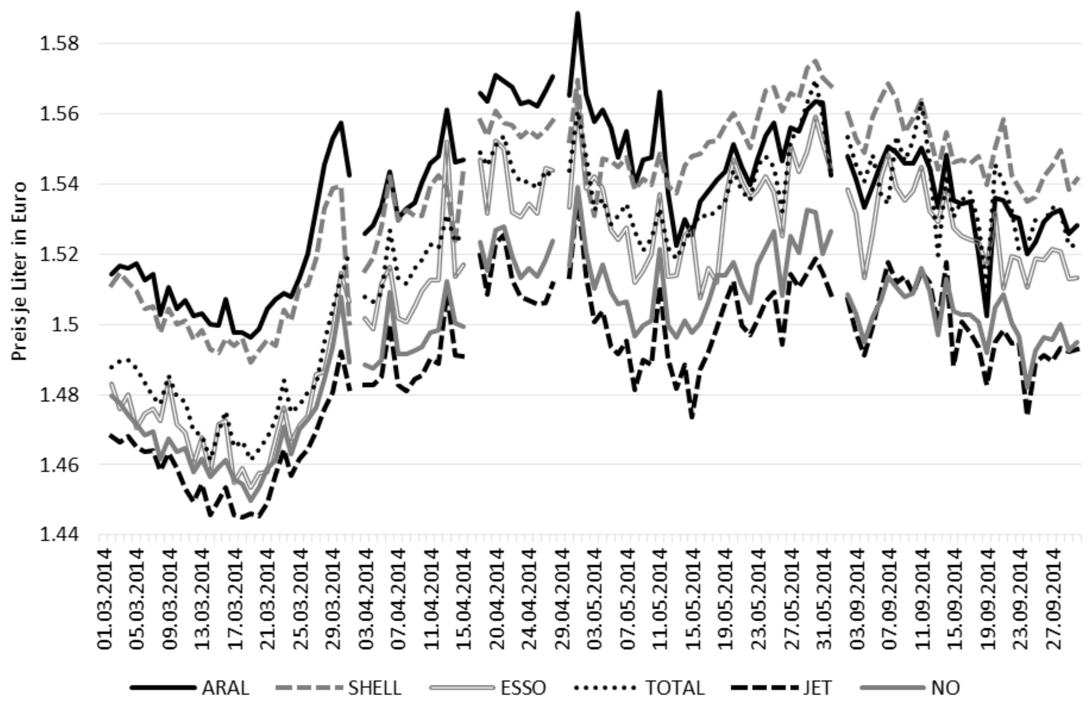

Abbildung 2.11: Tagesdurchschnittspreise Super E10 – Leipzig

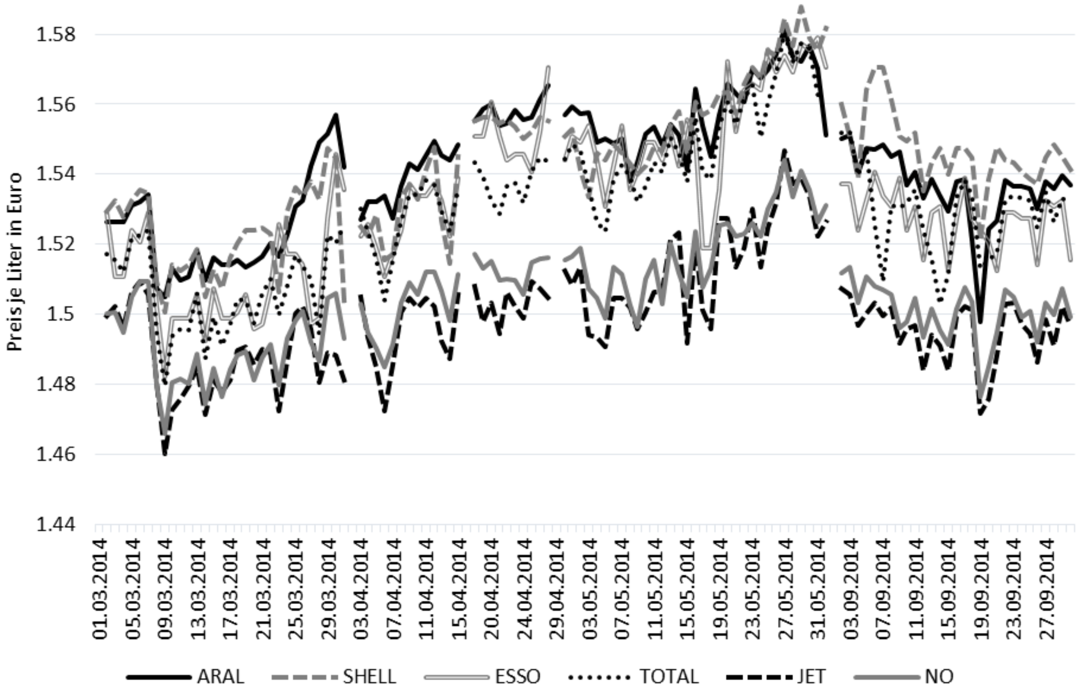

Abbildung 2.12: Tagesdurchschnittspreise Super E10 – München

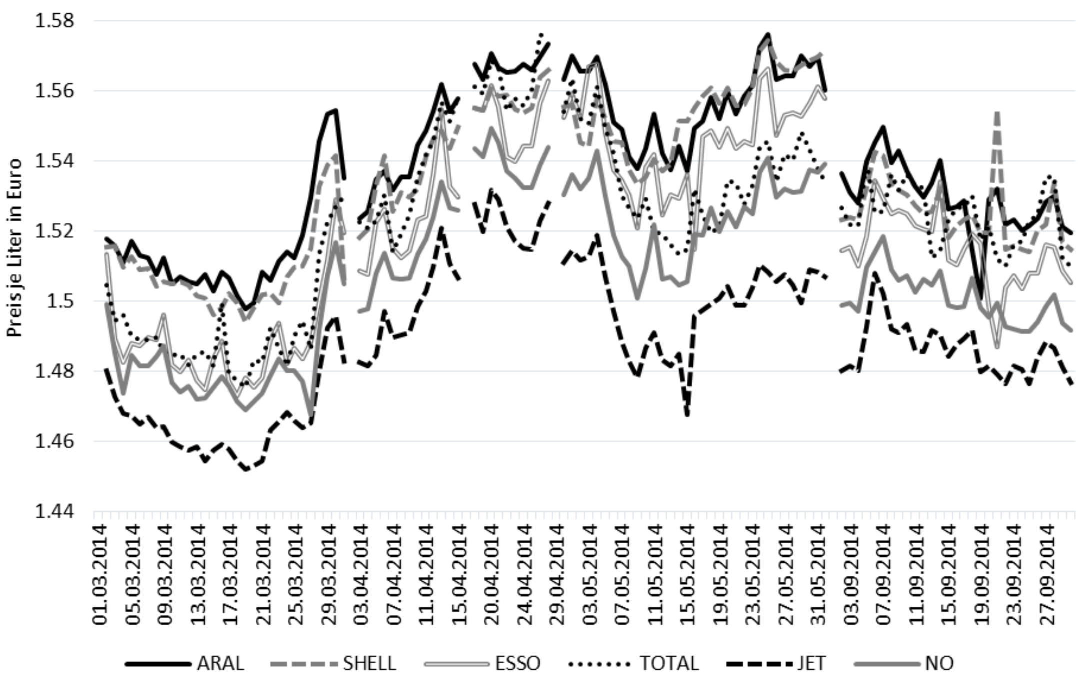

Abbildung 2.13: Preisentwicklung Diesel nach Wochentagen – Köln

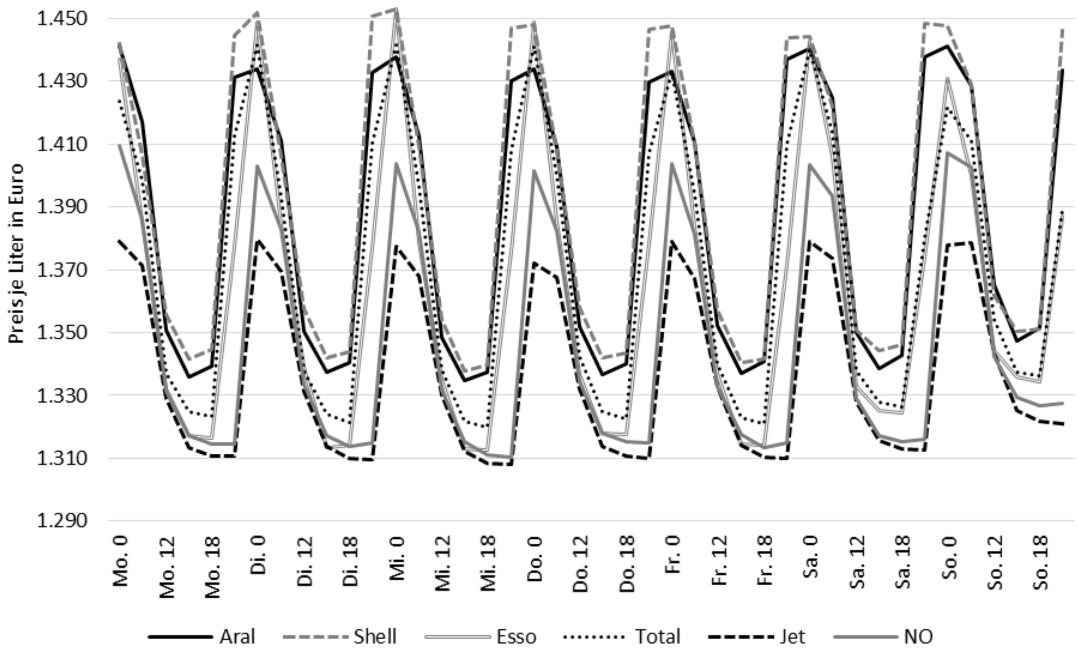

Abbildung 2.14: Preisentwicklung Diesel nach Wochentagen – Leipzig

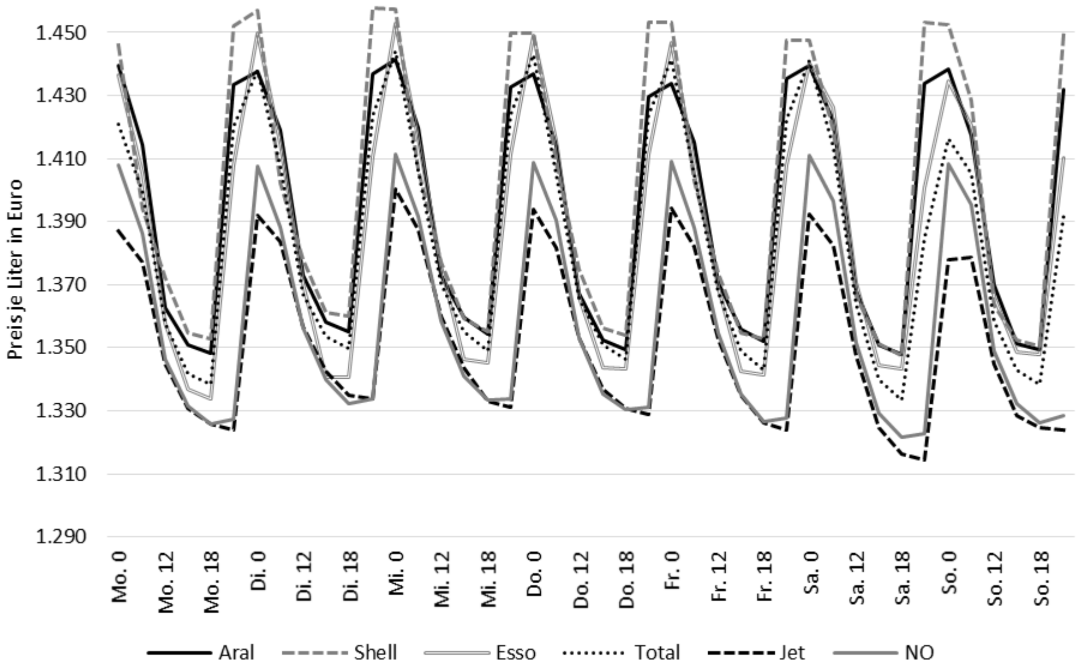

Abbildung 2.15: Preisentwicklung Diesel nach Wochentagen – München

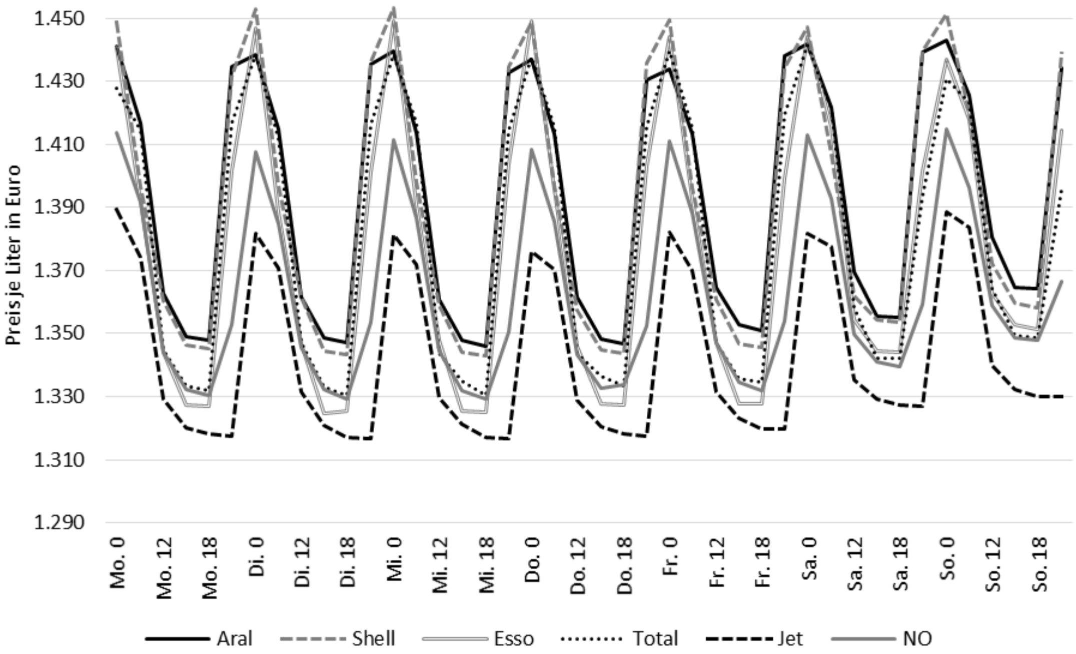

Abbildung 2.16: Preisentwicklung Super E10 nach Wochentagen – Köln

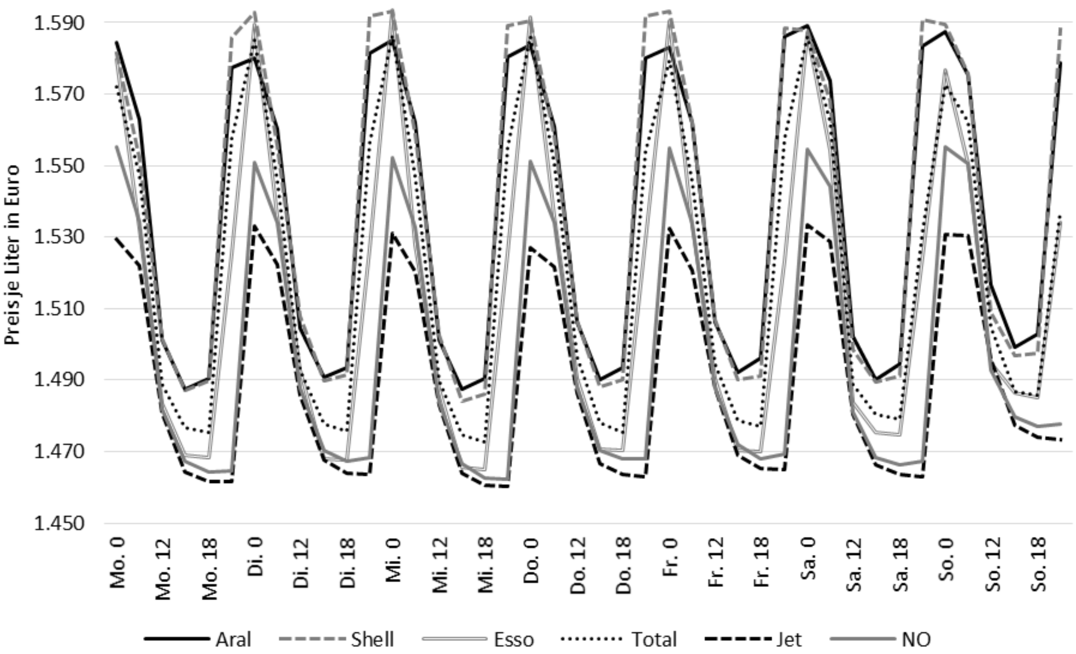

Abbildung 2.17: Preisentwicklung Super E10 nach Wochentagen – Leipzig

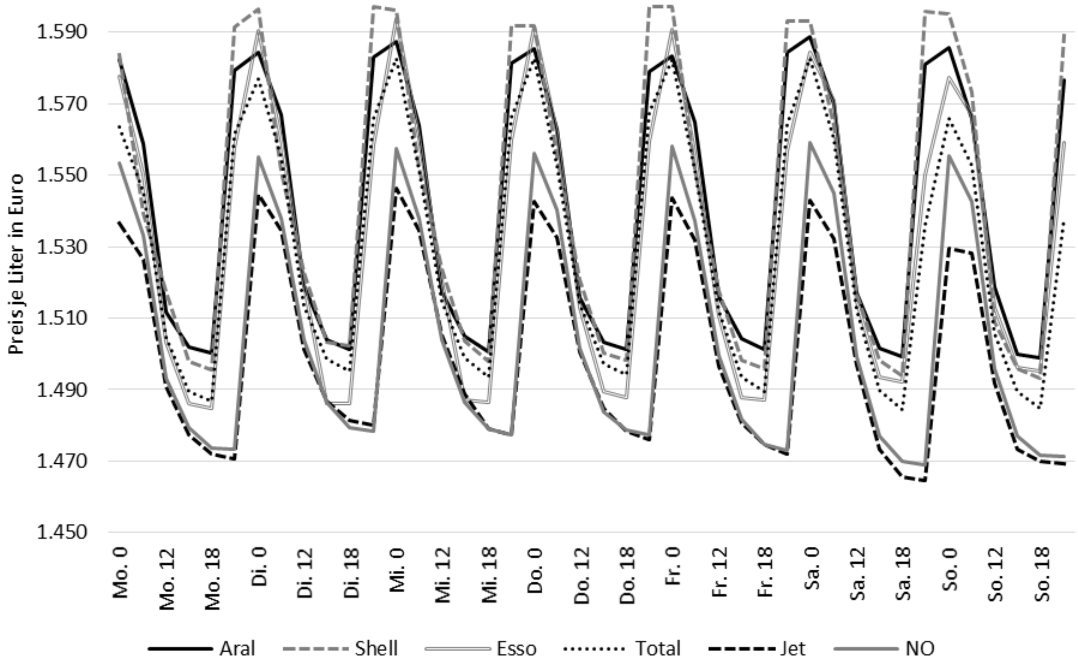

Abbildung 2.18: Preisentwicklung Super E10 nach Wochentagen – München

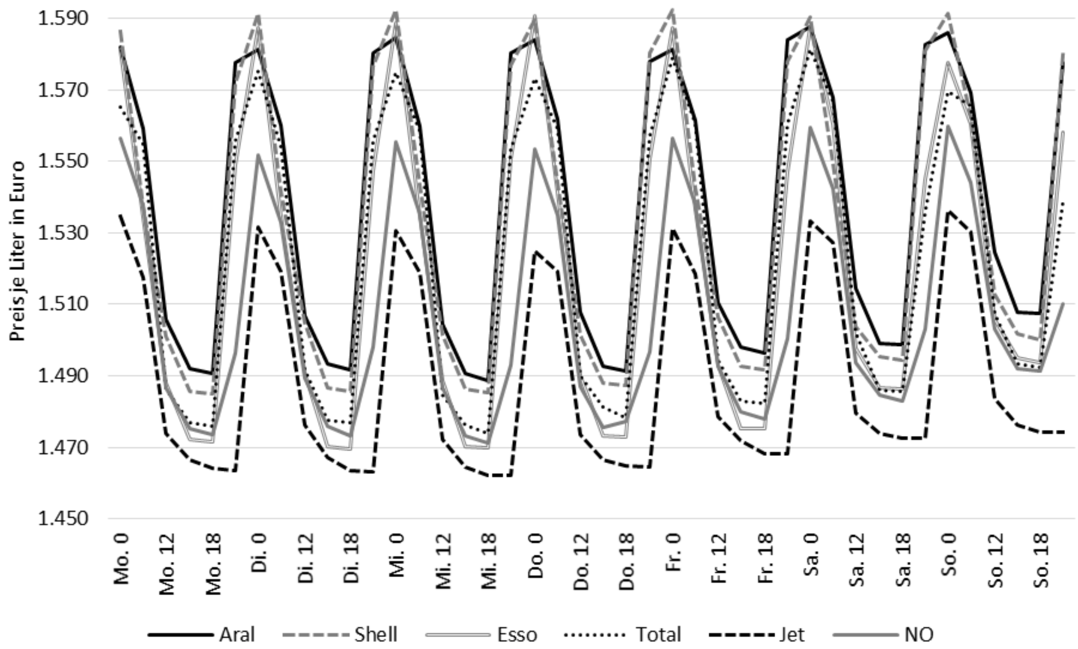

Tabelle 2.19: Preisentwicklung Diesel im Tagesverlauf nach Wochentagen – Köln

Tag/Zeit	Aral	Shell	Esso	Jet	Total	NO	Oli4	Oli5
Mo. 0	1.441	1.442	1.437	1.379	1.424	1.410	1.440	1.436
Mo. 6	1.417	1.406	1.385	1.371	1.399	1.386	1.408	1.403
Mo. 12	1.351	1.356	1.332	1.329	1.337	1.331	1.348	1.346
Mo. 16	1.336	1.342	1.317	1.313	1.325	1.317	1.334	1.331
Mo. 18	1.339	1.345	1.317	1.311	1.323	1.314	1.336	1.333
Mo. 20	1.431	1.445	1.377	1.311	1.412	1.314	1.425	1.411
Di. 0	1.434	1.452	1.449	1.380	1.441	1.403	1.440	1.437
Di. 6	1.411	1.406	1.384	1.370	1.393	1.383	1.404	1.400
Di. 12	1.350	1.358	1.339	1.331	1.338	1.333	1.349	1.347
Di. 16	1.337	1.342	1.313	1.314	1.324	1.317	1.334	1.331
Di. 18	1.340	1.344	1.314	1.310	1.321	1.314	1.336	1.333
Di. 20	1.433	1.451	1.377	1.309	1.410	1.315	1.427	1.412
Mi. 0	1.437	1.453	1.453	1.377	1.442	1.404	1.444	1.440
Mi. 6	1.413	1.409	1.378	1.368	1.396	1.382	1.405	1.400
Mi. 12	1.349	1.354	1.335	1.330	1.338	1.332	1.347	1.345
Mi. 16	1.335	1.338	1.313	1.312	1.322	1.315	1.331	1.329
Mi. 18	1.338	1.340	1.313	1.309	1.320	1.311	1.333	1.330
Mi. 20	1.430	1.447	1.376	1.308	1.408	1.310	1.424	1.410
Do. 0	1.434	1.448	1.449	1.372	1.441	1.401	1.440	1.436
Do. 6	1.409	1.408	1.386	1.367	1.400	1.382	1.404	1.400
Do. 12	1.352	1.358	1.337	1.332	1.342	1.334	1.350	1.348
Do. 16	1.337	1.342	1.318	1.314	1.325	1.318	1.334	1.332
Do. 18	1.340	1.344	1.317	1.311	1.322	1.315	1.336	1.333
Do. 20	1.430	1.447	1.378	1.310	1.407	1.315	1.424	1.410
Fr. 0	1.433	1.448	1.446	1.379	1.433	1.404	1.438	1.435
Fr. 6	1.410	1.410	1.383	1.367	1.394	1.381	1.405	1.400
Fr. 12	1.352	1.357	1.337	1.333	1.340	1.333	1.350	1.348
Fr. 16	1.337	1.340	1.315	1.314	1.323	1.318	1.333	1.331
Fr. 18	1.341	1.342	1.314	1.310	1.321	1.314	1.335	1.332
Fr. 20	1.437	1.444	1.372	1.310	1.410	1.315	1.426	1.412
Sa. 0	1.440	1.444	1.443	1.379	1.440	1.404	1.441	1.438
Sa. 6	1.425	1.422	1.406	1.374	1.414	1.394	1.420	1.415
Sa. 12	1.350	1.351	1.333	1.328	1.338	1.329	1.347	1.344
Sa. 16	1.338	1.344	1.325	1.316	1.328	1.317	1.337	1.334
Sa. 18	1.343	1.346	1.324	1.313	1.326	1.315	1.340	1.336
Sa. 20	1.437	1.448	1.374	1.313	1.380	1.316	1.426	1.412
So. 0	1.441	1.447	1.431	1.378	1.422	1.407	1.439	1.436
So. 6	1.429	1.429	1.400	1.378	1.411	1.403	1.423	1.417
So. 12	1.365	1.362	1.344	1.344	1.354	1.342	1.360	1.358
So. 16	1.347	1.350	1.336	1.325	1.337	1.329	1.346	1.343
So. 18	1.352	1.351	1.335	1.322	1.336	1.327	1.348	1.344
So. 20	1.433	1.446	1.387	1.321	1.389	1.328	1.426	1.413

Tabelle 2.20: Preisentwicklung Diesel im Tagesverlauf nach Wochentagen – Leipzig

Tag/Zeit	Aral	Shell	Esso	Jet	Total	NO	Oli4	Oli5
Mo. 0	1.439	1.446	1.436	1.387	1.421	1.408	1.434	1.431
Mo. 6	1.414	1.394	1.405	1.377	1.399	1.386	1.406	1.403
Mo. 12	1.363	1.372	1.358	1.345	1.358	1.346	1.361	1.360
Mo. 16	1.351	1.355	1.337	1.331	1.342	1.332	1.347	1.345
Mo. 18	1.348	1.353	1.334	1.326	1.338	1.326	1.344	1.342
Mo. 20	1.433	1.452	1.408	1.324	1.420	1.327	1.429	1.419
Di. 0	1.438	1.457	1.450	1.392	1.438	1.408	1.441	1.439
Di. 6	1.419	1.402	1.415	1.383	1.408	1.388	1.412	1.410
Di. 12	1.373	1.378	1.370	1.356	1.367	1.356	1.371	1.369
Di. 16	1.358	1.361	1.341	1.343	1.354	1.340	1.356	1.355
Di. 18	1.355	1.360	1.341	1.335	1.350	1.332	1.353	1.351
Di. 20	1.437	1.458	1.411	1.334	1.424	1.334	1.433	1.423
Mi. 0	1.441	1.457	1.453	1.400	1.444	1.411	1.445	1.443
Mi. 6	1.420	1.407	1.416	1.387	1.406	1.392	1.413	1.410
Mi. 12	1.373	1.377	1.376	1.360	1.370	1.358	1.372	1.371
Mi. 16	1.360	1.359	1.347	1.344	1.355	1.341	1.357	1.356
Mi. 18	1.354	1.355	1.345	1.333	1.349	1.333	1.352	1.350
Mi. 20	1.433	1.450	1.411	1.331	1.424	1.334	1.430	1.420
Do. 0	1.437	1.450	1.449	1.394	1.443	1.409	1.441	1.439
Do. 6	1.414	1.409	1.415	1.382	1.405	1.391	1.410	1.407
Do. 12	1.367	1.375	1.366	1.353	1.366	1.353	1.367	1.366
Do. 16	1.353	1.356	1.344	1.337	1.351	1.335	1.352	1.350
Do. 18	1.349	1.354	1.343	1.331	1.346	1.330	1.348	1.347
Do. 20	1.430	1.453	1.411	1.329	1.424	1.331	1.429	1.419
Fr. 0	1.434	1.453	1.447	1.394	1.442	1.409	1.440	1.438
Fr. 6	1.415	1.403	1.409	1.382	1.405	1.388	1.409	1.407
Fr. 12	1.371	1.374	1.369	1.353	1.368	1.355	1.370	1.368
Fr. 16	1.356	1.355	1.343	1.335	1.349	1.335	1.352	1.351
Fr. 18	1.352	1.353	1.341	1.326	1.343	1.327	1.348	1.346
Fr. 20	1.435	1.448	1.408	1.324	1.422	1.328	1.430	1.420
Sa. 0	1.440	1.448	1.440	1.393	1.441	1.411	1.441	1.439
Sa. 6	1.422	1.419	1.426	1.382	1.414	1.397	1.418	1.415
Sa. 12	1.368	1.367	1.371	1.347	1.364	1.352	1.366	1.364
Sa. 16	1.351	1.351	1.345	1.325	1.340	1.329	1.346	1.344
Sa. 18	1.348	1.347	1.343	1.316	1.333	1.322	1.342	1.339
Sa. 20	1.434	1.453	1.401	1.315	1.385	1.323	1.414	1.404
So. 0	1.439	1.453	1.435	1.378	1.416	1.408	1.432	1.430
So. 6	1.418	1.428	1.421	1.379	1.405	1.395	1.414	1.410
So. 12	1.370	1.363	1.366	1.345	1.358	1.349	1.364	1.362
So. 16	1.351	1.352	1.348	1.328	1.343	1.332	1.348	1.346
So. 18	1.350	1.350	1.348	1.325	1.338	1.326	1.345	1.343
So. 20	1.432	1.450	1.410	1.324	1.391	1.328	1.416	1.407

Tabelle 2.21: Preisentwicklung Diesel im Tagesverlauf nach Wochentagen – München

Tag/Zeit	Aral	Shell	Esso	Jet	Total	NO	Oli4	Oli5
Mo. 0	1.441	1.449	1.441	1.389	1.428	1.414	1.442	1.438
Mo. 6	1.417	1.397	1.392	1.374	1.415	1.392	1.405	1.400
Mo. 12	1.363	1.360	1.344	1.329	1.345	1.344	1.357	1.353
Mo. 16	1.349	1.346	1.327	1.320	1.333	1.332	1.342	1.339
Mo. 18	1.348	1.345	1.327	1.318	1.332	1.330	1.341	1.338
Mo. 20	1.435	1.432	1.402	1.317	1.417	1.353	1.425	1.410
Di. 0	1.439	1.453	1.447	1.382	1.438	1.407	1.444	1.438
Di. 6	1.415	1.397	1.389	1.371	1.412	1.385	1.403	1.399
Di. 12	1.361	1.362	1.347	1.331	1.347	1.346	1.357	1.354
Di. 16	1.348	1.344	1.325	1.321	1.333	1.332	1.341	1.338
Di. 18	1.347	1.343	1.325	1.317	1.330	1.329	1.340	1.337
Di. 20	1.435	1.436	1.401	1.317	1.416	1.354	1.426	1.411
Mi. 0	1.440	1.453	1.449	1.382	1.438	1.411	1.445	1.440
Mi. 6	1.414	1.398	1.391	1.372	1.417	1.387	1.404	1.399
Mi. 12	1.361	1.359	1.348	1.330	1.344	1.344	1.356	1.353
Mi. 16	1.348	1.344	1.325	1.321	1.335	1.332	1.341	1.338
Mi. 18	1.346	1.343	1.325	1.317	1.330	1.329	1.339	1.336
Mi. 20	1.433	1.434	1.404	1.317	1.415	1.350	1.426	1.411
Do. 0	1.437	1.449	1.449	1.376	1.438	1.409	1.443	1.437
Do. 6	1.413	1.397	1.396	1.370	1.416	1.386	1.404	1.399
Do. 12	1.362	1.357	1.346	1.329	1.344	1.343	1.356	1.352
Do. 16	1.348	1.345	1.328	1.321	1.336	1.333	1.342	1.339
Do. 18	1.347	1.344	1.327	1.318	1.333	1.334	1.341	1.337
Do. 20	1.430	1.436	1.403	1.317	1.416	1.352	1.425	1.410
Fr. 0	1.434	1.449	1.444	1.382	1.440	1.411	1.440	1.435
Fr. 6	1.413	1.396	1.393	1.370	1.415	1.388	1.404	1.399
Fr. 12	1.364	1.361	1.347	1.332	1.347	1.347	1.358	1.355
Fr. 16	1.353	1.347	1.328	1.323	1.336	1.335	1.344	1.341
Fr. 18	1.351	1.346	1.328	1.320	1.335	1.332	1.343	1.340
Fr. 20	1.438	1.434	1.399	1.320	1.419	1.354	1.427	1.412
Sa. 0	1.442	1.447	1.444	1.382	1.441	1.413	1.444	1.438
Sa. 6	1.422	1.407	1.415	1.378	1.421	1.393	1.416	1.411
Sa. 12	1.370	1.362	1.354	1.335	1.358	1.350	1.363	1.359
Sa. 16	1.355	1.354	1.344	1.329	1.342	1.341	1.352	1.349
Sa. 18	1.355	1.354	1.344	1.327	1.342	1.340	1.351	1.348
Sa. 20	1.439	1.439	1.401	1.327	1.393	1.359	1.428	1.414
So. 0	1.443	1.451	1.437	1.389	1.431	1.415	1.443	1.438
So. 6	1.425	1.420	1.418	1.383	1.423	1.396	1.422	1.416
So. 12	1.381	1.372	1.363	1.340	1.364	1.359	1.373	1.368
So. 16	1.365	1.360	1.353	1.332	1.350	1.349	1.360	1.356
So. 18	1.364	1.358	1.351	1.330	1.349	1.348	1.359	1.355
So. 20	1.434	1.439	1.414	1.330	1.396	1.366	1.429	1.415

Tabelle 2.22: Preisentwicklung Super E10 im Tagesverlauf nach Wochentagen – Köln

Tag/Zeit	Aral	Shell	Esso	Jet	Total	NO	Oli4	Oli5
Mo. 0	1.584	1.581	1.580	1.529	1.572	1.555	1.583	1.579
Mo. 6	1.563	1.552	1.533	1.522	1.548	1.534	1.554	1.550
Mo. 12	1.501	1.501	1.484	1.481	1.489	1.482	1.498	1.495
Mo. 16	1.487	1.487	1.469	1.464	1.477	1.467	1.484	1.481
Mo. 18	1.490	1.490	1.468	1.462	1.475	1.464	1.485	1.482
Mo. 20	1.577	1.586	1.525	1.462	1.558	1.465	1.570	1.556
Di. 0	1.580	1.593	1.589	1.533	1.585	1.551	1.584	1.581
Di. 6	1.560	1.556	1.536	1.522	1.546	1.534	1.554	1.550
Di. 12	1.504	1.508	1.493	1.486	1.493	1.488	1.503	1.500
Di. 16	1.491	1.490	1.468	1.468	1.478	1.470	1.486	1.484
Di. 18	1.494	1.492	1.468	1.464	1.476	1.467	1.488	1.485
Di. 20	1.582	1.592	1.527	1.464	1.556	1.468	1.573	1.560
Mi. 0	1.585	1.593	1.594	1.531	1.586	1.552	1.588	1.585
Mi. 6	1.562	1.559	1.528	1.520	1.547	1.533	1.554	1.550
Mi. 12	1.501	1.503	1.487	1.483	1.490	1.484	1.499	1.497
Mi. 16	1.487	1.484	1.466	1.464	1.475	1.467	1.482	1.480
Mi. 18	1.490	1.486	1.465	1.461	1.473	1.463	1.484	1.481
Mi. 20	1.580	1.589	1.525	1.460	1.555	1.462	1.572	1.558
Do. 0	1.584	1.590	1.591	1.527	1.586	1.551	1.587	1.583
Do. 6	1.561	1.558	1.536	1.522	1.550	1.534	1.555	1.551
Do. 12	1.506	1.506	1.490	1.486	1.497	1.488	1.503	1.501
Do. 16	1.490	1.488	1.471	1.467	1.478	1.470	1.486	1.483
Do. 18	1.494	1.490	1.470	1.464	1.475	1.468	1.488	1.485
Do. 20	1.580	1.592	1.529	1.463	1.554	1.468	1.573	1.559
Fr. 0	1.583	1.593	1.590	1.532	1.579	1.555	1.586	1.583
Fr. 6	1.562	1.562	1.533	1.521	1.546	1.534	1.556	1.552
Fr. 12	1.506	1.507	1.490	1.488	1.495	1.488	1.503	1.501
Fr. 16	1.492	1.490	1.470	1.469	1.479	1.472	1.487	1.485
Fr. 18	1.496	1.491	1.470	1.465	1.477	1.468	1.489	1.486
Fr. 20	1.586	1.589	1.523	1.465	1.558	1.469	1.574	1.561
Sa. 0	1.589	1.588	1.587	1.534	1.586	1.554	1.588	1.585
Sa. 6	1.574	1.568	1.554	1.529	1.562	1.544	1.568	1.564
Sa. 12	1.502	1.499	1.484	1.480	1.489	1.481	1.497	1.495
Sa. 16	1.490	1.489	1.475	1.466	1.480	1.468	1.487	1.484
Sa. 18	1.494	1.491	1.475	1.464	1.479	1.466	1.489	1.486
Sa. 20	1.584	1.591	1.525	1.463	1.531	1.467	1.572	1.558
So. 0	1.587	1.589	1.577	1.531	1.573	1.555	1.585	1.582
So. 6	1.575	1.576	1.551	1.530	1.562	1.551	1.570	1.565
So. 12	1.517	1.509	1.495	1.496	1.505	1.493	1.510	1.508
So. 16	1.499	1.497	1.486	1.477	1.487	1.480	1.496	1.493
So. 18	1.503	1.498	1.485	1.474	1.486	1.477	1.497	1.494
So. 20	1.579	1.588	1.534	1.473	1.538	1.478	1.571	1.558

Tabelle 2.23: Preisentwicklung Super E10 im Tagesverlauf nach Wochentagen – Leipzig

Tag/Zeit	Aral	Shell	Esso	Jet	Total	NO	Oli4	Oli5
Mo. 0	1.582	1.584	1.578	1.536	1.564	1.553	1.575	1.574
Mo. 6	1.559	1.539	1.550	1.526	1.545	1.533	1.551	1.548
Mo. 12	1.512	1.517	1.503	1.491	1.505	1.493	1.509	1.507
Mo. 16	1.502	1.498	1.486	1.477	1.490	1.480	1.496	1.494
Mo. 18	1.500	1.496	1.485	1.472	1.487	1.474	1.493	1.491
Mo. 20	1.579	1.592	1.558	1.471	1.562	1.473	1.572	1.562
Di. 0	1.584	1.596	1.590	1.545	1.577	1.555	1.583	1.582
Di. 6	1.567	1.551	1.560	1.535	1.555	1.538	1.560	1.558
Di. 12	1.519	1.523	1.520	1.501	1.514	1.504	1.517	1.516
Di. 16	1.504	1.503	1.486	1.487	1.499	1.486	1.501	1.500
Di. 18	1.501	1.502	1.486	1.481	1.495	1.479	1.498	1.497
Di. 20	1.583	1.597	1.558	1.480	1.566	1.478	1.576	1.567
Mi. 0	1.587	1.596	1.594	1.546	1.582	1.557	1.587	1.585
Mi. 6	1.564	1.552	1.560	1.535	1.551	1.538	1.557	1.555
Mi. 12	1.518	1.524	1.520	1.505	1.515	1.504	1.517	1.516
Mi. 16	1.505	1.504	1.487	1.489	1.499	1.487	1.502	1.500
Mi. 18	1.501	1.498	1.487	1.479	1.494	1.479	1.497	1.495
Mi. 20	1.581	1.592	1.560	1.478	1.566	1.477	1.575	1.566
Do. 0	1.586	1.592	1.592	1.543	1.583	1.556	1.586	1.584
Do. 6	1.563	1.555	1.562	1.533	1.553	1.540	1.558	1.555
Do. 12	1.516	1.521	1.513	1.501	1.514	1.502	1.516	1.514
Do. 16	1.503	1.500	1.490	1.485	1.497	1.484	1.500	1.498
Do. 18	1.501	1.498	1.488	1.478	1.494	1.479	1.497	1.496
Do. 20	1.579	1.597	1.560	1.476	1.568	1.477	1.575	1.566
Fr. 0	1.583	1.597	1.591	1.544	1.582	1.558	1.585	1.583
Fr. 6	1.565	1.552	1.556	1.532	1.551	1.537	1.557	1.555
Fr. 12	1.516	1.518	1.511	1.497	1.512	1.500	1.514	1.513
Fr. 16	1.504	1.498	1.488	1.481	1.494	1.482	1.498	1.497
Fr. 18	1.501	1.496	1.487	1.475	1.489	1.475	1.495	1.493
Fr. 20	1.584	1.593	1.557	1.472	1.564	1.473	1.576	1.566
Sa. 0	1.589	1.593	1.584	1.543	1.583	1.559	1.587	1.585
Sa. 6	1.570	1.564	1.571	1.532	1.560	1.545	1.565	1.562
Sa. 12	1.517	1.517	1.515	1.497	1.512	1.499	1.515	1.513
Sa. 16	1.502	1.498	1.493	1.473	1.490	1.477	1.496	1.494
Sa. 18	1.499	1.494	1.492	1.466	1.484	1.470	1.492	1.489
Sa. 20	1.581	1.596	1.550	1.465	1.536	1.469	1.562	1.553
So. 0	1.586	1.595	1.577	1.530	1.566	1.556	1.579	1.577
So. 6	1.566	1.573	1.567	1.528	1.553	1.543	1.561	1.558
So. 12	1.519	1.509	1.513	1.492	1.506	1.496	1.512	1.510
So. 16	1.500	1.496	1.496	1.473	1.489	1.477	1.495	1.493
So. 18	1.499	1.493	1.495	1.470	1.485	1.472	1.492	1.490
So. 20	1.577	1.589	1.559	1.469	1.538	1.471	1.561	1.552

Tabelle 2.24: Preisentwicklung Super E10 im Tagesverlauf nach Wochentagen – München

Tag/Zeit	Aral	Shell	Esso	Jet	Total	NO	Oli4	Oli5
Mo. 0	1.582	1.586	1.581	1.535	1.565	1.556	1.582	1.578
Mo. 6	1.559	1.537	1.534	1.517	1.555	1.538	1.547	1.543
Mo. 12	1.506	1.501	1.488	1.474	1.486	1.486	1.499	1.496
Mo. 16	1.492	1.486	1.472	1.467	1.477	1.475	1.485	1.482
Mo. 18	1.491	1.485	1.472	1.464	1.476	1.474	1.484	1.481
Mo. 20	1.577	1.572	1.549	1.463	1.556	1.496	1.568	1.553
Di. 0	1.581	1.591	1.587	1.532	1.575	1.552	1.585	1.580
Di. 6	1.560	1.542	1.535	1.519	1.554	1.533	1.549	1.544
Di. 12	1.507	1.505	1.491	1.476	1.492	1.489	1.502	1.498
Di. 16	1.493	1.487	1.470	1.467	1.478	1.476	1.485	1.483
Di. 18	1.492	1.486	1.470	1.464	1.477	1.473	1.484	1.481
Di. 20	1.580	1.577	1.547	1.463	1.556	1.498	1.570	1.555
Mi. 0	1.584	1.592	1.589	1.531	1.575	1.556	1.587	1.582
Mi. 6	1.560	1.543	1.535	1.519	1.558	1.535	1.550	1.545
Mi. 12	1.504	1.501	1.489	1.472	1.485	1.487	1.499	1.495
Mi. 16	1.491	1.486	1.470	1.465	1.476	1.473	1.484	1.481
Mi. 18	1.489	1.485	1.470	1.462	1.474	1.471	1.483	1.480
Mi. 20	1.580	1.577	1.551	1.462	1.554	1.493	1.571	1.555
Do. 0	1.584	1.590	1.591	1.525	1.573	1.553	1.587	1.581
Do. 6	1.562	1.544	1.541	1.519	1.559	1.535	1.552	1.547
Do. 12	1.508	1.501	1.490	1.473	1.490	1.487	1.501	1.497
Do. 16	1.493	1.488	1.473	1.467	1.481	1.475	1.486	1.483
Do. 18	1.491	1.487	1.473	1.465	1.478	1.477	1.485	1.482
Do. 20	1.578	1.580	1.551	1.464	1.557	1.497	1.571	1.556
Fr. 0	1.581	1.592	1.587	1.531	1.579	1.557	1.585	1.580
Fr. 6	1.561	1.543	1.537	1.519	1.561	1.538	1.551	1.546
Fr. 12	1.511	1.506	1.493	1.479	1.494	1.493	1.504	1.501
Fr. 16	1.498	1.493	1.475	1.472	1.483	1.480	1.490	1.488
Fr. 18	1.496	1.492	1.475	1.468	1.482	1.478	1.489	1.486
Fr. 20	1.584	1.578	1.547	1.468	1.560	1.500	1.573	1.558
Sa. 0	1.588	1.590	1.588	1.533	1.581	1.559	1.588	1.583
Sa. 6	1.568	1.549	1.560	1.527	1.567	1.542	1.561	1.556
Sa. 12	1.514	1.504	1.498	1.480	1.502	1.494	1.507	1.503
Sa. 16	1.499	1.495	1.487	1.474	1.486	1.485	1.494	1.491
Sa. 18	1.499	1.494	1.486	1.473	1.486	1.483	1.494	1.491
Sa. 20	1.583	1.581	1.545	1.472	1.536	1.503	1.571	1.557
So. 0	1.586	1.591	1.578	1.536	1.570	1.560	1.585	1.580
So. 6	1.569	1.562	1.561	1.530	1.566	1.544	1.565	1.560
So. 12	1.524	1.513	1.506	1.484	1.507	1.503	1.516	1.511
So. 16	1.508	1.502	1.495	1.476	1.493	1.492	1.502	1.499
So. 18	1.507	1.500	1.494	1.474	1.492	1.491	1.501	1.497
So. 20	1.578	1.580	1.558	1.474	1.539	1.510	1.571	1.558

Tabelle 2.25: Deskriptive Statistik für die Preiserhöhungssamples – Aral

Akteur Aral

Variable	N	Mittelwert	SD	Min	Max
Aktion Aral	452	9.4	1.85	2.82	14.19
Aral	452	8.1	1.66	1.61	12.41
Shell	452	10.44	3.49	-3.25	16
Jet	452	6.99	1.12	3	11.18
NO	452	8.18	1.31	1.91	10.86
Aral 18 Uhr Diesel	226	133.66	1.91	129.66	139.4
Shell 18 Uhr Diesel	226	133.52	1.85	129.79	141.05
Jet 18 Uhr Diesel	226	131.07	1.78	127.63	138.2333
NO 18 Uhr Diesel	226	131.49	1.82	127.59	137.5897
Aral 18 Uhr E10	226	148.11	1.89	144.69	153.56
Shell 18 Uhr E10	226	147.64	2.26	142.96	154.51
Jet 18 Uhr E10	226	145.60	1.91	141.40	150.57
NO 18 Uhr E10	226	145.88	1.86	141.44	150.97
E10	452	0.5		0	1
Montag	452	0.10		0	1
Dienstag	452	0.15		0	1
Mittwoch	452	0.16		0	1
Donnerstag	452	0.12		0	1
Freitag	452	0.16		0	1
Samstag	452	0.14		0	1
Sonntag	452	0.17		0	1
Wochenende/Feiertag§	452	0.31		0	1
Ferien	452	0.08		0	1
Marktanteil Oli4	452	54.07	6.91	45.16	60.87
Marktanteil Oli5	452	61.8	8.48	50	70.08
Handelspreis Diesel~	226	126.13	1.21	123.52	129.00
Änderung Handelsp. Diesel#	226	-0.05	0.34	-0.69	0.81
Handelspreis E10~	226	141.21	2.00	137.03	145.24
Änderung Handelspreis E10#	226	-0.01	0.33	-0.86	1.36

§Samstage, Sonntage und gesetzliche Feiertage; ~Großhandelspreis in der jeweiligen Region; #Änderungsrate Großhandelspreis im Vgl. zum Vortag in der Region in Prozent

Tabelle 2.26: Deskriptive Statistik für die Preiserhöhungssamples – Shell

Akteur Shell

Variable	N	Mittelwert	SD	Min	Max
Aktion Shell	462	9.69	2.59	2.31	16
Shell	462	9.38	3.2	0	16
Aral	462	8.15	1.68	0	12.34
Jet	462	6.03	1.43	-0.04	8.64
NO	462	8.08	1.31	1.77	11.94
Aral 18 Uhr Diesel	231	134.87	1.51	131.62	139.79
Shell 18 Uhr Diesel	231	135.34	1.67	130.76	139.95
Jet 18 Uhr Diesel	231	132.09	1.60	128.72	135.90
NO 18 Uhr Diesel	231	132.60	1.73	128.67	137.30
Aral 18 Uhr E10	231	150.46	1.64	144.27	155.73
Shell 18 Uhr E10	231	150.38	1.55	143.66	155.23
Jet 18 Uhr E10	231	147.66	1.71	141.70	152.90
NO 18 Uhr E10	231	148.12	1.72	142.33	152.82
E10	462	0.5		0	1
Montag	462	0.15		0	1
Dienstag	462	0.14		0	1
Mittwoch	462	0.12		0	1
Donnerstag	462	0.16		0	1
Freitag	462	0.14		0	1
Samstag	462	0.16		0	1
Sonntag	462	0.13		0	1
Wochenende/Feiertag§	462	0.35		0	1
Ferien	462	0.15		0	1
Marktanteil Oli4	462	53.8	6.96	45.16	60.87
Marktanteil Oli5	462	61.46	8.58	50	70.08
Handelspreis Diesel~	231	126.92	1.06	124.12	129.09
Änderung Handelsp. Diesel#	231	0.01	0.31	-1.03	1.09
Handelspreis E10~	231	143.21	1.38	137.92	145.66
Änderung Handelspreis E10#	231	0.05	0.27	-0.75	1.19

§Samstage, Sonntage und gesetzliche Feiertage; ~Großhandelspreis in der jeweiligen Region; #Änderungsrate Großhandelspreis im Vgl. zum Vortag in der Region in Prozent

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3. Collusive Upward Gasoline Price Movements in Medium-Sized German Cities

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Abstract

Following the publication of international literature about Edgeworth Cycles, German gasoline prices have been the centre of empirical analysis in the past few years, primarily due to the up-coming availability of Market Transparency Price Data. It remains theoretically and empirically unclear why gasoline stations initiate the "war of attrition" and go up on prices. Assuming strong competitive links between stations located in German cities with populations between 60,000 and 100,000 inhabitants and using 2014 Market Transparency Price Data from four months, we analyse which brands lead price increases, the first average price mark-up in the evening, and the following price development. Furthermore, we measure the response time it takes for competitors to react to price increases and how much prices change. By watching the local activities of big brands, it is possible to measure how smaller businesses, such as Jet and independent retailers, react to Aral's and Shell's price changes. Multivariate estimations allow for control of the market structure, wholesale and initial price level. Descriptive results show that Aral (or Shell) will start a round of price increases, and then Shell (or Aral) will more or less immediately follow. Total, Esso and Non-Oligopolists react within one to two hours. Jet behaves more as an "outsider" with later reaction times and lower price mark-ups. Multivariate estimations indicate that the single cause "price change by competitors" is less important and nearly irrelevant for Jet. Logit estimations, including market conditions, are not able to explain why the companies initiate up-ward price movements. Hence, parallel behaviour of gas stations seems less likely, if multivariate estimations are used compared to simple descriptive checks.

JEL Classification: L13, L41, L81

Keywords: Market Power, Collusive Behaviour, Gasoline Market

3.1. Introduction

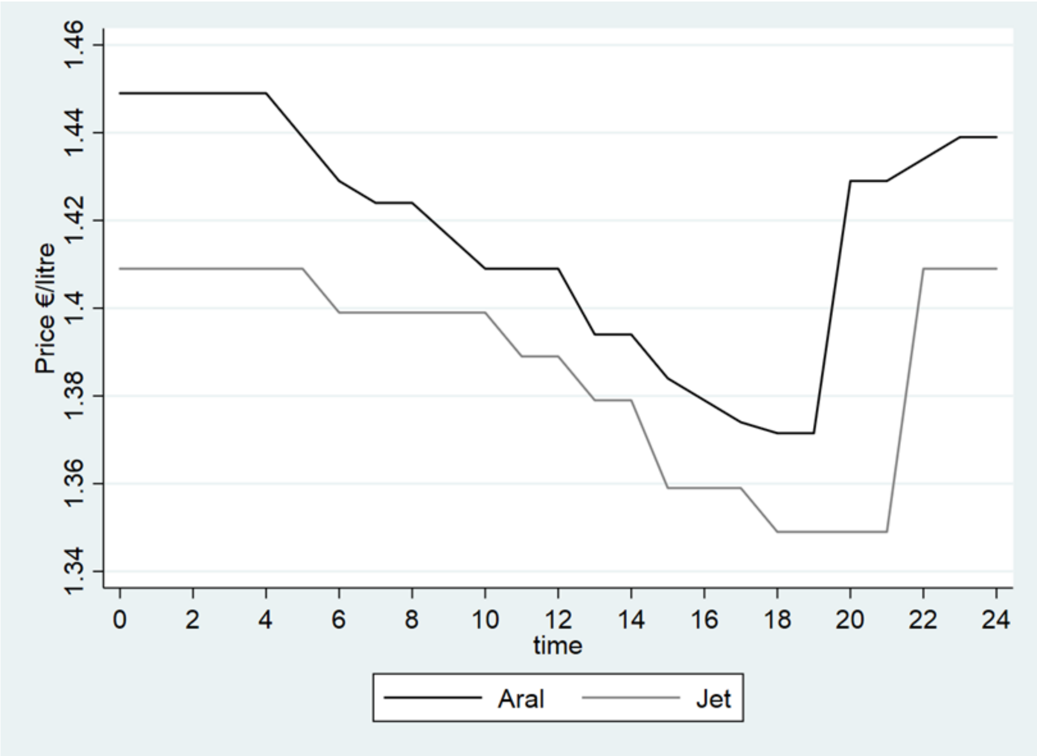
For many years, certain price patterns have been observed in retail gasoline markets, which are recurring monthly, weekly or daily. Allvine and Patterson (1974) were the first to empirically show for the U.S. that gasoline prices increase by large amounts within a relatively short period and slowly fall back to the initial levels, virtually independently of wholesale prices. Maskin and Tirole (1988) were able to explain this cyclical behavior with a dynamic pricing model – the so-called Edgeworth Price Cycles. The duopolists gradually undercut each other in price in small steps until marginal costs are reached. In this situation, one firm, given a certain probability, increases the price significantly and the other does the same afterwards to a somewhat lower level. Subsequently, underbidding begins again. This results in an asymmetric price cycle with many price reductions and only a few large price increases. Model extensions showed that the price increases are carried out by large firms and price reductions by small firms (Eckert 2003).

Researchers recently found price patterns that are very similar to those of Edgeworth Price Cycles for the U.S. (Zimmerman et al. 2013), Canada (Atkinson et al. 2014), Australia (de Roos and Katayama 2013) and Norway (Foros and Steen 2013). In the German market, the Federal Cartel Office also revealed price cycles in an investigation conducted between the beginning of 2007 and mid-2010 (Bundeskartellamt 2011). Daily and weekly price patterns were surveyed for four metropolises in Germany, with price increases mainly taking place in the evening. Most of these were carried out by two major companies – Aral and Shell – with the other company adjusting prices very quickly. The other oil companies did so later. A follow-up study showed that at the beginning of 2014 a daily price pattern was apparent in eight German metropolises. Starting from a relatively high price level at night, all petrol stations gradually lower their prices over the course of the day until the price level rises rapidly at 8 p.m. (Bundeskartellamt 2014). Neukirch and Wein (2016) showed that in the months March to May and September 2014 almost all price increases in the evening were started by Shell or Aral. Both brands followed the price changes of the other within an average of five to thirty minutes. The other companies, mostly with fewer petrol stations, only increased prices after one to three hours.

However, these investigations refer exclusively to a few metropolises, so the question arises whether these evening price increases also occur in other German cities and are only carried out by the major oil companies? Therefore, we examine in this paper the evening price increases in over 50 German cities with a population between 60,000 and 100,000 inhabitants.

Figure 3.1 shows an example of the price development for diesel in Bamberg – a Bavarian city with almost 76,000 inhabitants – for the brands Aral and Jet. The asymmetrical pattern of many price reductions over the course of the day and few increases in the evening can also be seen in this case. Whereby Jet, a price-aggressive brand, has an overall lower price level and carries out the price hike much later.

Figure 3.1: Price development in Bamberg – 06.03.2014 – Diesel



Note: Hourly average prices of the brands Aral and Jet in Bamberg

We proceed as follows: Section 3.2 reviews the relevant literature and Section 3.3 discusses the data as well as the methodology. Section 3.4 shows descriptively which companies implement the price increases and how the other companies subsequently behave in pricing. In section 3.5, we use OLS regressions to examine to what extent the "reaction" of some competitors can be explained by a price increase. Furthermore, we use a logit regression to explain in which situations a brand takes the price leadership. The final part, Section 3.6, includes the summary and conclusions of our results.

3.2. Literature

Price studies concerning retail gasoline markets inevitably come back to the phenomena of Edgeworth Price Cycles. Edgeworth (1925) argued that in an oligopolistic market with capacity-constrained firms, cyclical pricing is more likely than stable prices. If two firms undercut each other in price in small steps, at a certain point it is more profitable for one firm to increase the price and serve the remaining demand – as already mentioned above. Allvine and Patterson (1974) were the first to empirically demonstrate this asymmetric pricing for the U.S. gasoline market. Independently of these observations, Maskin and Tirole (1988) formalized such cyclical pricing pattern as a possible result of a dynamic duopoly game, without an exogenous demand or cost shock. Castanias and Johnson (1993) were the first to combine empirical results with the theory of Maskin and Tirole (1988).

Model extensions showed that Edgeworth Price Cycles continue to exist if products are slightly differentiated, a triopoly is assumed (Noel 2008) or that a greater asymmetry in the size of the duopolists leads to more cycles, with increases being made by large firms and decreases by small firms (Eckert 2003). These patterns recently could be empirically proven for the U.S. (Zimmerman et al. 2013), Canada (Atkinson et al. 2014), Australia (de Roos and Katayama 2013) and Norway (Foros and Steen 2013).

In an official investigation of the Federal Cartel Office, intraday price developments were analyzed for the first time in Germany. The inquiry lasted from January 2007 to June 2010 in the metropolitan regions of Cologne, Hamburg, Leipzig and Munich. They discovered that Shell's dominant price increases[1] mostly occurred in the early evening hours from 6 to 7 p.m. Immediately following, 90 percent of all Aral stations increased their prices. Shell reacted exactly the same way when Aral increased prices first. 70 percent of all regional Esso stations followed suit, but had a regional time difference of between three and six hours after the initial price change. Jet followed the price increase after five hours, or, at the latest, the following morning. (Bundeskartellamt 2011)

One consequence of this report was that the Market Transparency Office for Fuels was established at the end of 2013. This means that all petrol stations are obliged to report their prices to the competition authority in real time. The data collected should improve the Cartel Office's ability to intervene in cases of abuse of market power on the one hand and increase price transparency for consumers on the other. For this purpose, the reported prices are made available via the Internet or apps. In 2014, the German Cartel Office conducted the first follow-up analysis to their previous study using the new data (Bundeskartellamt 2014). Furthermore, they added the metropolitan regions of Berlin, Frankfort (Main), Stuttgart and Dresden to the four regions looked at in the previous study. They found price increases mostly occurred between 8 p.m. and midnight. From 8 to 9 p.m., Aral and Shell led the increases. Esso and Jet always responded with a price increase after 9 p.m. Jet often made their change at 11 p.m. or later.

Neukirch and Wein (2016) also used this new data for their study, which focused on the months of March to May and September of 2014. Nearly half of all evening price increases were started by Shell or Aral. Both brands followed each other's price changes within an average of five to thirty minutes. Esso and Total did not respond until between one and one and a half hour. Jet usually reacted even later, mostly after two and a half hours. Holding all other relevant factors constant, Shell increased their price by 1 to 1.2 ct. after Aral led in the price increase with 1 ct. Aral's reaction to Shell's price increase was weaker, by roughly 0.2 ct. in the case of a 1 ct. higher leading price. Jet always reacted with the lowest price changes, between 0.04 and 0.35 ct.

[1] More than 50 percent of all brand specific gasoline stations within one region.

The German Cartel Office's second report expanded their scope of data through the end of May 2015, and clearly showed that major price increases happened between 6 p.m. and midnight (Bundeskartellamt, 2015). The results were confirmed by a third report, which covered the rest of 2015 to May 2016 (Bundeskartellamt 2017).

There are few intraday price analysis studies outside of Germany. Atkinson (2009) found that both national major gasoline companies in Canada executed price increases mainly in the mid-afternoon. Data included eight daily price checks at individual stations in the summer and fall of 2005. Lewis (2012) found a highly vertical integrated brand often caused price increases for stations in the Midwestern United States after analyzing price data three times per day. Foros and Steen (2013) found that Norwegian gasoline stations simultaneously charged the same prices every Monday around noon.

Collective price movements are likely using illegal collusive agreements. For example, Wang (2008) clearly showed that the number of telephone calls between competitively related companies increased during rounds of upward price movements. Clark and Houde (2013) found the same effect for retailers in Quebec. Price leadership from the four major companies in Norway was enhanced by the publicly available price recommendations provided by Statoil, Shell and one unpublished major between the years of 2003 to 2006 (Foros and Steen 2013). Western Australia introduced a rule in 2001 to restrict the number of daily price changes to one, which effectively changed the pattern of price leadership. Three major companies now share the role of starting the price increases, compared to one price-leader in the pre-regulation-period (Wang 2009).

The German Market Transparency Unit Data allows us to analyze price adoption processes on seconds-based data. Combining that information with relevant local market relationships, we are able to exactly describe which brands are starting price increases, what amounts they are choosing to increase by, which brands react to upward price movements, how long the reactions last, and how strong each brand reacts. In contrast to other studies (Neukirch and Wein (2016) and Bundeskartellamt (2011, 2014)), we do not focus on metropolitan regions and instead examine cities with a population of 60,000 to 100,000.

3.3. Data

We use data from the consumer information service provider *clever-tanken.de* for 115 days taken from the months March, April, May and September of 2014[2]. We consider the fuel types Diesel and Super E10[3], which are not regarded as substitutes for consumer due to engine requirements. Motorway petrol stations are seen as an independent market (Bundeskartellamt 2011) and are therefore excluded from this analysis. All prices are final consumer prices in Eurocent per litre

[2] All variables are available for 03/04-03/31/2014, 04/02-04/15/2014, 04/17-04/27/2014, 04/29-06/01/2014 and 09/03-09/30/2014.

[3] Super E10 is a fuel mixture of 10% ethanol and 90% gasoline.

including taxes and duties. Retail prices higher than two Euro per litre are probably entry errors and are excluded from the dataset along with prices that remained fixed for over one week.
We allocate stations to the group of the "five-company oligopoly" suspected by the Federal Cartel Office, formed by Aral (BP), Shell, Esso (ExxonMobil), Total, and Jet (Phillips 66), which have a nationwide network of gasoline stations and access to refinery capacities in Germany. All other stations are assigned to the group of Non-oligopolists (NO).
In contrast to Neukirch and Wein (2016) and the Bundeskartellamt (2011, 2014), we do not focus on metropolitan regions, instead on cities with a population of between 60,000 and 100,000 inhabitants[4]. In this way, we can examine the influence of different brand structures on pricing. Table 3.1 shows how mid-sized German cities differ according their market structure. We ignore specific combinations which occurred less than five times[5]. Thus, in the analysis we consider 52 cities with diesel stations and 51 cities with Premium E10.
In the most frequent market structure, twelve cities have stations from each of the oligopolists, except for Total. This market structure contains 178 suppliers, with 37 Aral, 20 Shell, 21 Jet, 18 Esso and 82/80 Non-Oligopolists stations. The second most frequent market structure, which includes all oligopolists, has roughly 140 stations. Local markets without Jet and Total, as well as markets without Esso, are found in seven cities. Jet is not represented in six cities. A restricted supply side without Esso and Jet is found in five cities. Exclusions of Esso and Total exist in six cities concerning Diesel supply and five without Weimar for Premium E10.

Table 3.1: Market Structure – Diesel/E10 (52/51 Regions)

Market Structure	Aral	Shell	Esso	Total	Jet	NO	Number of Stations	Regions
All majors	21/21	20/20	15/15	13/13	12/12	64/59	145/140	9/9
Without Jet	17/16	11/11	9/9	10/10		39/36	86/82	6/6
Without Total	37/37	20/20	18/18		21/21	82/80	178/176	12/12
Without Esso	18/18	13/13		11/11	11/11	57/49	110/102	7/7
Aral, Shell, Esso	15/15	18/18	11/11			50/47	94/91	7/7
Aral, Shell, Total	12/12	9/9		5/5		33/32	59/58	5/5
Aral, Shell, Jet	11/9	11/10			8/6	55/50	85/75	6/5
Sum	131/128	102/101	53/53	39/39	52/50	380/353	757/724	52/51

Table 3.11 in the Appendix shows the included 52/51 cities, their market structure and the total number of filling stations by brand. In mid-sized cities, there are between ten and twenty petrol stations. Aral and Shell are active in all cities and operate a maximum of five stations per city. One or two of either Esso, Total or Jet are active in each city. The Non-Oligopolists play a crucial role in these markets because they make up one-half to three quarters of all existing stations. In sum,

[4] Cities/Regions are defined by the postal code.
[5] A change of the market structure due to openings and closures of petrol stations is possible. The cities Minden and Rheine change into a non-considered market structure category during the period.

more than 720 stations are included in the data. Roughly 30 percent of the stations belong to Aral or Shell, and more than one half are other brands outside the oligopoly. The Appendix shows two maps with the locations of the included gasoline stations (Figure 3.3). Most cities are probably not interconnected because the distances between them are relatively large, but competitive relations between cities are possible in North Ruhr and Lower Rhine (Figure 3.4).

This paper focuses on the price increases in the evening and the subsequent behavior of the different brands. Table 3.2 shows all price increases in our dataset at different time intervals. More than 77 percent of all price increases occur between 6 p.m. and 10 p.m.[6]. In addition, the majority of petrol stations are not open 24 hours a day. According to Figure 3.2, at 10 p.m. only almost half of all petrol stations are still active[7]. We are therefore concentrating on the period between 6 p.m. and 10 p.m., as more of the price increases take place during this time and a large number of petrol stations are open.

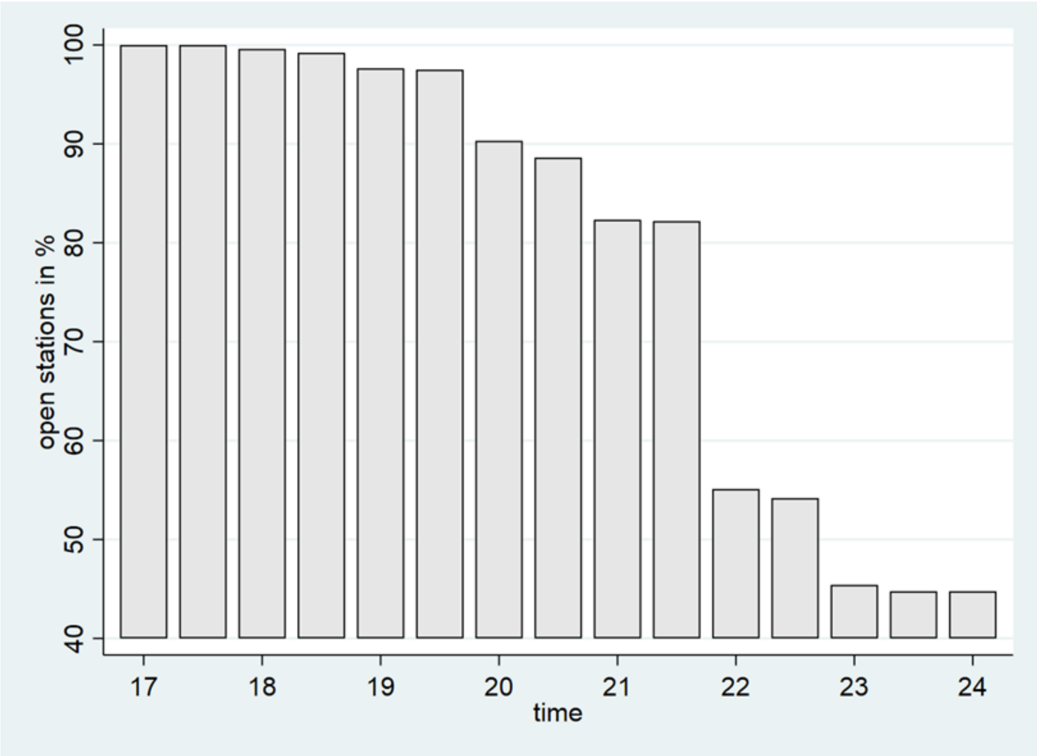
Table 3.2: Upward Price Movements – Number of Price Increases in 52/51 Regions

	Diesel		E10	
Time	Absolute	Percentage	Absolute	Percentage
00-06	7713	7.8%	6222	6.7%
06-12	7774	7.9%	6801	7.3%
12-18	2395	2.4%	2144	2.3%
18-20	35488	36.1%	34666	37.5%
20-22	39986	40.7%	38134	41.2%
22-24	4994	5.1%	4599	5.0%
Sum	98350	100%	92566	100%

[6] There is no pricing regulation in the German fuel retail market (e.g. Austria or Australia), thus the number and height of price changes is not limited.

[7] In Castrop-Rauxel and Gera the only Total petrol station and the only Esso station in Bamberg closes before 10 p.m.

Figure 3.2: Number of open petrol stations in percent



Note: The dates of the opening hours were provided by Petrolview

It is important to point out that price reductions are usually implemented by fuel companies at individual stations at different times, while price increases take place simultaneously in one or more regions with the other companies taking part. The result is an alternating increase of the price level by the different brands, the so-called "round of price increases" within one day. In line with the Federal Cartel Office's definition (Bundeskartellamt 2011), we define the first dominant price increase, which is carried out simultaneously by at least 50 percent of the petrol stations of a brand in a region, as the start of a round of price increases.

Table 3.3 shows the absolute number and percentage value of rounds of price increase per brand. Starting with timespans after 6 p.m., Aral and Shell are unambiguously responsible for upward price rounds. Regardless of the market structure, Shell is the price leader in roughly 50 percent of all cases, with Aral leading in slightly less than 50 percent. The three other players – Esso, Total and Jet as well as the so-called Non-Oligopolists – almost never start price increasing rounds.

Table 3.3: Number of Rounds of Price Increases after 6 p.m. – Diesel/E10

Market Structure	Aral	Shell	Esso	Total	Jet	Diesel/E10
All Majors	518/522	527/522	22/23	47/47	-	1114/1114
Without Jet	270/296	387/383	22/8	11/3	-	690/690
Without Total	594/600	760/757	22/20	-	2/1	1378/1378
Without Esso	342/340	378/377	-	5/8	1/1	726/726
Aral, Shell, Esso	370/372	424/425	10/9	-	-	804/806
Aral, Shell, Total	259/260	310/309	-	6/6	-	575/575
Aral, Shell, Jet	239/186	324/263	-	-	3/2	566/451
Sum	2592/2576	3110/3036	76/60	69/64	6/4	5853/5740
All Majors	46%/47%	47%/47%	2%/2%	4%/4%	-	100%/100%
Without Jet	39%/43%	56%/56%	3%/1%	2%/0%	-	100%/100%
Without Total	43%/44%	55%/55%	2%/1%	-	0%/0%	100%/100%
Without Esso	47%/47%	52%/52%	-	1%/1%	0%/0%	100%/100%
Aral, Shell, Esso	46%/46%	53%/53%	1%/1%	-	-	100%/100%
Aral, Shell, Total	45%/45%	54%/54%	-	1%/1%	-	100%/100%
Aral, Shell, Jet	42%/41%	57%/58%	-	-	1%/0%	100%/100%

Due to the high number of rounds of price increases initiated by the two largest petrol station operators in Germany (Aral and Shell), we restrict the following analysis to these. Tables 3.4 and 3.5 give an overview of the variables contained in the data set for price increase rounds initiated by Aral and Shell respectively.

The first variable in Table 3.4 is the dominant price increase[8] of Aral (*Aral first up*), whereas the respective "first strike" of Shell (*Shell first up*) is shown in Table 3.5.

The following five variables reflect the first price change of the other four, so-called oligopolists, and the Non-Oligopolists after the start of the round of price increases. It is noticeable that the premium brands Aral and Shell have the highest average values. Jet, compared to the others and in particular to the Non-Oligopolists, performs the lowest price increases. The brands Esso and Total show the highest deviation from the mean.

The second block of variables (*share*) reflects the share of participating gas stations per brand in the first strike, as well as the "counterstrike". In the case of the latter, more than 50 percent of the stations participate independently of the brand. Only the proportion of Non-Oligopolists is lower due to the aggregation of different smaller brands. The analysis also considers the start time of the dominant price increase and the first price change of the competitors (*time*).

Average prices before the first dominant price increase are shown in Table 3.4 and 3.5 (*baseline price*), which shows Aral and Shell, followed by Esso and Total, charge the highest prices, and that Jet is cheaper than the independent petrol station operators are. Variables that specify the average price difference between the baseline price and the price at 10 p.m. are marked with *"total +"*. It

[8] All prices or price changes, excluding the wholesale prices, are final consumer prices in Eurocent per litre including taxes and duties.

is evident that Aral and Shell do not significantly change their prices after the first increase at 10 p.m. However, Esso, Total, and Jet continue to raise prices after the first reaction.

In order to shed some light on these results, it is helpful to consider these findings in more detail separately for the different market structures (see Section 3.4) and to control for other possible influencing factors (see Section 3.5). Therefore, the dataset is extended by the market structure as a dummy variable. The number of petrol stations of a brand provides information about the competitive situation. The most important cost factor (*wholesale prices*) were collected by the price information service provider *Oil Market Report (O.M.R.)*. The average daily gross wholesale prices in Eurocent per liter are available for eight German refinery centers.[9] Stations in the 51/52 regions were assigned to the nearest center. Since information is not available for weekends, the price from the previous Friday is used. In addition, we calculated the percentage change of the wholesale price compared to the previous day (*change of wholesale price*). Table 3.12 and 3.13 in the Appendix provide a descriptive overview of the control variables weekday, school holidays, and public holidays for Aral's or Shell's rounds of price increases. Unfortunately, as in most scientific studies dealing with the gasoline market, data on quantities demanded or sold are not available or can be plausibly approximated.

In the following chapter, we characterize the occurrence of market relevant price increases initiated by Aral or Shell, depending on the selected market structures. We measure the average dominant price increase, the share of participating stations, the start time, and the price development until 10 p.m. We then follow with a description of the average responses of the other oligopolists and independent retailers. Multivariate OLS-estimations in Section 3.5 attempt to explain the magnitude of upward price movements by explanatory variables, such as the initial price level, wholesale price, and market structure.

[9] For more information on the eight German price centers, see https://www.omr.de/neu/service/erlaeuterungen/o-m-r-tagespreiszentren.html.

Table 3.4: Descriptive Statistics for Price Increase Rounds Initiated by Aral

		Diesel					E10				
	Variable	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
	Aral first up	2592	9.37	2.66	1	19	2576	8.62	2.46	1	16.5
	Shell first up	2592	10.97	3.77	-6	18	2576	10.23	3.53	-4	18
	Esso first up	2592	6.63	5.29	-2	19	2576	6.52	5	-3	17
	Total first up	2592	5.3	5.36	-7	15	2576	4.93	4.88	-6	16
	Jet first up	2592	4.11	3.57	-7	12	2576	4.15	3.62	-8	13
	NO first up	2592	7.89	4.53	-9	21	2576	7.54	4.02	-6	19
	Aral share	2592	0.96	0.11	0.6	1	2576	0.96	0.11	0.6	1
	Shell share	2592	0.84	0.28	0	1	2576	0.83	0.28	0	1
	Esso share	2592	0.56	0.45	0	1	2576	0.58	0.44	0	1
	Total share	2592	0.53	0.5	0	1	2576	0.55	0.5	0	1
	Jet share	2592	0.57	0.46	0	1	2576	0.57	0.47	0	1
	NO share	2592	0.2	0.08	0	0.67	2576	0.21	0.11	0	1
	Aral total+	2592	9.63	2.75	0.6	19	2576	8.88	2.57	0.6	17
	Shell total+	2592	10.49	3.73	-2	18	2576	9.81	3.45	-2	17.33
	Esso total+	1721	10	5.35	-1	19	1759	9.19	4.87	-1.5	18
	Total total+	1278	10.03	2.42	0	15	1307	9.08	2.15	0	16
	Jet total+	1693	6.51	1.92	-1	12	1648	6.62	1.94	-2	13
	NO total+	2592	5.33	3.76	-4	17.83	2576	5.36	3.62	-3.5	16.33
Baseline price	Aral	2592	133.79	2.37	127.9	143.9	2576	148.13	2.72	141.9	160.23
	Shell	2592	133.85	2.87	127.9	149.9	2576	147.97	3.46	140.9	165.9
	Esso	1752	132.52	2.68	126.9	148.9	1790	146.82	2.97	140.9	160.9
	Total	1389	132.38	2.42	127.9	144.9	1418	147.03	2.86	140.9	159.9
	Jet	1693	131.49	2.45	126.9	140.9	1648	145.97	2.73	139.9	156.9
	NO	2592	131.83	2.48	126.81	143.4	2576	146.22	2.75	140.15	159.4
Market structure	All Majors	2592	0.21		0	1	2576	0.22		0	1
	Without Jet	2592	0.10		0	1	2576	0.11		0	1
	Without Total	2592	0.23		0	1	2576	0.23		0	1
	Without Esso	2592	0.13		0	1	2576	0.13		0	1
	Aral, Shell, Esso	2592	0.14		0	1	2576	0.14		0	1
	Aral, Shell, Total	2592	0.10		0	1	2576	0.10		0	1
	Aral, Shell, Jet	2592	0.09		0	1	2576	0.07		0	1
	Number of Aral	2592	2.54	1.17	1	5	2576	2.55	1.17	1	5
	Number of Shell	2592	1.96	0.83	1	4	2576	1.98	0.83	1	4
	Number of Esso	2592	1.07	0.92	0	3	2576	1.1	0.91	0	3
	Number of Jet	2592	0.96	0.86	0	4	2576	0.93	0.85	0	4
	Number of Total	2592	0.8	0.93	0	3	2576	0.81	0.93	0	3
	Number of NO	2592	6.81	2.83	2	14	2576	6.4	2.66	2	14
	Wholesale price	2592	125.91	1.11	123.52	129	2576	140.87	2.07	135.9	145.3
	Change of wholesale price	2592	0.02	0.42	-1.03	1.13	2576	0.06	0.45	-1	1.36

Table 3.5: Descriptive Statistics for Price Increase Rounds Initiated by Shell

		Diesel					E10				
	Variable	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
	Shell first up	3110	10.43	3.34	1	18	3036	10.1	2.86	1	17
	Aral first up	3110	9.08	2.85	0	17	3036	8.94	2.67	-9	16
	Esso first up	3110	6.95	5.32	-2	17	3036	6.98	5.17	-2	16
	Total first up	3110	4.95	5.22	-5	15.5	3036	4.83	4.95	-4	16.5
	Jet first up	3110	3.9	3.42	-9	11	3036	3.92	3.4	-8	12
	NO first up	3110	7.95	4.67	-9	19	3036	7.67	4.3	-8	18
	Shell share	3110	0.97	0.09	0.67	1	3036	0.97	0.09	0.67	1
	Aral share	3110	0.86	0.25	0	1	3036	0.86	0.25	0	1
	Esso share	3110	0.58	0.45	0	1	3036	0.59	0.45	0	1
	Total share	3110	0.51	0.5	0	1	3036	0.52	0.5	0	1
	Jet share	3110	0.51	0.44	0	1	3036	0.51	0.44	0	1
	NO share	3110	0.19	0.09	0	0.67	3036	0.21	0.12	0	1
	Shell total+	3110	10.21	3.79	-3	18.33	3036	9.91	3.27	-2	18.5
	Aral total+	3110	9.01	3.2	-1	18	3036	8.91	3.08	-1	17
	Esso total+	2016	11.21	3.61	0	18	2005	10.79	3.29	0	17
	Total total+	1486	9.85	2.22	0	15.5	1475	9.42	1.99	-0.5	16.5
	Jet total+	1989	6.22	1.75	-2	11	1919	6.26	1.69	-1	12
	NO total+	3110	7.24	3.19	-2.83	16.47	3036	7.36	3	-2.83	15.5
Baseline price	Shell	3110	134.79	2.09	128.9	142.9	3036	150.12	1.95	141.9	158.4
	Aral	3110	134.85	2.48	127.9	146.4	3036	150.53	2.51	142.9	160.4
	Esso	2098	133.14	2.82	127.9	144.9	2087	148.88	2.76	141.9	159.9
	Total	1602	132.83	2.6	127.9	142.9	1591	148.79	2.63	141.9	160.9
	Jet	1989	132.11	2.33	126.9	141.9	1919	147.92	2.29	140.9	156.9
	NO	3110	132.43	2.37	127.23	143.27	3036	148.21	2.37	141.02	158.02
Market structure	All majors	3110	0.18		0	1	3036	0.17		0	1
	Without Jet	3110	0.12		0	1	3036	0.13		0	1
	Without Total	3110	0.24		0	1	3036	0.25		0	1
	Without Esso	3110	0.12		0	1	3036	0.12		0	1
	Aral, Shell, Esso	3110	0.14		0	1	3036	0.14		0	1
	Aral, Shell, Total	3110	0.10		0	1	3036	0.10		0	1
	Aral, Shell, Jet	3110	0.10		0	1	3036	0.09		0	1
	Number of Aral	3110	2.55	1.15	1	5	3036	2.53	1.14	1	5
	Number of Shell	3110	1.98	0.87	1	4	3036	2	0.87	1	4
	Number of Esso	3110	1.03	0.89	0	3	3036	1.05	0.89	0	3
	Number of Jet	3110	1.01	0.94	0	4	3036	0.99	0.94	0	4
	Number of Total	3110	0.73	0.88	0	3	3036	0.75	0.88	0	3
	Number of NO	3110	6.95	2.72	2	14	3036	6.57	2.48	2	14
	Wholesale price	3110	126.58	1	123.52	129.09	3036	142.97	1.3	137.09	145.66
	Change of wholesale price	3110	0.02	0.43	-1.03	1.13	3036	0.05	0.34	-0.87	1.19

3.4. Descriptive Results

Tables 3.6 and 3.7 describe price rounds started by Aral or Shell, as well as the reactions of other major companies and of Non-Oligopolists, separated for the seven market structures. The data reports who starts a price increase, the average starting time of relevant price restorations (*time*), the average magnitude of the first price increase (*first up*), and the average price difference between the baseline price and the price at 10 p.m. (*total +*). Additionally, we calculated the average number of participating stations of respective brands (*share*). The behavior of the other major companies and Non-Oligopolists is described by the average first price change after the market dominant price restoration (*first up*), the average timespan for reaction (*time*), the average number of reacting stations inside respective brands (*share*), and by the total price change until 10 p.m. (*total +*).

For example, Aral started with the market relevant price restorations for Diesel. Table 3.6 shows that Aral increased prices on average between 6:33 p.m. and 6:44 p.m. They began starting upward price movements in the range between 8.05 ct. (without Esso) and 10.60 ct. (without Jet). As seen in the market structure "Aral, Shell, Total" in cities with Aral, Shell and Jet, 90 to 100 percent of the Aral stations participated in the first price increase. Aral is able to charge slightly higher prices until 10 p.m., roughly 0.15 ct. higher compared to the starting upward price movement. Their final upward price movements end between 8.36 ct. in the market structure, which includes all majors except Esso, and 11.11 ct. in market structures without Jet.

Shell stations respond on average within 26 minutes in markets with all majors. Their counterstrike price increase is roughly 1.5 ct. higher, which diminishes by 1 ct. until 10 p.m. Three quarters of all Shell stations cause reactive price increases in all majors-market structures. Looking at the other market structures, we see Shell's stations react with higher first price counterstrike's (between 0.89 ct. [ARAL, Shell, Total] and 2.25 ct. without Esso), and reduce the prices again until the late evening (between -0.12 ct. without Jet and -0.69 ct. [Aral, Shell, Esso]).

Esso stations react to Aral's first up price changes between an average of 25 minutes to one hour. If the reaction is within two hours, it stays at nearly the same magnitude (about 10 ct.) by the same share of participating price increasers, and must reduce a little bit (one and ¼ ct.), or in one case with additional price increases of roughly ½ ct. On average, Total stations reacts with parallel price movements roughly one and half hours later, with +10 ct. in the first round, and are able to go up a little bit more (+0.18 and +0.5 ct.), or reduce prices (-0.08 and -0.37 ct.). Jet typically reacts very late, between two and a half and three hours, with roughly a 6 ct. price increase until 10 p.m. All Non-Oligopolists go up between 6 and 9.2 ct., depending on the different market structures. Reaction times are between one hour and fifteen minutes and two hours and eight minutes. Table 3.6 shows that the number of observations differ between 259 price increase rounds in the market structure with Aral, Shell, and Jet, and 594 price restorations in cities without Total.

Table 3.6: Upward Price Rounds/Starter Aral/Diesel

		Market Structure						
	Action	All majors	Without Jet	Without Total	Without Esso	Aral, Shell, Esso	Aral, Shell, Total	Aral, Shell, Jet
Aral	time	18:44:37	18:36:53	18:38:30	18:34:21	18:36:22	18:39:09	18:33:46
	first up	9.53	10.60	9.08	8.05	9.46	10.40	8.99
	share	0.98	0.96	0.94	0.99	0.95	0.90	1.00
	total +	9.75	11.11	9.34	8.36	9.59	10.55	9.29
	Response							
Shell	time	00:26:32	00:40:09	00:37:08	00:30:20	00:34:49	00:26:48	00:26:59
	first up	11.31	11.61	10.55	10.30	10.96	11.29	11.24
	share	0.78	0.88	0.89	0.86	0.74	0.83	0.88
	total +	10.29	11.46	10.36	9.96	10.27	11.01	10.63
Esso	time	01:25:39	01:15:20	01:54:39		01:36:00		
	first up	9.90	10.72	9.73		9.16		
	share	0.74	0.89	0.88		0.84		
	total +	9.39	12.63	9.46		9.64		
Total	time	01:21:48	01:33:13		01:35:52		01:32:07	
	first up	10.08	9.56		9.84		9.96	
	share	0.99	0.97		1.00		1.00	
	total +	9.96	10.13		10.34		9.59	
Jet	time	02:42:29		02:53:13	02:52:50			02:46:16
	first up	6.49		6.48	6.16			5.63
	share	0.87		0.87	0.89			0.91
	total +	6.55		6.58	6.50			6.28
NO	time	02:08:43	01:48:48	01:39:36	01:32:52	01:29:58	01:54:16	01:16:57
	first up	9.21	8.96	7.34	6.35	8.29	8.62	5.97
	share	0.20	0.17	0.23	0.18	0.20	0.17	0.17
	total +	5.43	5.53	5.53	5.31	3.53	6.65	5.74
	Observations	518	270	594	342	370	259	239

Table 3.14 in the Appendix refers to dominant price upward movements completed by Aral for Premium E10. Aral roughly starts with 7.4 to 9.3 ct., created by nearly one price change per station. Mark-ups can be increased by roughly 0.5 ct. Shell responds with a greater increase of mostly 10 ct. and waits approximately 30 minutes before making the change. Esso's reaction is an increase of 9 to 10 ct. after one and a half hours; the same can be said for Total. Jet goes up by a little bit more than 6 ct. within two and a half to three hours. The Non-Oligopolists mostly charge 1 or 2 ct. more than Jet within shorter timespans.

Tables 3.7 and 3.15 (the latter in the Appendix) clearly show that Shell starts very early if it plays the starting role in the price rounds, independent of whether Diesel or E10 is regarded. Shell mostly charges initial price mark-ups by 10 ct. or 11 ct., and does not substantially reduce prices until 10 p.m. Aral reacts very quickly (at a maximum of one-quarter hour) and has price mark-ups of roughly 8 to 10 ct. Esso, Total, and the Non-Oligopolists react and increase prices by 8 to 10 ct. within one to two hours. Jet increases prices later (after three hours) and weaker (by 6 ct.).

Table 3.7: Upward Price Rounds/Starter Shell/Diesel

		Market Structure						
	Action	All majors	Without Jet	Without Total	Without Esso	Aral, Shell, Esso	Aral, Shell, Total	Aral, Shell, Jet
Shell	time	18:05:36	18:09:58	18:11:43	18:06:58	18:05:56	18:07:36	18:07:26
	first up	10.60	11.37	9.98	10.51	9.85	10.40	10.80
	share	0.96	1.00	0.99	1.00	0.92	0.94	0.97
	total +	10.34	11.12	9.75	10.33	9.63	10.28	10.50
	Response							
Aral	time	00:09:00	00:07:43	00:10:56	00:10:43	00:10:08	00:08:08	00:14:56
	first up	8.87	10.06	8.25	8.87	9.13	10.04	9.50
	share	0.85	0.82	0.83	0.95	0.86	0.81	0.95
	total +	8.74	9.55	8.26	9.24	8.89	9.83	9.68
Esso	time	01:47:55	00:59:45	02:01:46		01:35:28		
	first up	10.73	10.76	10.24		9.45		
	share	0.80	0.84	0.91		0.85		
	total +	11.59	12.67	10.59		10.11		
Total	time	01:32:10	01:27:51		01:29:35		01:30:08	
	first up	9.47	9.87	0.00	9.55	0.00	9.56	0.00
	share	0.99	0.99	0.00	0.99	0.00	1.00	0.00
	total +	9.65	10.16		10.00		9.57	
Jet	time	02:57:10		02:48:11	02:57:18			02:43:52
	first up	6.45	0.00	5.97	6.34	0.00	0.00	5.60
	share	0.81	0.00	0.76	0.81	0.00	0.00	0.86
	total +	6.42		6.09	6.29			6.15
NO	time	01:57:26	01:38:56	01:30:57	01:36:45	01:19:51	01:48:32	01:16:08
	first up	8.54	11.31	7.23	7.08	7.20	8.71	5.92
	share	0.20	0.18	0.22	0.18	0.20	0.17	0.16
	total +	7.50	9.26	6.93	7.36	4.98	7.06	8.16
	Observations	527	387	760	378	424	310	324

The descriptive analysis shows the behavior is very similar in the different market structures and fuel types. The following multivariate analysis is intended to clarify whether pricing behavior can be explained in more detail with further variables. It also examines whether certain influencing factors cause Aral or Shell to begin price increases.

3.5. Multivariate Results

The following OLS regressions show the correlation between a higher price difference between the baseline and the price at 10 p.m. of one big major and the subsequent price-setting behavior of the other major, Jet, or independent resellers during the same time span. The reactions of Esso and Total can be excluded for these estimations due to their upward price movements staying between Shell/Aral and Jet/NO as described by the previous bivariate descriptive analysis. Table 3.8 and 3.16/3.18/3.19 in the Appendix present multivariate estimations on how Shell, Jet, and the Non-Oligopolists react to Aral's price increases. Respectively, Table 3.9 and 3.17/3.20/3.21 in the Appendix show how Aral, Jet, or the Non-Oligopolists follow Shell's price increase rounds. Tables 3.12 and 3.13 in the Appendix show descriptive statistics for the dataset used for these estimations. Because Aral or Shell started the observed price increases, we run a logit estimation trying to determine the influencing factors for Shell's price increases (see Table 3.10). Table 3.22 provides descriptive values.

If Aral started with a dominant price restoration for Diesel, we are able to analyze how Shell, as the main inside competitor, reacts when we control for other possible influencing factors (see Table 3.9, models 1 to 4). Model 1 shows that Shell will respond to Aral's price markup of 1 ct. by an increase of 0.45 ct., which is significant and has a low error probability of less than 1/1000. Compared to market structures with all major companies, Shell charges 0.6 ct. higher prices if Jet is not active in these cities, which is significant on the five percent level. All other market structure variables are insignificant.

Following the adjusted R^2 we are able to explain roughly 10 percent of Shell's price increases until 10 p.m. Models 2 to 4 include further step-by-step explanatory variables, such as the same-day wholesale price, the change in wholesale price compared to the day before, Shell's price before its upward price movement (*Shell Baseline*), and the number of Non-Oligopolists (*Number of NO*) as an indicator for "outsider" competition in the local market. Using Model 4, Shell stations on average react with 0.17 ct. higher prices if Aral stations move up by 1 ct., and the coefficient has a probability less than 0.001 equal to zero. If Shell stations are only active in local markets with Aral and Esso, they show 0.37 ct. higher reactions, but have a relatively high error-probability. 1 ct. higher wholesale prices are correlated with 0.21 ct. higher price reactions of Shell if Aral increased prices (the highest significance level), but wholesale price changes are not connected to each other. A one-cent lower Shell price before local upward price movement is accompanied by a 0.86 ct. lower price reaction by Shell (which is highly significant). One additional Non-Oligopolists station diminishes the price reaction by 0.07 ct. (highly significant). Model 4 explains 47.9 percent of the variance within Shell's price reaction.

Average price reactions of Non-Oligopolists on Aral's Diesel price starts are estimated within models 5 to 8. Looking at the best explaining model (Model 8), we find no evidence that Aral's price upward movements are correlated with Non-Oligopolists pricing, holding other influencing factors constant. Significant other factors are market structures without Total (+0.6 ct.; significant on the one percent level), Aral/Shell/Esso (-1.6 ct. which is significant on one thousand percent level), and Aral/Shell/Total (+1.5 ct.; significant on one thousand percent level). Furthermore, a one-cent higher wholesale price is related with a -0.4 ct. lower price surcharge of Non-Oligopolists (highly significant on the thousand percent level). A one-cent higher average starting price level of Non-Oligopolists explains 0.3 ct. lower price reaction of this type of stations. Upward price movements are on average 0.4 ct. lower if the number of competitors increases by one. Model 8 explains roughly 20 percent of the variance. Models 9-12 might explain Jet's reactions to Aral's price starts. Model 12 is the most suitable, as it has the highest R^2 (0.601). There, we find no significant price surcharge by Jet, holding constant all other influencing factors. All possible market structures show significant higher price reactions of Jet compared to markets with all majors. A 1 ct. higher wholesale price leads to a 0.3 ct. higher price reaction. A one percent increase of wholesale price diminishes contra intuitively by exactly the same amount. A 0.667 lower price reaction is seen if Jet's baseline price is higher by 1 ct. (highly significant). The number of Non-Oligopolists is statistically significant, but results in an economically irrelevant price reaction. Tables 3.18 and 3.19 in the Appendix evaluate the robustness of our econometric estimations by adding further explanatory variables (weekend/holiday, school holidays, and weekdays). The results show no better explanations and the coefficients already considered change only marginally.

Table 3.9 shows how Aral, Non-Oligopolists, and Jet change prices until 10 p.m. if Shell behaves as the price starter in the early evening. Models 1 to 4 show the upward price movements of Aral, controlling for other influencing factors. Looking at the mostly explanatory model (Model 4, which has the highest R^2), Aral stations charge 0.04 ct. higher prices until 10 p.m. (highly significant), if the price starter Shell announces a 1 ct. higher price. In market structures in which not all majors are active, Aral stations go up on prices between 0.6 and 1.5 ct., with the exception of local markets without Total. A 1 ct. higher wholesale price results in an additional 0.7 ct. price surcharge by Aral stations (significant of 1/000-level). If Aral's baseline price is higher by 1 ct., the price markup of Aral stations lower by 0.9 ct. More Non-Oligopolists stations are significantly correlated with higher price increases, but an economically insignificant coefficient is given. Model 4 nearly explains half of the price increase variances of Aral stations. Models 5 to 8 are estimated for Non-Oligopolists' price markups up to 10 p.m. Following the most widely explaining estimation of Model 8, Non-Oligopolists answer with 0.2 ct. in the case of a 1 ct. price start by Shell. Price markups are higher by 1.3 ct. if Jet is not part of the market. Stations which supply only in combination with Aral, Shell, and Esso stay behind an average of 1.5 ct. A 1ct. higher wholesale price is correlated with a 0.3 ct. price markup. Decreasing wholesale prices are answered by a 0.4 ct. lower markup, again contra intuitively. One additional Non-Oligopolists station is related to a 0.2 ct. higher price markup. This might be the result of higher price competition before 6 p.m.

The final models 9-12 describe Jet's price increases. As we saw in the previous models, the last estimation is at best able to explain the variance of Jet's price increases (R^2: 0.456). We found, however, that Shell's price start is not related to Jet's upward price movements, regardless of different market structures. Increasing wholesale prices are significantly positively correlated with Jet's price markups as well as the number of Non-Oligopolists stations, and negatively correlated with the change rate of wholesale prices and Jet's average baseline prices. Tables 3.20 and 3.21 add further explanatory variables (weekend/holidays, school holidays, and weekdays) and do not seriously change the presented results.

Table 3.8: Upward Price Rounds/Starter Aral/Diesel

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Shell total+	Shell total+	Shell total+	Shell total+	NO total+	NO total+	NO total+	NO total+	Jet total+	Jet total+	Jet total+	Jet total+
Aral total+	0.446***	0.405***	0.170***	0.174***	0.191***	0.146***	0.0561	0.0274	0.240***	0.217***	-0.00185	-0.0105
	(0.0285)	(0.0286)	(0.0221)	(0.0221)	(0.0262)	(0.0262)	(0.0292)	(0.0292)	(0.0183)	(0.0182)	(0.0103)	(0.0105)
Without Jet[2]	0.560*	0.496	0.0490	0.0121	-0.167	-0.269	-0.402	-0.245				
	(0.279)	(0.276)	(0.190)	(0.188)	(0.258)	(0.265)	(0.271)	(0.266)				
Without Total[2]	0.254	0.381	-0.0168	-0.0461	0.172	0.341	0.433*	0.595**	0.129	0.205	0.389***	0.414***
	(0.221)	(0.217)	(0.169)	(0.168)	(0.231)	(0.223)	(0.220)	(0.201)	(0.113)	(0.112)	(0.0839)	(0.0846)
Without Esso[2]	0.295	0.120	0.262	0.308	0.144	-0.0773	-0.0279	-0.239	0.278*	0.175	0.434***	0.389***
	(0.255)	(0.249)	(0.183)	(0.184)	(0.247)	(0.241)	(0.238)	(0.227)	(0.127)	(0.125)	(0.0883)	(0.0827)
Aral, Shell, Esso[2]	0.0487	-0.169	0.399*	0.370*	-1.875***	-2.156***	-1.768***	-1.564***				
	(0.221)	(0.218)	(0.175)	(0.175)	(0.254)	(0.251)	(0.260)	(0.225)				
Aral, Shell, To-tal[2]	0.366	0.538*	0.145	0.128	1.060**	1.276***	1.429***	1.542***				
	(0.269)	(0.259)	(0.213)	(0.215)	(0.343)	(0.324)	(0.326)	(0.304)				
Aral, Shell, Jet[2]	0.542	0.447	0.122	0.153	0.398	0.271	0.407	0.285	-0.168	-0.225	0.263**	0.238*
	(0.310)	(0.309)	(0.224)	(0.223)	(0.269)	(0.265)	(0.259)	(0.262)	(0.140)	(0.141)	(0.100)	(0.0975)
Wholesale price		-0.608***	0.241***	0.210***		-0.783***	-0.539***	-0.355***		-0.356***	0.249***	0.277***
		(0.0633)	(0.0514)	(0.0517)		(0.0648)	(0.0718)	(0.0693)		(0.0398)	(0.0306)	(0.0307)
Change of wholesale price		0.663***	0.0789	0.0834		0.232	0.0708	0.0267		0.197	-0.277***	-0.277***
		(0.181)	(0.143)	(0.143)		(0.173)	(0.172)	(0.165)		(0.109)	(0.0793)	(0.0784)
Shell Baseline			-0.864***	-0.862***								
			(0.0199)	(0.0199)								
NO Baseline							-0.255***	-0.301***				
							(0.0347)	(0.0339)				
Jet Baseline											-0.659***	-0.663***
											(0.0150)	(0.0151)
Number of NO				-0.0747***				0.357***				0.0629***
				(0.0190)				(0.0245)				(0.0116)
Constant	5.947***	82.86***	93.98***	98.13***	3.573***	102.7***	106.3***	87.02***	4.216***	49.32***	61.51***	58.14***
	(0.332)	(8.010)	(6.038)	(6.118)	(0.329)	(8.243)	(8.114)	(7.837)	(0.212)	(5.035)	(3.300)	(3.290)
Observations	2592	2592	2592	2592	2592	2592	2592	2592	1693	1693	1693	1693
Adjusted R^2	0.110	0.142	0.476	0.479	0.063	0.111	0.127	0.196	0.123	0.163	0.592	0.601
F	40.14	47.42	272.4	250.1	27.98	39.02	46.44	66.81	45.51	46.04	371.5	346.9

All models were estimated by OLS with the price difference between the baseline price and the price at 10 p.m. (total+) as the dependent variable. For an exact definition of the variables, see text. [2]Compared to all majors. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Own Calculations with Stata 13.1.

Table 3.9: Upward Price Rounds/Starter Shell/Diesel

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Aral total+	Aral total+	Aral total+	Aral total+	NO total+	NO total+	NO total+	NO total+	Jet total+	Jet total+	Jet total+	Jet total+
Shell total+	0.106***	0.125***	0.0448***	0.0439***	0.277***	0.260***	0.196***	0.191***	0.0921***	0.0739***	0.00240	0.00100
	(0.0149)	(0.0150)	(0.0108)	(0.0107)	(0.0128)	(0.0129)	(0.0122)	(0.0122)	(0.0110)	(0.0114)	(0.00847)	(0.00843)
Without Jet²	0.731***	0.796***	0.756***	0.839***	1.542***	1.364***	0.982***	1.312***				
	(0.203)	(0.202)	(0.150)	(0.151)	(0.208)	(0.209)	(0.199)	(0.203)				
Without Total²	-0.412*	-0.419*	-0.0232	0.0106	-0.416*	-0.384*	-0.0954	0.0498	-0.278*	-0.246*	0.0432	0.0683
	(0.165)	(0.166)	(0.129)	(0.128)	(0.171)	(0.169)	(0.150)	(0.134)	(0.108)	(0.107)	(0.0823)	(0.0834)
Without Esso²	0.505**	0.585**	0.572***	0.590***	-0.143	-0.325*	-0.0583	0.0226	-0.130	-0.319**	0.102	0.117
	(0.186)	(0.189)	(0.151)	(0.150)	(0.161)	(0.163)	(0.139)	(0.131)	(0.119)	(0.117)	(0.0921)	(0.0923)
Aral, Shell, Esso²	0.225	0.312	1.470***	1.492***	-2.330***	-2.499***	-1.624***	-1.514***				
	(0.173)	(0.174)	(0.136)	(0.136)	(0.185)	(0.187)	(0.187)	(0.169)				
Aral, Shell, Total²	1.098***	1.043***	0.906***	0.950***	-0.431*	-0.310	-0.261	-0.0795				
	(0.204)	(0.205)	(0.159)	(0.156)	(0.206)	(0.206)	(0.188)	(0.179)				
Aral, Shell, Jet²	0.924***	0.973***	0.981***	0.962***	0.610***	0.490**	0.856***	0.788***	-0.280*	-0.405***	0.0151	0.000749
	(0.216)	(0.215)	(0.180)	(0.180)	(0.185)	(0.184)	(0.167)	(0.156)	(0.118)	(0.117)	(0.0915)	(0.0903)
Wholesale price		0.172**	0.729***	0.762***		-0.390***	0.163**	0.312***		-0.403***	0.170***	0.198***
		(0.0648)	(0.0429)	(0.0440)		(0.0483)	(0.0529)	(0.0523)		(0.0376)	(0.0327)	(0.0337)
Change of wholesale price		0.428***	-0.0436	-0.0620		0.175	-0.372***	-0.461***		0.139	-0.493***	-0.511***
		(0.124)	(0.0896)	(0.0894)		(0.115)	(0.112)	(0.110)		(0.0993)	(0.0841)	(0.0838)
Aral Baseline			-0.883***	-0.883***								
			(0.0166)	(0.0166)								
NO Baseline							-0.518***	-0.532***				
							(0.0231)	(0.0218)				
Jet Baseline											-0.537***	-0.536***
											(0.0160)	(0.0157)
Number of NO				0.0561***				0.229***				0.0440***
				(0.0167)				(0.0178)				(0.0103)
Constant	7.641***	-14.30	34.70***	30.19***	4.636***	54.18***	53.20***	34.62***	5.467***	56.69***	55.55***	51.57***
	(0.179)	(8.224)	(5.619)	(5.771)	(0.180)	(6.136)	(5.745)	(5.892)	(0.138)	(4.764)	(3.370)	(3.481)
Observations	3110	3110	3110	3110	3110	3110	3110	3110	1989	1989	1989	1989
Adjusted R^2	0.043	0.049	0.458	0.460	0.236	0.249	0.344	0.379	0.042	0.091	0.451	0.456
F	16.85	15.70	327.2	297.9	151.2	125.3	222.9	236.4	19.03	33.43	229.9	206.9

All models were estimated by OLS with the price difference between the baseline price and the price at 10 p.m. (total+) as the dependent variable. For an exact definition of the variables see text. ²Compared to all majors. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. Own Calculations with Stata 13.1.

Overall, no economic or statistical significant correlation can be explained between an initial price increase of Aral or Shell with the price reactions of the other market participants. There is no clear evidence of the influence on price adjustments due to other market structures than in complete markets usually.

Final estimations reveal empirical evidence about the reasons for Shell and Aral price starts. Restricted to our dataset, other companies have not undertaken price starts the way Shell and Aral do. Hence, a logit estimation was possible, in which the value 1 is allocated to Shell's price starts and 0 for Aral's starts. Table 3.10 presents the econometric results, separated between Diesel and E10. Looking at the price differences between Shell and Aral, Shell's higher prices before the price start would be a plausible argument that the company has a lower probability of starting a price round. Furthermore, the calculated marginal effects are so low that negative effects are negligible. Different market structures also seem to have no influence. Weekday effects compared to Monday are mostly insignificant or economically small. Shell stations have a roughly 45 percent higher probability to start price rounds on school holidays compared to Aral (significant on 1/1000 level), holding all other influencing factors constant. The number of specific brand stations are probably not different to nil, almost in all cases; rare events of significant coefficients are characterized by small marginal effects.

If we compare the percentage of correctly classified price starts by using logit estimations (roughly 58 to 59 percent) with the percentage of classified cases without econometric estimation (56 percent, see Table A12), only a small improvement is found. In summary, the result estimations are not able to explain why Shell starts. The tested explanatory variables are not significant and economically negligible without school holidays. Table 3.22 fully shows descriptive statistics for Shell's price increase rounds.

Table 3.10: Logit Estimations for Shell's Price Starts

	Diesel (1)	Diesel (2)	E10 (1)	E10 (2)
Price Shell – Aral, before	-0.00903***	-0.00890***	-0.0114***	-0.0113***
	(0.00264)	(0.00264)	(0.00289)	(0.00290)
Without Jet[1]	0.0355		0.0150	
	(0.0241)		(0.0239)	
Without Total[1]	-0.00112		-0.000842	
	(0.0202)		(0.0202)	
Without Esso[1]	-0.0282		-0.0247	
	(0.0236)		(0.0236)	
Aral, Shell, Esso[1]	-0.0272		-0.0229	
	(0.0230)		(0.0230)	
Aral, Shell, Total[1]	-0.0103		-0.0100	
	(0.0253)		(0.0253)	
Aral, Shell, Jet[1]	0.0314		0.0494	
	(0.0256)		(0.0276)	
Tuesday[2]	-0.101***	-0.100***	-0.0927***	-0.0923***
	(0.0245)	(0.0245)	(0.0248)	(0.0248)
Wednesday[2]	-0.129***	-0.129***	-0.119***	-0.119***
	(0.0243)	(0.0243)	(0.0246)	(0.0246)
Thursday[2]	-0.0157	-0.0156	-0.00706	-0.00686
	(0.0241)	(0.0241)	(0.0244)	(0.0244)
Friday[2]	-0.141***	-0.141***	-0.130***	-0.129***
	(0.0242)	(0.0242)	(0.0245)	(0.0245)
Saturday[2]	-0.0714**	-0.0711**	-0.0615*	-0.0613*
	(0.0240)	(0.0240)	(0.0243)	(0.0243)
Sunday[2]	-0.154***	-0.153***	-0.147***	-0.147***
	(0.0241)	(0.0241)	(0.0243)	(0.0243)
School Holidays	0.447***	0.444***	0.452***	0.449***
	(0.0252)	(0.0252)	(0.0255)	(0.0256)
Number of Shell		0.00792		0.00584
		(0.00761)		(0.00766)
Number of Aral		-0.00520		-0.00935
		(0.00558)		(0.00566)
Number of Esso		-0.00536		-0.0100
		(0.00740)		(0.00750)
Number of Total		-0.0160*		-0.0177*
		(0.00726)		(0.00729)
Number of Jet		0.0117		0.0173*
		(0.00714)		(0.00724)
Number of NO		0.00358		0.00162
		(0.00237)		(0.00262)
Observations	5593	5593	5503	5503
Correctly classified	58.39%	58.97%	58.48%	59.11%

Note: Table contains average marginal effects. [1]Compared to all majors. [2]Compared to Monday. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

3.6. Conclusion

German gasoline prices show high price volatilities. More than 80 percent of upward price movements occur between 6 p.m. and midnight, which create market-wide upward price movements during that time. Previous studies have shown that the two dominant majors, Aral and Shell, start price increases shortly after 6 p.m. If one dominant player increased prices, the others follow within a maximum of 30 minutes. Esso, Total, and the Non-Oligopolists need no more than two hours to react. Jet roughly waits three hours. Jet also follows with lower price increases compared to the other competitors. These empirical facts are mainly derived from price data for big cities in Germany, and have been stable for several years.

It seems that little attention is given to the fact that all petrol stations in big cities do not belong to the same type of market. In particular, if the distance between stations is high, then we expect no real competitive relationship. To analyze real competitive relations, we focused on mid-sized cities between 60,000 and 100,000 inhabitants, which have no more than 20 gas stations. These 66 cities are characterized by different market structures because not all brands are active in all local markets. By building comparative markets, we excluded brand combinations which occurred in less than five cities. Depending on whether Diesel or E10 filing stations are active, the number of analyzed cities must be diminished to 54/53 cities. We completed a descriptive and multivariate analysis of dominant price rounds (price restorations), which means that at least 50 percent of all stations of one brand increase prices at the same time in one city.

As for the descriptive analysis for Hamburg, Cologne, Leipzig and Munich, Shell's price restorations start roughly five to ten minutes after 6 p.m. with a 10 ct. price mark-up, which is not reduced until 10 p.m. Aral, Esso and Total respond with roughly 2 ct. lower prices until 10 p.m. Aral reacts very quickly (within 10 minutes) and Esso, Total, and the Non-Oligopolists wait for about two hours to respond. Jet's reaction is smaller by roughly 6 ct. and certainly lasts longer, roughly three hours. If Aral is responsible for price starts, Aral starts later (30 minutes after 6 p.m.), weaker (+9 ct.) and must give up 1-2 ct. until 10 p.m. The reactions of the other brands are comparable to the way they respond to Shell's price increases. Hence, it seems that Jet behaves less parallel compared to other oligopolists and more aggressive compared to Non-Oligopolists.

Multivariate OLS-estimations show that the strength of reaction is low. Aral goes only up 0.04 ct. if Shell charges 1 ct. more (Diesel), when we control for other influential factors. Shell's reactions to Aral's changes are little bit higher (0.17 ct.). Jet does not economically react, independent of the starter (0.04 ct.). Non-Oligopolists significantly react with 0.2 ct. if Shell starts the price increase and with 0.09 ct. when Aral starts the price increase. Hence, Jet's picture of price aggressive behavior is not different from the others. Because our dataset allows us to analyze different market structures, we are also able to check whether the presence of different brands can explain upward price movements. Most market structures give no clear indication of this aspect. But, if Total and Jet are not active, price rounds are 1 to 1.5 ct. lower compared to complete market structures. This result might be explained because markets without Jet and Total are less price aggressive before 6 p.m., so price markups are less important.

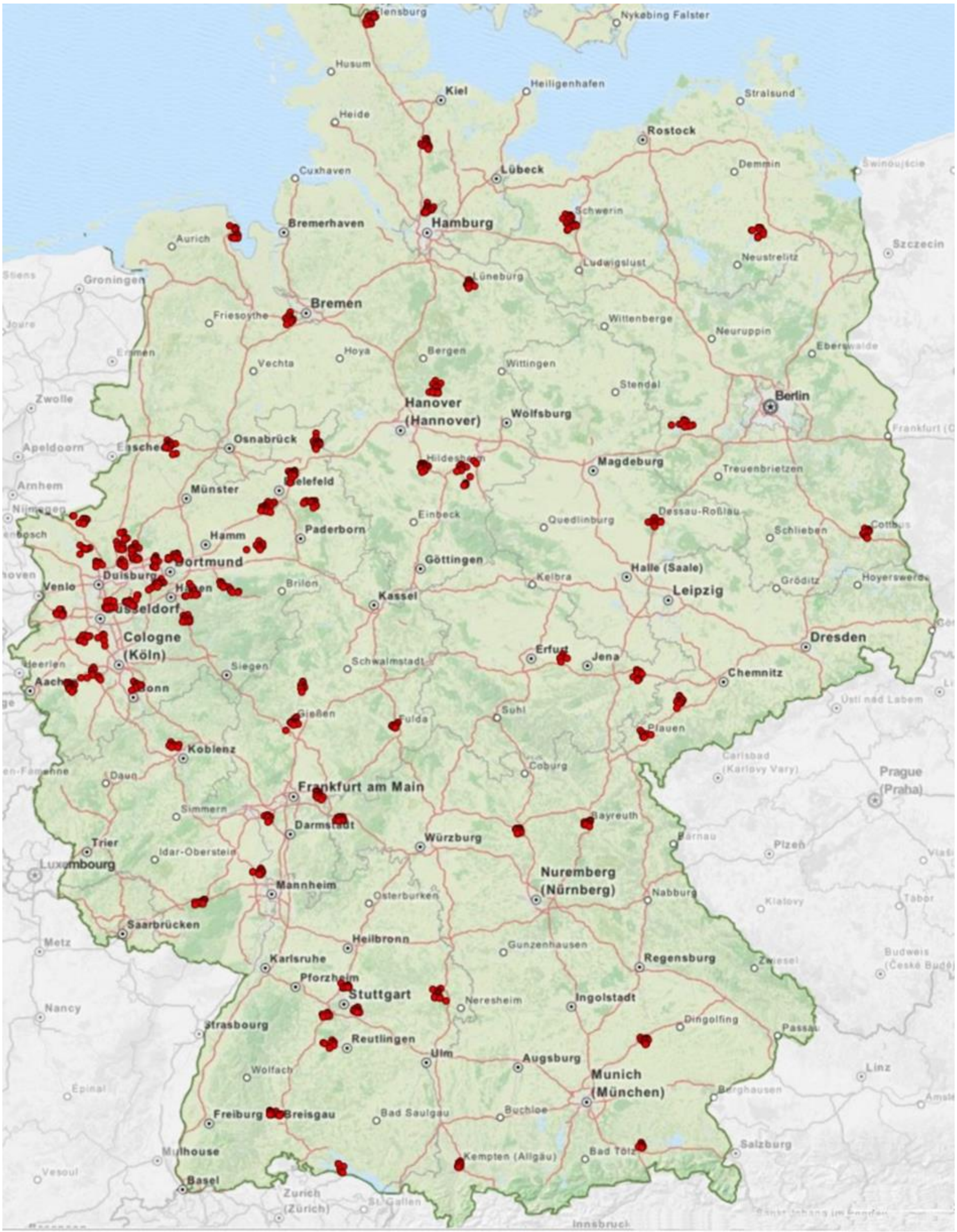
The undertaken logit estimations are not able to explain Shell's or and Aral's starting behavior. School holidays in some regions might be more relevant for Shell's upward price movements, but a pattern is not recognizable.

Looking back to our theoretical considerations, it seems plausible that the war of attrition would end by following mixed strategies. Looking at bivariate descriptive results, Aral follows Shell's price increases quickly and strong (and vice versa), followed by other majors, Non-Oligopolists, and Jet. This type of price leadership must be denied or seems to certainly have smaller relevance if additional explaining factors are controlled for. Hence, the conjecture of parallel behavior by price leadership of Aral or Shell cannot really be upheld.

Comparing our results with the metropolitan regions Cologne, Hamburg, Munich, and Leipzig, it is evident that reaction times are comparable, but price reactions are certainly lower and it is unclear why. A correct definition of markets seems to create the necessity of a tighter market definition. Our empirical results indicate that metropolitan regions are less competitive because of higher upward movements. Perhaps the existence of more stations in one neighborhood, which is certainly more relevant in metropolises, allows us to see more upward price movements. Hence, the collusive speed of price rounds accelerate.

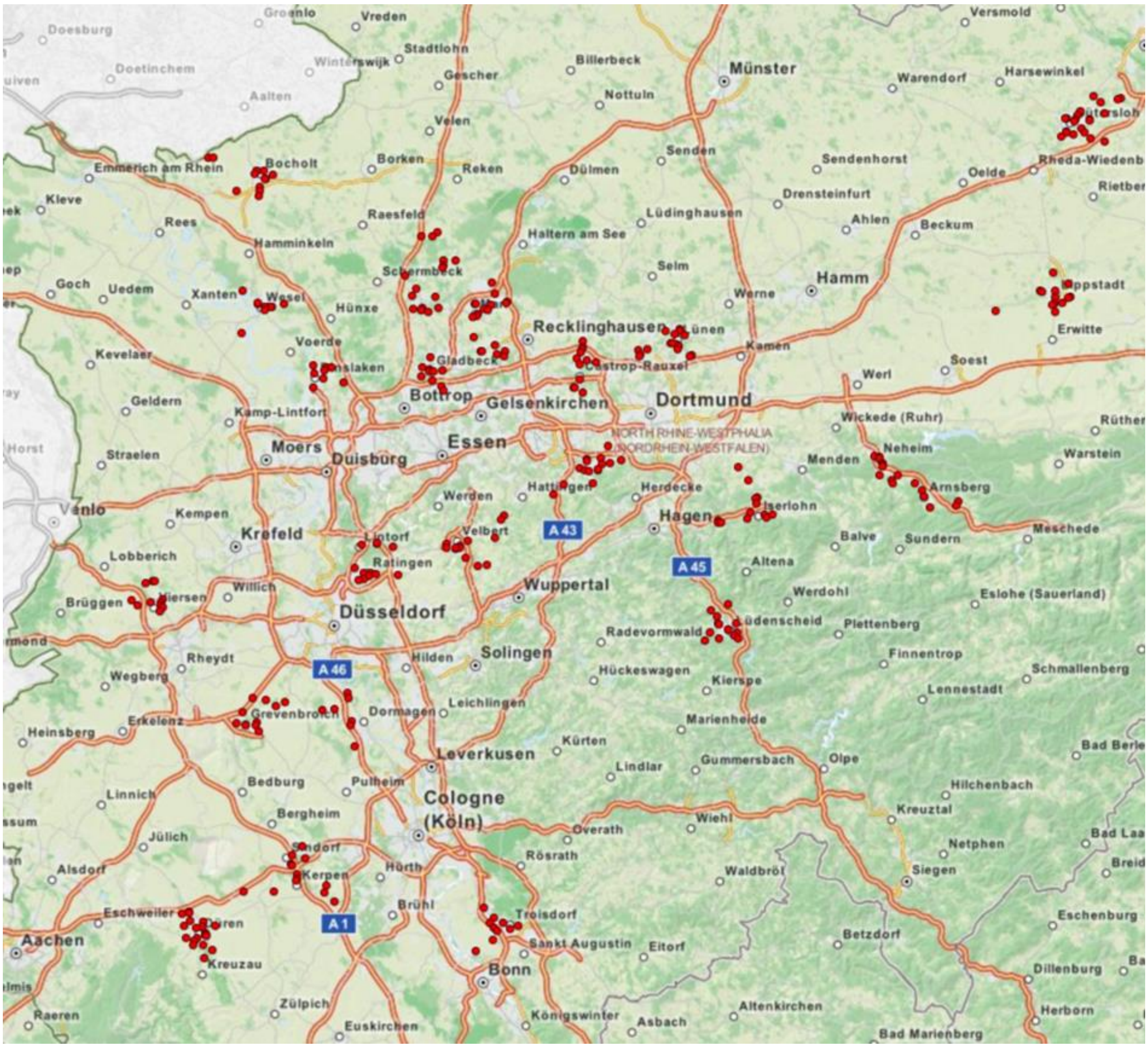
Appendix

Figure 3.3: Map of Germany Showing Petrol Stations



Source: Map created at GPSVisualizer.com, OpenStreeMap data from MapQuest

Figure 3.4: Map of the Ruhr Region Showing Petrol Stations



Source: Map created at GPSVisualizer.com, OpenStreeMap data from MapQuest

Table 3.11: Number of Petrol Stations – Diesel/E10 (52/51 Regions)

Cities/Brands	Market	Aral	Shell	Esso	Total	Jet	NO	Sum
Aalen	5/5	2/2	1/1	1/1	0/0	0/0	12/11	16/15
Arnsberg	6/6	3/3	1/1	0/0	1/1	0/0	11/11	16/16
Aschaffenburg	2/2	4/3	2/2	2/2	1/1	0/0	8/8	17/16
Bamberg	3/3	4/4	1/1	1/1	0/0	2/2	10/9	18/17
Bayreuth	3/3	1/1	2/2	3/3	0/0	2/2	13/12	21/20
Brandenburg an der	2/2	2/2	2/2	1/1	3/3	0/0	5/5	13/13
Castrop-Rauxel	4/4	1/1	1/1	0/0	1/1	2/2	7/5	12/10
Celle	3/3	4/4	2/2	1/1	0/0	2/2	8/8	17/17
Cottbus	1/1	2/2	2/2	1/1	2/2	1/1	3/3	11/11
Delmenhorst	4/4	2/2	2/2	0/0	2/2	2/2	8/7	16/15
Dessau	1/1	3/3	2/2	1/1	1/1	1/1	4/4	12/12
Detmold	7/7	1/1	2/2	0/0	0/0	1/1	12/11	16/15
Dormagen	5/5	1/1	2/2	1/1	0/0	0/0	3/2	7/6
Dueren	1/1	1/1	2/2	1/1	3/3	2/2	12/12	21/21
Fulda	3/3	2/2	1/1	1/1	0/0	2/2	3/3	9/9
Gera	6/6	3/3	2/2	0/0	1/1	0/0	6/6	12/12
Giessen	3/3	3/3	3/3	2/2	0/0	4/4	6/6	18/18
Gladbeck	2/2	2/2	1/1	1/1	1/1	0/0	5/4	10/9
Guetersloh	1/1	1/1	4/4	2/2	1/1	1/1	13/12	22/21
Hanau	1/1	2/2	3/3	1/1	2/2	1/1	9/8	18/17
Herford	1/1	3/3	1/1	3/3	1/1	1/1	8/8	17/17
Hildesheim*	4/4	4/4	2/2	0/0	1/1	2/2	12/10	21/19
Iserlohn	6/6	3/3	3/3	0/0	1/1	0/0	6/6	13/13
Kaiserslautern	1/1	4/4	3/3	2/2	1/1	2/2	6/6	18/18
Kempten	3/3	2/2	1/1	1/1	0/0	1/1	8/8	13/13
Ludwigsburg	1/1	3/3	1/1	2/2	1/1	2/2	3/3	12/12
Luedenscheid	1/1	2/2	2/2	2/2	1/1	1/1	6/3	14/11
Lueneburg	5/5	4/4	3/3	1/1	0/0	0/0	7/7	15/15
Luenen	3/3	4/4	2/2	1/1	0/0	1/1	8/8	16/16
Marburg	3/3	4/4	1/1	2/2	0/0	2/2	4/4	13/13
Marl	5/5	2/2	1/1	2/2	0/0	0/0	7/7	12/12
Minden*	7/7	1/1	3/3	0/0	0/0	1/1	14/14	19/19
Neubrandenburg	4/4	2/2	2/2	0/0	1/1	1/1	8/7	14/13
Neumuenster	4/4	2/2	2/2	0/0	3/3	2/2	11/10	20/19
Neuwied	6/6	1/1	2/2	0/0	1/1	0/0	5/5	9/9
Norderstedt	3/3	3/3	2/2	1/1	0/0	1/1	7/7	14/14
Plauen	6/6	2/2	1/1	0/0	1/1	0/0	5/4	9/8
Ratingen	2/2	2/2	2/2	2/2	1/1	0/0	5/5	12/12
Rheine*	7/7	1/1	1/1	0/0	0/0	2/2	12/12	16/16
Rosenheim*	3/3	1/1	2/2	1/1	0/0	1/1	4/4	9/9
Salzgitter	5/5	2/2	4/4	1/1	0/0	0/0	10/10	17/17
Schwerin	2/2	5/5	2/2	1/1	3/3	0/0	10/8	21/19
Sindelfingen	5/5	1/1	3/3	3/3	0/0	0/0	4/4	11/11
Velbert	2/2	2/2	2/2	2/2	1/1	0/0	6/6	13/13
Viersen	7/7	3/3	1/1	0/0	0/0	1/1	6/6	11/11
Villingen-Schwen-	5/5	3/3	4/4	2/2	0/0	0/0	7/6	16/15
Weimar	7/0	2/-	1/-	0/-	0/-	2/-	4/-	9/-
Wesel	4/4	2/2	2/2	0/0	1/1	1/1	5/5	11/11
Wilhelmshaven	7/7	3/3	3/3	0/0	0/0	1/1	7/7	14/14
Witten	3/3	4/4	1/1	2/2	0/0	1/1	7/7	15/15
Worms	3/3	5/5	2/2	2/2	0/0	2/2	4/4	15/15
Zwickau	4/4	5/5	2/2	0/0	2/2	1/1	6/5	16/15
Sum		131/12	102/10	53/53	39/39	52/50	380/35	757/72

Note: The number of gasoline stations varies because not all of them supply Super E10. Because of brand changes, openings and closures the number of stations can vary during the period. *Change of the market structure due to openings and closures.

Table 3.12: Descriptive Statistics of Control Variables for Price Increase Rounds Initiated by Aral

	Diesel				E10			
Variable	N	Mean	Min	Max	N	Mean	Min	Max
Weekend/Holiday	2592	0.32	0	1	2576	0.32	0	1
School holidays	2592	0.04	0	1	2576	0.04	0	1
Monday	2592	0.10	0	1	2576	0.11	0	1
Tuesday	2592	0.14	0	1	2576	0.14	0	1
Wednesday	2592	0.16	0	1	2576	0.16	0	1
Thursday	2592	0.12	0	1	2576	0.12	0	1
Friday	2592	0.16	0	1	2576	0.16	0	1
Saturday	2592	0.14	0	1	2576	0.14	0	1
Sunday	2592	0.17	0	1	2576	0.17	0	1

Table 3.13: Descriptive statistics of control variables for price increase rounds initiated by Shell

	Diesel				E10			
Variable	N	Mean	Min	Max	N	Mean	Min	Max
Weekend/Holiday	3110	0.35	0	1	3036	0.34	0	1
School holidays	3110	0.20	0	1	3036	0.20	0	1
Monday	3110	0.15	0	1	3036	0.15	0	1
Tuesday	3110	0.14	0	1	3036	0.14	0	1
Wednesday	3110	0.12	0	1	3036	0.12	0	1
Thursday	3110	0.16	0	1	3036	0.16	0	1
Friday	3110	0.14	0	1	3036	0.14	0	1
Saturday	3110	0.15	0	1	3036	0.15	0	1
Sunday	3110	0.13	0	1	3036	0.13	0	1

Table 3.14: Upward Price Rounds/Starter Aral/Premium E10

		Market Structure						
	Action	All majors	Without Jet	Without Total	Without Esso	Aral, Shell, Esso	Aral, Shell, Total	Aral, Shell, Jet
Aral	time	18:44:39	18:34:04	18:38:39	18:34:32	18:35:57	18:38:33	18:35:02
	first up	8.92	9.32	8.54	7.35	8.89	8.94	8.28
	share	0.98	0.93	0.94	0.99	0.95	0.89	1.00
	total +	9.19	9.78	8.77	7.65	9.02	9.15	8.60
	Response							
Shell	time	00:26:53	00:45:48	00:36:33	00:30:35	00:34:44	00:26:35	00:26:09
	first up	10.59	10.71	10.03	9.53	10.55	10.17	9.89
	share	0.77	0.89	0.89	0.85	0.73	0.83	0.86
	total +	9.68	10.62	9.92	9.22	9.89	9.89	9.37
Esso	time	01:25:19	01:14:13	01:54:50		01:35:19		
	first up	9.40	10.00	9.35		8.90		
	share	0.74	0.87	0.88		0.83		
	total +	8.46	11.54	8.77		9.03		
Total	time	01:21:26	01:34:27		01:35:02		01:31:41	
	first up	9.26	9.08		8.63		8.63	
	share	0.99	0.98		1.00		0.99	
	total +	9.21	9.10		9.07		8.35	
Jet	time	02:43:01		02:53:45	02:55:21			02:48:54
	first up	6.70		6.69	6.27			5.66
	share	0.87		0.88	0.89			0.94
	total +	6.72		6.77	6.47			6.16
NO	time	02:09:16	01:54:34	01:41:38	01:36:57	01:32:22	01:55:11	01:03:26
	first up	8.52	8.83	7.12	6.13	7.97	7.63	5.66
	share	0.23	0.18	0.23	0.21	0.25	0.18	0.14
	total +	5.88	5.59	5.32	5.90	3.55	5.90	5.46
	Observations	522	296	600	340	372	260	186

Table 3.15: Upward Price Rounds/Starter Shell/Premium E10

		Market Structure						
	Action	All majors	Without Jet	Without Total	Without Esso	Aral, Shell, Esso	Aral, Shell, Total	Aral, Shell, Jet
Shell	time	18:05:21	18:09:02	18:11:34	18:06:47	18:05:58	18:07:38	18:07:58
	first up	10.34	10.99	9.81	10.24	9.47	9.91	10.24
	share	0.96	1.00	0.99	1.00	0.92	0.94	0.96
	total +	10.11	10.78	9.63	10.04	9.32	9.78	9.98
	Response							
Aral	time	00:08:59	00:07:35	00:09:55	00:10:42	00:10:15	00:08:10	00:16:37
	first up	8.83	9.93	8.27	8.70	8.95	9.55	9.28
	share	0.85	0.83	0.83	0.96	0.87	0.81	0.96
	total +	8.74	9.49	8.33	9.04	8.84	9.39	9.49
Esso	time	01:48:13	00:59:41	02:01:38		01:35:51		
	first up	10.44	10.55	10.15		9.42		
	share	0.80	0.84	0.91		0.84		
	total +	11.04	11.98	10.38		9.85		
Total	time	01:32:50	01:28:28		01:30:11		01:30:24	
	first up	9.29	9.44		9.16		8.91	
	share	1.00	0.99		1.00		1.00	
	total +	9.34	9.72		9.48		8.87	
Jet	time	02:56:34		02:50:16	02:57:03			02:45:05
	first up	6.46		6.17	6.23			5.71
	share	0.81		0.77	0.81			0.92
	total +	6.47		6.19	6.19			6.17
NO	time	01:59:00	01:56:35	01:32:12	01:37:34	01:20:57	01:49:59	01:01:38
	first up	8.35	10.58	7.01	6.75	6.98	8.18	5.75
	share	0.20	0.19	0.23	0.21	0.26	0.18	0.13
	total +	7.63	9.55	6.86	8.11	5.08	7.10	7.95
	Observations	522	383	757	377	425	309	263

Table 3.16: Upward Price Rounds/Starter Aral/E10

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Shell total+	Shell total+	Shell total+	Shell total+	NO total+	NO total+	NO total+	NO total+	Jet total+	Jet total+	Jet total+	Jet total+
Aral total+	0.324***	0.287***	0.0401	0.0401	0.157***	0.188***	0.125***	0.104***	0.200***	0.208***	-0.0420**	-0.0493***
	(0.0292)	(0.0308)	(0.0239)	(0.0239)	(0.0271)	(0.0244)	(0.0267)	(0.0260)	(0.0194)	(0.0199)	(0.0134)	(0.0134)
Without Jet[2]	0.755**	0.737**	0.189	0.189	-0.386	-0.0426	-0.132	-0.122				
	(0.250)	(0.247)	(0.192)	(0.192)	(0.265)	(0.203)	(0.207)	(0.208)				
Without Total[2]	0.378	0.295	0.399*	0.399*	-0.496*	0.0734	0.195	0.258	0.133	0.217	0.646***	0.654***
	(0.210)	(0.209)	(0.161)	(0.161)	(0.220)	(0.187)	(0.185)	(0.172)	(0.116)	(0.114)	(0.0890)	(0.0889)
Without Esso[2]	0.0468	-0.0276	-0.0983	-0.0978	0.261	0.425*	0.427*	0.318	0.0584	0.0868	0.341***	0.316***
	(0.247)	(0.245)	(0.175)	(0.175)	(0.246)	(0.200)	(0.198)	(0.181)	(0.133)	(0.134)	(0.0987)	(0.0943)
Aral, Shell, Esso[2]	0.274	0.194	1.098***	1.098***	-2.303***	-1.434***	-1.175***	-1.035***				
	(0.216)	(0.215)	(0.180)	(0.180)	(0.243)	(0.220)	(0.226)	(0.197)				
Aral, Shell, Total[2]	0.231	0.260	-0.347	-0.347	0.0255	-0.386	-0.307	-0.412				
	(0.259)	(0.258)	(0.213)	(0.213)	(0.309)	(0.281)	(0.280)	(0.255)				
Aral, Shell, Jet[2]	-0.117	-0.185	-0.0197	-0.0162	-0.328	0.197	0.344	-0.385	-0.445**	-0.367*	0.352**	0.216*
	(0.302)	(0.303)	(0.218)	(0.223)	(0.280)	(0.210)	(0.207)	(0.222)	(0.160)	(0.159)	(0.116)	(0.109)
Wholesale price		-0.0624	0.965***	0.964***		0.920***	1.067***	1.156***		0.134***	0.705***	0.721***
		(0.0343)	(0.0397)	(0.0399)		(0.0277)	(0.0398)	(0.0361)		(0.0224)	(0.0214)	(0.0212)
Change of wholesale price		1.049***	0.368**	0.368**		-1.210***	-1.283***	-1.332***		-0.182	-0.434***	-0.437***
		(0.155)	(0.124)	(0.124)		(0.142)	(0.143)	(0.135)		(0.102)	(0.0710)	(0.0709)
Shell Baseline			-0.868***	-0.868***								
			(0.0224)	(0.0224)								
NO Baseline							-0.171***	-0.225***				
							(0.0334)	(0.0308)				
Jet Baseline											-0.679***	-0.686***
											(0.0176)	(0.0177)
Number of NO				-0.00184				0.409***				0.0748***
				(0.0195)				(0.0218)				(0.0124)
Constant	6.702***	15.80**	1.798	1.837	4.440***	-125.7***	-120.9***	-127.9***	4.879***	-14.13***	6.476**	4.701*
	(0.312)	(4.863)	(3.847)	(3.875)	(0.295)	(3.923)	(4.014)	(3.730)	(0.219)	(3.115)	(2.176)	(2.200)
Observations	2576	2576	2576	2576	2576	2576	2576	2576	1648	1648	1648	1648
Adjusted R^2	0.065	0.082	0.439	0.438	0.055	0.319	0.326	0.412	0.084	0.102	0.522	0.533
F	20.40	29.84	227.6	207.0	25.53	161.3	145.9	200.4	31.02	32.44	258.7	235.6

Note: All models were estimated by OLS with the price difference between the baseline price and the price at 10 p.m. (total+) as the dependent variable. For an exact definition of the variables see text. [2]Compared to all majors. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3.17: Upward Price Rounds/Starter Shell/E10

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Aral total+	Aral total+	Aral total+	Aral total+	NO total+	NO total+	NO total+	NO total+	Jet total+	Jet total+	Jet total+	Jet total+
Shell total+	0.0626***	0.0721***	0.0203	0.0190	0.301***	0.305***	0.245***	0.235***	0.103***	0.107***	0.0472***	0.0432***
	(0.0165)	(0.0172)	(0.0116)	(0.0115)	(0.0142)	(0.0150)	(0.0137)	(0.0135)	(0.0127)	(0.0142)	(0.0110)	(0.0109)
Without Jet[2]	0.706***	0.717***	0.619***	0.683***	1.718***	1.721***	1.323***	1.737***				
	(0.197)	(0.197)	(0.146)	(0.147)	(0.184)	(0.183)	(0.167)	(0.173)				
Without Total[2]	-0.380*	-0.361*	0.210	0.234	-0.622***	-0.615***	-0.238	-0.0679	-0.229*	-0.281**	0.0857	0.124
	(0.167)	(0.165)	(0.126)	(0.125)	(0.164)	(0.165)	(0.149)	(0.126)	(0.106)	(0.105)	(0.0873)	(0.0889)
Without Esso[2]	0.300	0.317	0.379**	0.410**	0.500***	0.506***	0.650***	0.863***	-0.266*	-0.320**	-0.00228	0.0488
	(0.184)	(0.185)	(0.145)	(0.144)	(0.150)	(0.151)	(0.122)	(0.111)	(0.116)	(0.113)	(0.0929)	(0.0945)
Aral, Shell, Esso[2]	0.148	0.174	1.429***	1.443***	-2.310***	-2.302***	-1.538***	-1.430***				
	(0.177)	(0.178)	(0.134)	(0.134)	(0.179)	(0.182)	(0.177)	(0.151)				
Aral, Shell, Total[2]	0.672***	0.662**	0.692***	0.723***	-0.433*	-0.436*	-0.295	-0.0812				
	(0.203)	(0.204)	(0.153)	(0.152)	(0.187)	(0.188)	(0.169)	(0.162)				
Aral, Shell, Jet[2]	0.756***	0.779***	0.907***	0.842***	0.361	0.369*	0.730***	0.305	-0.280*	-0.335**	0.0408	-0.0621
	(0.223)	(0.223)	(0.181)	(0.184)	(0.185)	(0.186)	(0.169)	(0.160)	(0.127)	(0.125)	(0.100)	(0.0978)
Wholesale price		0.0448	0.766***	0.778***		0.0141	0.463***	0.551***		-0.178***	0.298***	0.319***
		(0.0464)	(0.0323)	(0.0327)		(0.0454)	(0.0489)	(0.0463)		(0.0293)	(0.0258)	(0.0260)
Change of wholesale price		0.596***	-0.245	-0.256*		0.215	-0.295*	-0.378**		-0.280	-0.775***	-0.800***
		(0.172)	(0.125)	(0.125)		(0.146)	(0.139)	(0.130)		(0.147)	(0.131)	(0.131)
Aral Baseline			-0.906***	-0.907***								
			(0.0166)	(0.0166)								
NO Baseline							-0.479***	-0.496***				
							(0.0231)	(0.0213)				
Jet Baseline											-0.491***	-0.492***
											(0.0168)	(0.0166)
Number of NO				0.0441*				0.296***				0.0705***
				(0.0177)				(0.0193)				(0.0128)
Constant	8.107***	1.566	35.02***	33.22***	4.587***	2.515	9.769	-2.345	5.431***	30.88***	35.75***	32.51***
	(0.191)	(6.616)	(4.236)	(4.311)	(0.185)	(6.468)	(6.277)	(5.993)	(0.148)	(4.141)	(2.968)	(2.979)
Observations	3036	3036	3036	3036	3036	3036	3036	3036	1919	1919	1919	1919
Adjusted R^2	0.022	0.026	0.470	0.471	0.272	0.272	0.368	0.422	0.041	0.062	0.376	0.386
F	8.813	8.212	327.1	298.1	190.0	150.1	232.7	238.5	17.61	21.92	157.8	144.1

Note: All models were estimated by OLS with the price difference between the baseline price and the price at 10 p.m. (total+) as the dependent variable. For an exact definition of the variables see text. [2]Compared to all majors. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3.18: Upward Price Rounds/Starter Aral/Diesel [2]

	(1)	(2)	(3)	(4)	(5)	(6)
	Shell total+	Shell total+	NO total+	NO total+	Jet total+	Jet total+
Aral total+	0.182***	0.180***	0.0155	0.0227	-0.0145	-0.0121
	(0.0221)	(0.0219)	(0.0294)	(0.0292)	(0.0107)	(0.0105)
Without Jet[2]	0.0341	0.0444	-0.267	-0.254		
	(0.187)	(0.185)	(0.265)	(0.266)		
Without Total[2]	-0.0388	-0.0291	0.603**	0.608**	0.416***	0.417***
	(0.168)	(0.167)	(0.200)	(0.200)	(0.0845)	(0.0841)
Without Esso[2]	0.296	0.319	-0.217	-0.237	0.393***	0.388***
	(0.183)	(0.183)	(0.226)	(0.226)	(0.0826)	(0.0817)
Aral, Shell, Esso[2]	0.363*	0.381*	-1.548***	-1.537***		
	(0.174)	(0.174)	(0.225)	(0.225)		
Aral, Shell, Total[2]	0.106	0.133	1.609***	1.550***		
	(0.214)	(0.212)	(0.304)	(0.304)		
Aral, Shell, Jet[2]	0.159	0.174	0.301	0.299	0.242*	0.237*
	(0.222)	(0.221)	(0.260)	(0.261)	(0.0974)	(0.0969)
Wholesale price	0.247***	0.210***	-0.434***	-0.353***	0.269***	0.272***
	(0.0545)	(0.0518)	(0.0702)	(0.0697)	(0.0313)	(0.0307)
Change of wholesale price	0.100	0.298	0.124	-0.00950	-0.306***	-0.316***
	(0.149)	(0.154)	(0.174)	(0.173)	(0.0835)	(0.0843)
Shell Baseline	-0.843***	-0.851***				
	(0.0197)	(0.0202)				
NO Baseline			-0.317***	-0.317***		
			(0.0345)	(0.0348)		
Jet Baseline					-0.670***	-0.668***
					(0.0157)	(0.0156)
Number of NO	-0.0708***	-0.0752***	0.350***	0.358***	0.0625***	0.0632***
	(0.0190)	(0.0187)	(0.0245)	(0.0244)	(0.0115)	(0.0115)
Weekend/Holi-day	-0.312*		0.180		0.157*	
	(0.125)		(0.148)		(0.0694)	
School holidays	-1.086***		1.958***		0.258	
	(0.289)		(0.269)		(0.143)	
Tuesday[3]		-0.0532		-0.645*		-0.0614
		(0.183)		(0.270)		(0.114)
Wednesday[3]		-0.548**		-0.301		-0.0192
		(0.185)		(0.269)		(0.110)
Thursday[3]		-0.847***		-1.027***		-0.553***
		(0.188)		(0.280)		(0.126)
Friday[3]		-1.047***		-0.156		-0.0401
		(0.222)		(0.271)		(0.114)
Saturday[3]		-0.498*		-0.605*		0.00783
		(0.194)		(0.273)		(0.120)
Sunday[3]		-1.089***		-0.0546		0.0290
		(0.221)		(0.267)		(0.113)
Constant	91.03***	97.22***	99.01***	89.22***	60.12***	59.49***
	(6.624)	(6.060)	(8.034)	(7.803)	(3.461)	(3.308)
Observations	2592	2592	2592	2592	1693	1693
Adjusted R2	0.482	0.488	0.205	0.202	0.603	0.608
F	223.8	165.4	61.03	45.06	289.5	212.9

Note: All models were estimated by OLS with the price difference between the baseline price and the price at 10 p.m. (total+) as the dependent variable. For an exact definition of the variables see text. [2]Compared to all majors. [3]Compared to Monday. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3.19: Upward Price Rounds/Starter Aral/E10 [2]

	(1)	(2)	(3)	(4)	(5)	(6)
	Shell total+	Shell total+	NO total+	NO total+	Jet total+	Jet total+
Aral total+	0.0514*	0.0387	0.112***	0.105***	-0.0403**	-0.0500***
	(0.0237)	(0.0240)	(0.0264)	(0.0262)	(0.0134)	(0.0135)
Without Jet[2]	0.209	0.220	-0.113	-0.115		
	(0.190)	(0.190)	(0.207)	(0.208)		
Without Total[2]	0.437**	0.414**	0.269	0.261	0.664***	0.654***
	(0.161)	(0.160)	(0.172)	(0.172)	(0.0878)	(0.0886)
Without Esso[2]	-0.129	-0.0996	0.304	0.318	0.304**	0.318***
	(0.172)	(0.173)	(0.181)	(0.182)	(0.0947)	(0.0937)
Aral, Shell, Esso[2]	1.097***	1.114***	-1.045***	-1.033***		
	(0.176)	(0.178)	(0.197)	(0.197)		
Aral, Shell, Total[2]	-0.389	-0.337	-0.442	-0.411		
	(0.211)	(0.211)	(0.254)	(0.255)		
Aral, Shell, Jet[2]	-0.0175	0.00746	-0.393	-0.380	0.207	0.222*
	(0.217)	(0.220)	(0.222)	(0.222)	(0.108)	(0.109)
Wholesale price	0.991***	0.970***	1.168***	1.156***	0.729***	0.716***
	(0.0408)	(0.0394)	(0.0362)	(0.0363)	(0.0215)	(0.0210)
Change of wholesale price	0.360**	0.566***	-1.355***	-1.313***	-0.475***	-0.392***
	(0.129)	(0.135)	(0.140)	(0.140)	(0.0743)	(0.0756)
Shell Baseline	-0.851***	-0.864***				
	(0.0217)	(0.0225)				
NO Baseline			-0.214***	-0.223***		
			(0.0312)	(0.0315)		
Jet Baseline					-0.675***	-0.687***
					(0.0179)	(0.0179)
Number of NO	0.00113	-0.00285	0.410***	0.408***	0.0752***	0.0740***
	(0.0193)	(0.0193)	(0.0218)	(0.0218)	(0.0123)	(0.0123)
Weekend/Holi-day	-0.402***		-0.114		-0.0255	
	(0.118)		(0.120)		(0.0732)	
School holidays	-2.040***		-0.973***		-0.802***	
	(0.285)		(0.275)		(0.173)	
Tuesday[3]		-0.279		-0.198		-0.207
		(0.164)		(0.221)		(0.128)
Wednesday[3]		-0.641***		-0.345		-0.0102
		(0.173)		(0.219)		(0.126)
Thursday[3]		-0.722***		-0.0892		-0.459**
		(0.175)		(0.234)		(0.141)
Friday[3]		-1.141***		-0.184		-0.220
		(0.214)		(0.216)		(0.129)
Saturday[3]		-0.557**		-0.294		-0.174
		(0.184)		(0.221)		(0.132)
Sunday[3]		-1.244***		-0.244		-0.201
		(0.213)		(0.214)		(0.126)
Constant	-4.361	1.103	-131.2***	-128.0***	2.068	5.865**
	(4.048)	(3.760)	(3.791)	(3.781)	(2.423)	(2.205)
Observations	2576	2576	2576	2576	1648	1648
Adjusted R2	0.452	0.450	0.414	0.411	0.538	0.536
F	189.2	135.7	173.5	130.7	197.8	138.5

Note: All models were estimated by OLS with the price difference between the baseline price and the price at 10 p.m. (total+) as the dependent variable. For an exact definition of the variables see text. [2]Compared to all majors. [3]Compared to Monday. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3.20: Upward Price Rounds/Starter Shell/Diesel [2]

	(1)	(2)	(3)	(4)	(5)	(6)
	Aral total+	Aral total+	NO total+	NO total+	Jet total+	Jet total+
Shell total+	0.0565***	0.0414***	0.195***	0.186***	0.0117	0.00274
	(0.0113)	(0.0107)	(0.0124)	(0.0123)	(0.00812)	(0.00790)
Without Jet²	0.792***	0.828***	1.292***	1.310***		
	(0.152)	(0.150)	(0.204)	(0.204)		
Without Total²	0.0183	0.00749	0.0552	0.0533	0.0817	0.0771
	(0.127)	(0.127)	(0.135)	(0.134)	(0.0827)	(0.0810)
Without Esso²	0.537***	0.583***	0.00847	0.0228	0.0799	0.109
	(0.150)	(0.149)	(0.132)	(0.130)	(0.0919)	(0.0897)
Aral, Shell, Esso²	1.456***	1.469***	-1.520***	-1.516***		
	(0.137)	(0.134)	(0.170)	(0.169)		
Aral, Shell, Total²	0.975***	0.960***	-0.0693	-0.0735		
	(0.157)	(0.154)	(0.179)	(0.178)		
Aral, Shell, Jet²	0.933***	0.966***	0.783***	0.796***	-0.0144	0.00293
	(0.180)	(0.178)	(0.156)	(0.155)	(0.0889)	(0.0880)
Wholesale price	0.679***	0.742***	0.287***	0.303***	0.126***	0.164***
	(0.0520)	(0.0449)	(0.0555)	(0.0528)	(0.0350)	(0.0354)
Change of wholesale price	-0.00780	-0.0540	-0.449***	-0.489***	-0.471***	-0.566***
	(0.0879)	(0.0955)	(0.111)	(0.113)	(0.0814)	(0.0840)
Aral Baseline	-0.890***	-0.872***				
	(0.0171)	(0.0173)				
NO Baseline			-0.537***	-0.533***		
			(0.0224)	(0.0223)		
Jet Baseline					-0.547***	-0.540***
					(0.0154)	(0.0156)
Number of NO	0.0480**	0.0553***	0.226***	0.228***	0.0352***	0.0393***
	(0.0170)	(0.0166)	(0.0180)	(0.0178)	(0.0103)	(0.0101)
Weekend/Holiday	0.0900		0.0772		0.266***	
	(0.0976)		(0.0958)		(0.0522)	
School Holidays	0.554***		0.166		0.474***	
	(0.121)		(0.103)		(0.0619)	
Tuesday³		0.293*		0.601***		0.0375
		(0.128)		(0.176)		(0.0846)
Wednesday³		-0.122		0.421*		-0.848***
		(0.142)		(0.184)		(0.164)
Thursday³		-0.0812		0.523**		0.0972
		(0.154)		(0.172)		(0.0811)
Friday³		0.253*		0.552**		-0.0569
		(0.124)		(0.178)		(0.0836)
Saturday³		0.394**		0.628***		0.137
		(0.124)		(0.173)		(0.0697)
Sunday³		-0.686***		0.315		0.251***
		(0.201)		(0.179)		(0.0698)
Constant	41.46***	31.25***	38.32***	35.53***	61.97***	56.51***
	(6.908)	(5.907)	(6.316)	(5.906)	(3.745)	(3.678)
Observations	3110	3110	3110	3110	1989	1989
Adjusted R2	0.464	0.469	0.380	0.382	0.471	0.487
F	261.9	200.4	202.3	159.1	181.3	129.9

Note: All models were estimated by OLS with the price difference between the baseline price and the price at 10 p.m. (total+) as the dependent variable. For an exact definition of the variables see text. ²Compared to all majors. ³Compared to Monday. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3.21: Upward Price Rounds/Starter Shell/E10 [2]

	(1)	(2)	(3)	(4)	(5)	(6)
	Aral total+	Aral total+	NO total+	NO total+	Jet total+	Jet total+
Shell total+	0.0204	0.0122	0.220***	0.231***	0.0534***	0.0482***
	(0.0128)	(0.0121)	(0.0142)	(0.0135)	(0.0105)	(0.0101)
Without Jet[2]	0.681***	0.677***	1.761***	1.736***		
	(0.148)	(0.145)	(0.173)	(0.173)		
Without Total[2]	0.232	0.226	-0.0487	-0.0707	0.115	0.119
	(0.126)	(0.124)	(0.125)	(0.126)	(0.0887)	(0.0864)
Without Esso[2]	0.407**	0.404**	0.894***	0.858***	0.0333	0.0483
	(0.145)	(0.143)	(0.110)	(0.111)	(0.0943)	(0.0919)
Aral, Shell, Esso[2]	1.439***	1.418***	-1.393***	-1.441***		
	(0.134)	(0.132)	(0.152)	(0.151)		
Aral, Shell, Total[2]	0.726***	0.730***	-0.116	-0.0744		
	(0.152)	(0.149)	(0.161)	(0.161)		
Aral, Shell, Jet[2]	0.840***	0.850***	0.314	0.308	-0.0632	-0.0585
	(0.184)	(0.181)	(0.160)	(0.160)	(0.0972)	(0.0960)
Wholesale price	0.772***	0.757***	0.616***	0.535***	0.274***	0.287***
	(0.0362)	(0.0330)	(0.0509)	(0.0456)	(0.0266)	(0.0256)
Change of wholesale price	-0.256*	-0.191	-0.385**	-0.340**	-0.783***	-0.879***
	(0.126)	(0.134)	(0.130)	(0.130)	(0.128)	(0.133)
Aral Baseline	-0.907***	-0.897***				
	(0.0168)	(0.0171)				
NO Baseline			-0.493***	-0.495***		
			(0.0217)	(0.0216)		
Jet Baseline					-0.497***	-0.493***
					(0.0165)	(0.0164)
Number of NO	0.0436*	0.0426*	0.302***	0.295***	0.0662***	0.0670***
	(0.0179)	(0.0175)	(0.0193)	(0.0192)	(0.0129)	(0.0125)
Weekend/Holi-day	0.000226		-0.0614		0.179***	
	(0.0930)		(0.0883)		(0.0531)	
School holidays	0.0440		-0.458***		0.242***	
	(0.111)		(0.104)		(0.0661)	
Tuesday[3]		0.679***		0.468**		0.0326
		(0.122)		(0.161)		(0.0900)
Wednesday[3]		0.431***		0.519**		-0.874***
		(0.126)		(0.169)		(0.172)
Thursday[3]		0.104		0.372*		0.0619
		(0.151)		(0.157)		(0.0894)
Friday[3]		0.547***		0.419**		-0.0785
		(0.119)		(0.159)		(0.0881)
Saturday[3]		0.679***		0.522***		0.0369
		(0.117)		(0.155)		(0.0724)
Sunday[3]		-0.410*		0.228		0.111
		(0.191)		(0.161)		(0.0751)
Constant	34.06***	34.56***	-11.82	-0.578	39.53***	37.21***
	(4.873)	(4.269)	(6.757)	(5.832)	(3.125)	(2.854)
Observations	3036	3036	3036	3036	1919	1919
Adjusted R2	0.471	0.485	0.425	0.424	0.390	0.415
F	253.1	200.8	206.0	159.4	118.2	91.04

Note: All models were estimated by OLS with the price difference between the baseline price and the price at 10 p.m. (total+) as the dependent variable. For an exact definition of the variables see text. [2]Compared to all majors. [3]Compared to Monday. Standard errors in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3.22: Descriptive Statistics for Price Increase Rounds Initiated by Shell [Logit]

	Diesel					E10				
Variable	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Logit	5593	0.56	0.50	0	1	5503	0.55	0.50	0	1
Price Shell – Aral, before	5593	-0.04	2.44	-16	17	5503	-0.33	2.22	-15	18
All majors	5593	0.17		0	1	5503	0.17		0	1
Without Jet	5593	0.12		0	1	5503	0.12		0	1
Without Total	5593	0.24		0	1	5503	0.25		0	1
Without Esso	5593	0.13		0	1	5503	0.13		0	1
Aral, Shell, Esso	5593	0.14		0	1	5503	0.14		0	1
Aral, Shell, Total	5593	0.10		0	1	5503	0.10		0	1
Aral, Shell, Jet	5593	0.10		0	1	5503	0.08		0	1
Number of Aral	5593	1.97	0.86	1	4	5503	1.99	0.86	1	4
Number of Shell	5593	2.56	1.16	1	5	5503	2.55	1.16	1	5
Number of Esso	5593	1.04	0.90	0	3	5503	1.07	0.90	0	3
Number of Jet	5593	0.76	0.91	0	3	5503	0.78	0.91	0	3
Number of Total	5593	0.99	0.91	0	4	5503	0.96	0.91	0	4
Number of NO	5593	6.88	2.76	2	13	5503	6.52	2.51	2	12
Monday	5593	0.13		0	1	5503	0.13		0	1
Tuesday	5593	0.14		0	1	5503	0.14		0	1
Wednesday	5593	0.14		0	1	5503	0.14		0	1
Thursday	5593	0.14		0	1	5503	0.14		0	1
Friday	5593	0.15		0	1	5503	0.15		0	1
Saturday	5593	0.15		0	1	5503	0.15		0	1
Sunday	5593	0.15		0	1	5503	0.15		0	1
School Holidays	5593	0.12		0	1	5503	0.12		0	1

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4. Price Gouging at the Pump? The Lerner Index and the German Fuel Market

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Abstract

Gasoline prices in Germany fluctuate significantly within one day. Price ranges of 15 euro cent per day are not uncommon. Consumers therefore often perceive that market power is exercised in the retail fuel market. Especially high surcharges in the late evening are considered to be price gouging. The German Federal Cartel Authority used these price mark-ups as evidence for oligopoly market power in four metropolitan regions between 2007 and 2010. Data for eight metropolises and 65 medium-sized cities from May 2016 to June 2019 show that the lowest price level in the day is reached in the early evening and then rises sharply. We use the well-known Lerner Index to measure market power in these evening hours. Our descriptive analysis shows that the Lerner Indices of the premium brands Aral, Shell, and Total S.A. rise after 10 p.m., that is, after a large part of the price-aggressive gas stations have closed. The results were about 0.1 for diesel and 0.08 for gasoline. Other companies achieve lower values of 0.05-0.07. Compared to other international studies that deal with the fuel market, we find a similar level of Lerner Indices, but only for few hours and not for the whole day. Multivariate estimations cannot show that a larger market share of the analysed brand or a lower market share of price-aggressive firms increases the index. Influences of weekdays, different cities or wholesale prices cannot be proven either. Therefore, the gasoline market seems to be competitive, at least in a higher dimension as it is publicly perceived. Hence, pricing behaviour in the evening and at night cannot be used as evidence of a serious abuse of market power by petrol stations, which could be relevant for the evaluation of future mergers in the petrol market.

JEL Classification: L13, L43, L91

Keywords: Gasoline, Market Power, Lerner Index

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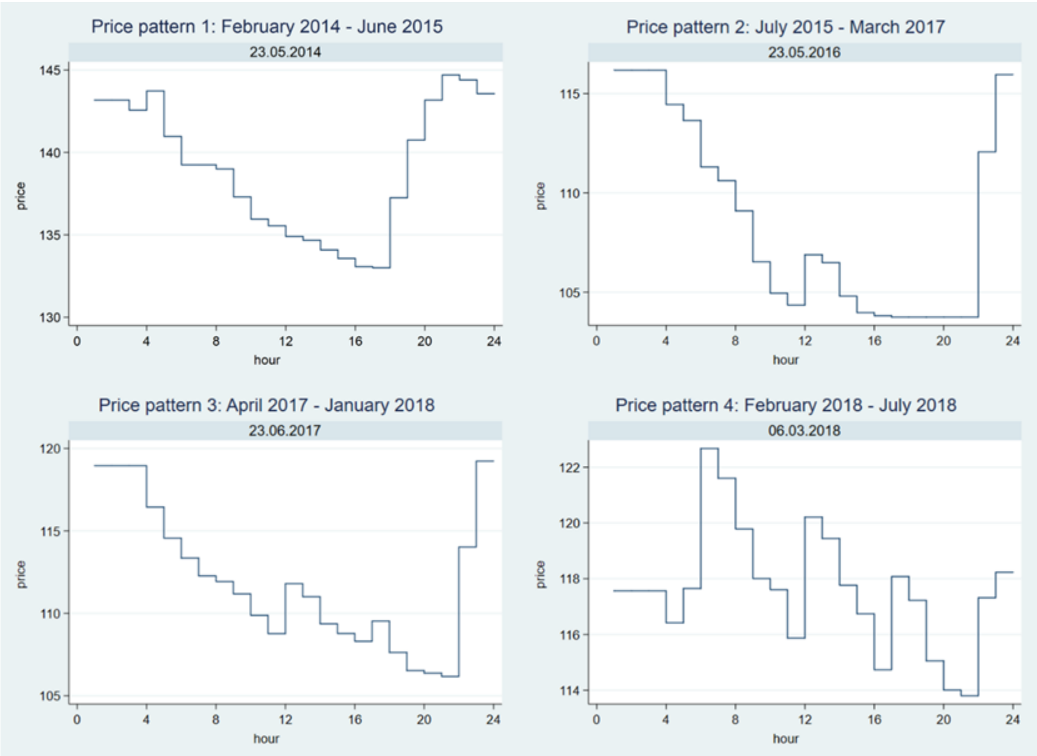
4.1. Introduction

Compared to other countries, German fuel prices heavily fluctuate within any given day and are not subject to price regulations. In the regions we are looking at, petrol stations changed their prices on average eight times a day in 2016, and nearly ten times a day in 2017. In the first half of 2018, the price changes increased to an average of over eleven adjustments per station. Figure 4.1 shows four consecutive price patterns that have occurred nationwide since mid-2014, with the city of Luneburg serving as a prime example. The lowest prices observed within all patterns occur in the early evening hours, followed by strong price increases in the late evening. A typical price mark-up is between 10 and 15 euro cents per liter.

Figure 4.1: Four price patterns – Luneburg – Diesel



Note: Hourly point-in-time prices in euro cents per liter, averaged from all stations.
Data: clevertanken.de, Tankerkönig.

Price Pattern 1 shows a single step-by-step price increase starting at about 6 p.m. In price pattern 2 the strong price increase takes place later, at about 10 p.m., and a further small price hike occurs at noon. Price Pattern 3 is characterized by an additional afternoon mark-up. Since February of 2018, the high price increases have happened in two steps. The first step still occurs in the late evening hours and continues until the next day between 5 and 6 a.m. The price jumps at noon and in the afternoon are more pronounced in this price pattern.

Why are there higher prices in the evening hours? A possible explanation could be that there are a larger number of price insensitive customers on the roads at night compared to daytime. In addition, there are fewer open stations, which limits the possibilities for refuelling. However, customers who have to fill up are exposed to "price gouging" (Snyder 2009; Montgomery et al 2007, Süddeutsche Zeitung 2018), which seems to happen every evening, not just during a supply or cost shock. So, how economically relevant are these price increases in the evening hours? The German Federal Cartel Authority used these price mark-ups as evidence for oligopoly market power in four metropolitan regions between 2007 and 2010 (Bundeskartellamt 2011).

In measuring the relevance of market power, most economists will likely keep in mind the concept of the Lerner Index (Cairns 1995; Feinberg 1980; Giocoli 2012; Lerner 1934; Saving 1970). In 1934, Abba P. Lerner formalized the index of the degree of market power of a monopoly, which measures the proportional deviation of the price (P_i) at the profit maximizing quantity of the company (i) from the company's marginal cost (MC_i):

$$LI_i = \frac{P_i - MC_i}{P_i} \tag{4.1}$$

The Lerner Index (L_i) can have any value between zero and one. Assuming perfect competition marginal costs are equivalent to price and the index becomes nil. An increase in market power, thus an increase in the price markup (P_i - MC_i), causes the index to converge into one.

Table 4.1 shows examples of estimated Lerner Indices for several industries, products and brands. However, the empirical literature, particularly that dealing with the gasoline market, is relatively limited. The availability of data, especially marginal costs, is often restricted and therefore the calculation without suitable approximations is difficult. Slade (1987) collected daily station prices, variable costs and sales volumes in the Kingsway area of Vancouver, Canada, for three months during the summer of 1983. She tested oligopoly models by estimating demand and first-order-profit-maximization-equations for each station, thus calculating indices of 0.1 on average. Another study used daily retail prices and quantities from eight stations in Perth, Australia, for different periods between 2001 and 2003 (Wang 2009). Calculations with after-tax-retail-prices and wholesale prices resulted in very low values between 0.02 and 0.07 per station. Nguyen and Steen (2018) used daily retail and wholesale prices as well as quantities from 180 stations in the three largest cities in Sweden for the entire year of 2012. Using a two-stage least square model and controlling for other variables like distance to competitors, density in the number of stations, and population, they found values of maximum 0.015 for the brand Preem. Compared to other markets, industries or brands, Lerner Indices for gasoline seem to be very low (see Table 4.1).

Table 4.1: Lerner indices for selected industries/brands

Industry/Brand	Lerner Index	Country	Source
Fuels	max. 0.015	Sweden	Nguyen and Steen (2018)
Fuels	0.02 - 0.07	Australia	Wang (2009)
Fuels	0.1	Canada	Slade (1987)
Financial institutions	0.35 - 0.82	Europe	Gischer et al. (2015)
Financial institutions	0.05 - 0.32	Worldwide	Coccorese (2014)
Bananas	0.29	Germany	Deodhar and Sheldon (1995)
Kodak	0.5	U.S.A.	U.S. D.O.J. (1994)
Coca-Cola & Pepsi	0.24 - 0.45	U.S.A.	Golan et al. (2000)
AT&T	0.2	U.S.A.	Kahai et al. (1996)

Further studies analysed in which gasoline markets higher price mark-ups occur. In Canadian and Austrian cities it was observed that a decreasing number of stations is associated with higher mark-ups (Clemenz and Gugler 2006; Eckert and West 2004). This effect can also be observed when the distance between petrol stations increases (USA: Barron et al. 2004) and there are less price-aggressive suppliers (Austria: Pennerstorfer 2009; Germany: Haucap et al. 2016). Lower brand diversity (USA: Lewis 2008; Hosken et al. 2008) and lower service quality at petrol stations (England: Ning and Haining 2003; Germany: Haucap et al. 2017) also lead to higher surcharges. The German Cartel Office argued that Aral, Shell, Esso, Total S.A., and Jet form an oligopoly and are able to execute market power (Bundeskartellamt 2011). However, it seems empirically clear that Jet, a nationwide operating fuel company, behaves more like a non-vertically integrated company and follows a price aggressive strategy (Neukirch and Wein 2016). Hence, we can expect that a lower degree of competition between gasoline stations will reduce the Lerner Indices. A lower degree of competition can be expected if the market shares of low-priced companies, in particular Jet and independent retailers, are lower and with fewer opened stations within time periods of potentially increased demand, such as on weekends or public holidays.

Consumers and the antitrust authorities claim that the evening price increases are an abuse of market power. We calculate the Lerner Index at these times to investigate this allegation and analyse whether the companies' market shares and further features have an impact on the magnitude of the indices.

To preview results, we show that the values are comparable to those of other countries, but these refer to a daily basis and not to a high price period within a day. Therefore, the German gasoline market seems to be competitive, at least in a higher dimension as it is publicly and officially perceived. Furthermore, a multivariate analysis cannot confirm that market shares, weekdays or regions have an influence on the size of the Lerner Indices.

Our paper is organized as follows. We discuss data and methods in Section 4.2, and present descriptive results for calculated Lerner Indices in Section 4.3. To explain factors for different values of the index, we present in Section 4.4 results of Ordinary Least Squares regressions (OLS). Robustness tests are shown in Section 4.5, and Section 4.6 concludes.

4.2. Data and Methods

Since December 2013, when the German Federal Cartel Office introduced the Market Transparency Unit for Fuels, all filling stations have been required to report all prices in real time. Consumers can retrieve this information via the Internet or by using an app, which is intended to reduce the information asymmetry that exists to the disadvantage of consumers in order to intensify competition between service station operators. Furthermore, the data improves the ability of the Federal Cartel Office to intervene in price gouging situations. The app provider, Tankerkoenig.de[17], provided us with data for over two years – from May 2, 2016 to June 21, 2018 – 780 days, so we can focus on the Price Patterns 2, 3, and 4 mentioned in the introduction (see Figure 4.1). In addition to the prices for diesel and petrol (unleaded Super E5 and E10), the dataset contains information about the address, brand and opening hours of the respective petrol station. Unfortunately, no information is available on the quantities sold.

For market definition, we use the same metropolitan regions as the German Cartel Office (Bundeskartellamt 2015) used in their reports: Hamburg, Berlin, Munich, Cologne, Frankfurt am Main, Stuttgart, Leipzig, and Dresden. As these market areas are quite large, it can be criticized that petrol stations located far apart are not in direct competition with each other. Therefore we extend the analysis by 65 medium-sized cities with populations between 60,000 and 100,000. In these regions the number as well as the distance between the stations is smaller and so we can control for different market conditions.

As brands, we consider companies that are nationally represented and vertically integrated, such as Aral, Shell, Esso, Total S.A., and Jet. Again, the Cartel Office recognizes these brands as an oligopoly. Our study classifies petrol stations that operate nationwide but do not belong to the alleged oligopoly into a group that we define as Non-Oligopolists 1 (NO1). The group includes: Star, AVIA, HEM, OIL!, Agip, OMV, and Westfalen. We grouped locally active sellers, mostly independent stations, together and refer to them as Non-Oligopolists 2 (NO2). Table 4.9 gives an overview of the cities and the number of fuel stations of each brand.

Table 4.2 shows the number of petrol stations in our dataset, which does not include motorway petrol stations. Of the approximately 14,000 existing filling stations in Germany, we consider around 2000. Aral has the highest market share of an individual brand, followed by Shell and Esso. All local or independent stations (NO2) have the highest market share, but only during the daytime. We will present more about operating hours later on. Together, the nationwide Non-Oligopolists 1 (NO1) possess a comparable market share to Aral.

[17] https://creativecommons.tankerkoenig.de

Table 4.2: Number of Petrol Stations – Diesel/E5/E10

	Aral	Shell	Esso	Jet	Total S.A.	NO1	NO2	Sum
Diesel	368	274	172	140	150	365	465	1934
E5	367	274	171	141	150	362	456	1921
E10	366	273	169	141	150	359	430	1888

Note: Maximum number of gas stations open at the same time

We determine the Lerner Index for six specific times during the evening and night. We calculate the hourly point-in-time prices in euro cents per liter, averaged over all stations of a brand or group in a region from 7 p.m. to midnight. Since there is no detailed information about costs available, we use the lowest daily average price of a brand as an approximation for the marginal cost. If we assume that companies do not set prices below their marginal costs, the lowest daily price is the upper limit of marginal costs. With the following equation we calculate the daily Lerner Index:

$$LI_{jit} = \frac{Average\ price_{jit} - Lowest\ average\ price_{jit}}{Average\ price_{jit}} \tag{4.2}$$

With: j=brand/group; i=region; t=7 p.m. to 12 a.m.

In Section 4.5, we use wholesale prices, including all taxes and fees, provided by the Oil Market Report (O.M.R.) to conduct robustness tests for quality assurance. Due to very low regional price differences and a lack of information about exact delivery routes, we use the data from the "West" trading place, which has the highest wholesale turnover in Germany[18]. Wholesale quantities are only traded between Monday and Friday, so corresponding prices were not available for weekends and public holidays. To analyze all daily retail prices, we apply Friday wholesale prices for weekends, and use the value from the day before for public holidays. The data contains only the highest as well as lowest price of the day and do not include transportation costs from refineries to filling stations, or operating costs. These prices form the lower limit of the marginal costs, with which we clearly overestimate the Lerner Index.

Figure 4.2 depicts the lowest daily price averaged from all stations and regions as well as the minimum and maximum wholesale prices for Diesel (see Figures 4.7 and 4.8 for both gasoline types). The data shows price changes follow a common trend. Table 4.3 shows the average difference between the lowest daily retail price and the maximum and minimum wholesale price, thus all possible distribution costs and profits of the companies. The values range between 4.8 and 8.2 euro cents per liter for the lower wholesale price, and between 4.2 and 7.7 for the higher daily

[18] See https://www.omr.de/neu/ for detailed information on how price tracking is done and how the eight trading centers in Germany are distributed.

price. Information on costs for transport and distribution are not obtainable; however, an annual study suggests that costs are between 6 and 8 cents per liter (Gürsel and Tölke 2017, 2018).

Figure 4.2: Average daily minimum retail price, minimum and maximum wholesale price for Diesel

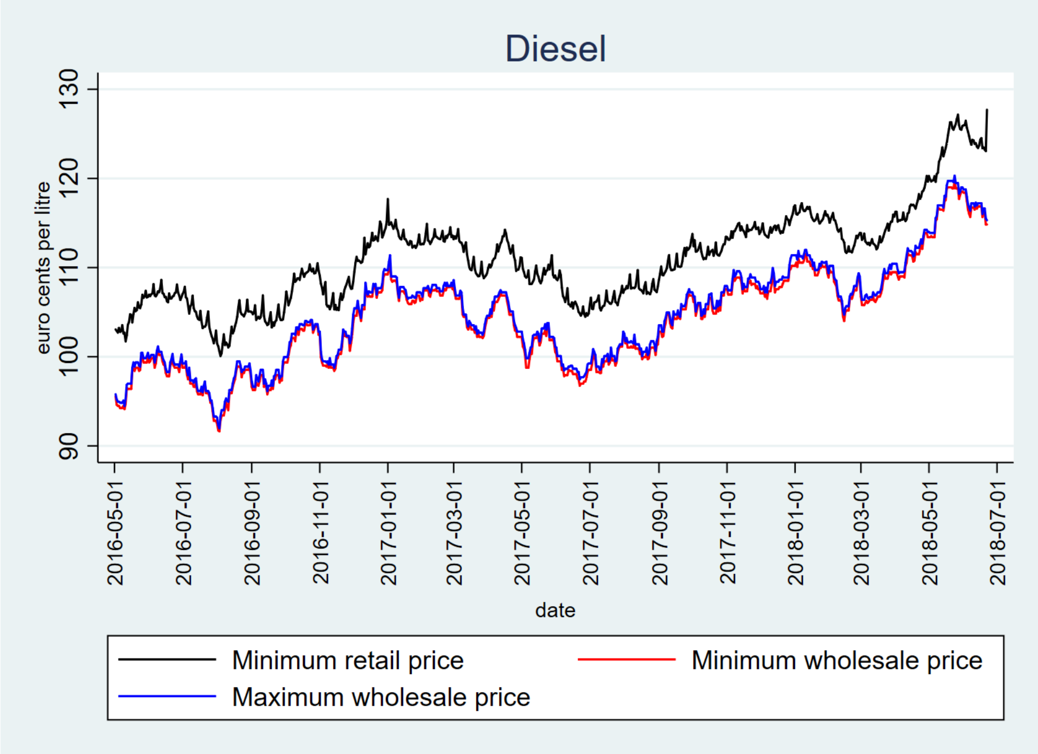


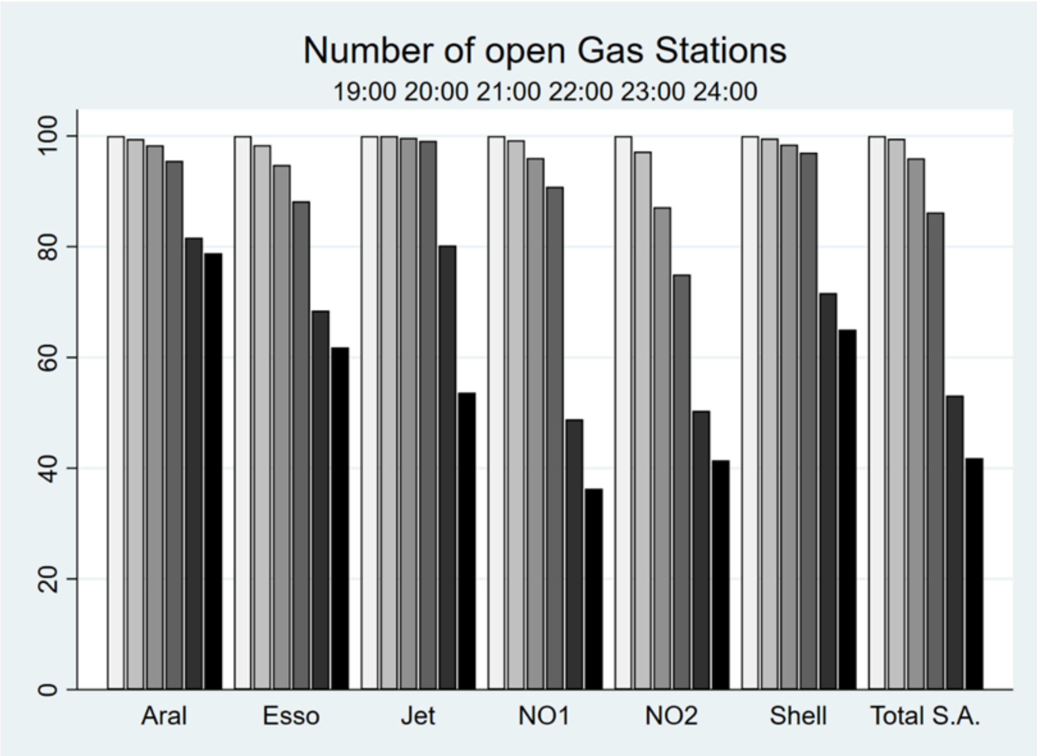
Table 4.3: Average difference between lowest daily price and wholesale price

	Minimum Wholesale Price			Maximum Wholesale Price		
	Diesel	E5	E10	Diesel	E5	E10
Aral	8.21	7.50	7.40	7.70	6.90	6.82
Shell	7.89	6.93	6.06	7.37	6.34	5.47
Esso	7.18	6.21	6.13	6.67	5.62	5.54
Total S.A.	6.89	6.21	6.11	6.38	5.61	5.53
Jet	5.96	5.11	4.80	5.44	4.51	4.21
NO1	6.30	5.49	5.38	5.79	4.90	4.80
NO2	5.96	5.16	4.77	5.45	4.56	4.18

Since the values do not differ we assume that we reliably estimate the Lerner Index with the lowest daily retail price, taking into account other costs, such as transportation, which are not considered when using wholesale prices.

Figure 4.3 and Table 4.4 give an impression about the operating hours of gas stations in our sample. Several stations are closed after 10 p.m.. Less than the half of non-oligopolists and Total S.A. stations still provide service at 11 p.m., and at midnight that number drops to forty percent or lower. On the contrary, Aral, and to a minor extent Shell and Esso, keep between three quarters and two thirds of their stations open after 11 p.m. Jet keeps a high market coverage until 11 p.m., but has a significant number of stations that close afterwards. Overall, the composition of the market changes significantly during the evening.

Figure 4.3: Number of open gas stations in percent



Note: Number of open gas stations in percent compared to 7 p.m. average over all days of the week and holidays.

Table 4.4: Number of open gas stations in percent

Time/Brand	Aral	Esso	Jet	NO1	NO2	Shell	Total S.A.
7 p.m.	100%	100%	100%	100%	100%	100%	100%
8 p.m.	99%	98%	100%	99%	97%	100%	99%
9 p.m.	98%	95%	100%	96%	87%	98%	96%
10 p.m.	96%	88%	99%	91%	75%	97%	86%
11 p.m.	82%	68%	80%	49%	50%	72%	53%
12 a.m.	79%	62%	54%	36%	41%	65%	42%

Note: Open gas stations in percent compared to 7 p.m. Average over all days of the week and holidays.

4.3. Descriptive Results

We calculate the Lerner Index using the lowest daily price as the marginal cost for all 1,934 gas stations from May 2, 2016 to June 21, 2018 for six points in time between 7 p.m. and 12 a.m. Figure 4.4 shows the indices for diesel over all regions, separated by brands in a box plot. The box represents 50 % of all values, bounded by the 75% quartile and the 25% quartile. The median of the data is noted by a line within the box. Values outside of that range are graphically expressed by "whiskers", which show possible values within 1.5 times the distance of the mentioned quartiles. For the purpose of presentation, we excluded outliers from the boxplot.

During the early evening, from 7 to 10 p.m., the Lerner Indices were very small, close to nil. The results are independent from the analyzed brands – other than Total S.A., which already raised prices by 10 p.m., reaching a median of nearly 0.1. The early price change is probably related to the closing time of the station operator.

Afterward, we see higher and more dispersed indices of Aral and Shell (median of over 0.1). While other market participants' increased prices moderately at 11 p.m., Jet kept prices at a low level and did not exert any market power. After that, higher values began to appear from the other companies, but their values were still lower compared to Aral and Shell.

Figure 4.4: Lerner Index by brand – Diesel – minimum retail price is used for the marginal costs

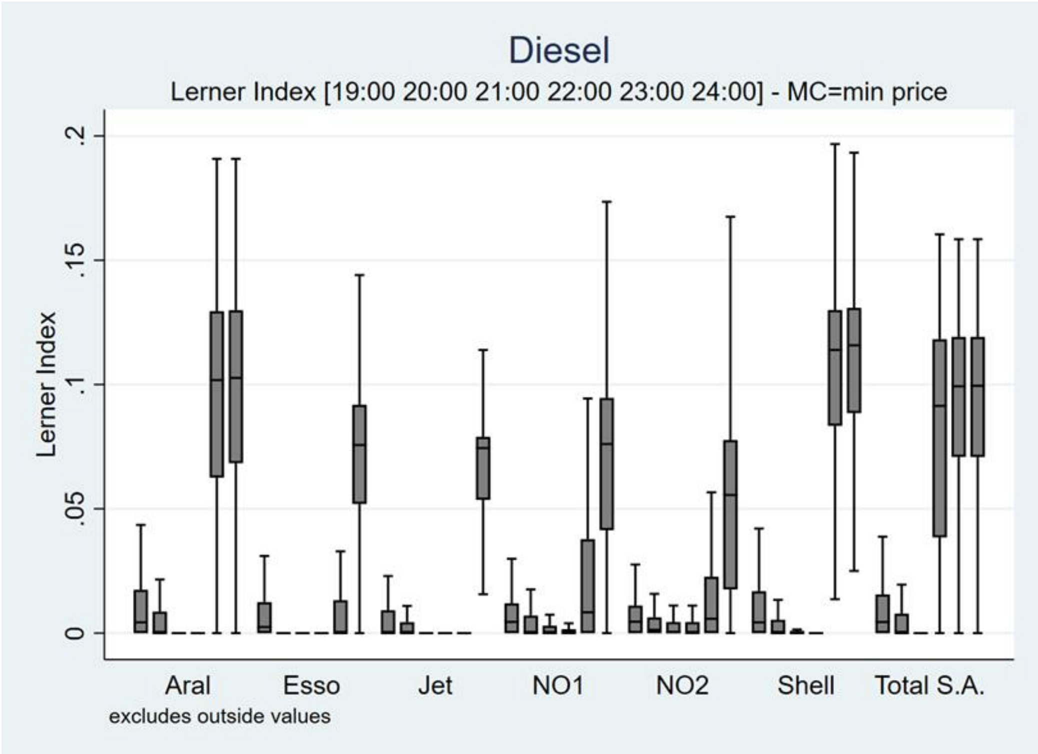


Table 4.5 shows even more clearly that after the closure of a large part of the independent fuel stations at 10 p.m., the indices for diesel of Aral and Shell rise to an average of 0.1 and their dispersion increases to 0.04. We observed the largest deviations from the lowest price level of Esso, Jet, and the Non-Oligopolists between 11 p.m. and midnight. The indices are between 0.05 and 0.07, well below the values of Aral and Shell. Also, the standard deviation is slightly lower overall. In particular, Jet's share of open gas stations falls sharply during this period.

Table 4.5: Descriptive Statistics for Diesel – Lerner Index

		Lerner Index		
Diesel		10 p.m.	11 p.m.	12 a.m.
Aral	mean	0.003	0.096	0.098
Aral	sd	0.008	0.043	0.042
Shell	mean	0.004	0.102	0.104
Shell	sd	0.015	0.039	0.037
Esso	mean	0.004	0.011	0.071
Esso	sd	0.013	0.019	0.026
Total S.A.	mean	0.077	0.089	0.089
Total S.A.	sd	0.045	0.037	0.037
Jet	mean	0.001	0.002	0.062
Jet	sd	0.004	0.008	0.027
NO1	mean	0.002	0.026	0.070
NO1	sd	0.005	0.038	0.041
NO2	mean	0.004	0.018	0.053
NO2	sd	0.009	0.028	0.039
Overall	mean	0.011	0.052	0.080
Overall	sd	0.028	0.053	0.042

Note: The daily minimum retail price is used as the marginal costs

The corresponding figures and tables for the petrol types Super E5 and E10 are in the appendix and assume the lowest retail price as the marginal cost. The average value of the Lerner Indices is lower for both types compared to diesel, but the graphs (Figure 4.9 and 4.12) show that the temporal patterns are identical. After 10 p.m., we measure values between 0.07 and 0.09 for Aral, Shell, and Total S.A. The companies Esso and Jet and the Non-Oligopolists later increase prices and the indices rise to 0.05-0.06 (see Table 4.10 and 4.11).

To summarize, we only find significant values for Lerner Indices in the late evening hours after 10 p.m., which are in fact comparable to estimated values in other fuel markets. The difference is that these studies do not focus on single periods within a day. The values are small compared to other markets or industries, as is the expectation of price gouging. Hence, market power in the evening seems to be restricted and only effecting nighttime customers. The small increase of market power may be caused by the closing of stations of price-aggressive brands. In the following section, we will take a closer look at the Lerner Indices of the brands Aral and Shell because they have the highest values and the largest market shares.

4.4. Multivariate Analysis

In the previous section, we saw that the premium brands Aral and Shell exert more market power after 10 p.m. compared to the others. However, we did not differentiate between the regions, periods and the market situations. In order to examine the influence of these and other factors on the magnitude of the indices, we perform OLS regressions for Aral and Shell. Table 4.6 gives an overview of the variables used. For the dependent variable, the Lerner Index at 11 p.m. and 12 a.m., we count more than a quarter of a million observations with an average of 0.09 for each brand. The Lerner Indices rise after some of the gas stations close. Therefore, a larger market share of price-aggressive brands (*OtherShare* of Non-Oligopolists and Jet) could lead to less exercise of market power. On the other hand, a larger share of the considered brand (*OwnShare* of Aral/Shell) and the other major (*OtherShare* of Aral/Shell) could lead to a stronger exercise of market power. To show this, we include the market shares, measured as the percentage of all active service stations, in our analysis. We also differentiate between the eight metropolises and the medium-sized cities, with Aral in 61 and Shell in 51 having service stations open. Concerning the different price cycle periods as described in Figure 4.1, we focus on Price Pattern 2 (July 2015 to March 2017), Pattern 3 (April 2017 to January 2018) and Pattern 4 (February 2018 to July 2018). Other control variables included the average wholesale price, weekdays, holidays, the fuel type, and time of the survey (11 p.m. or 12 a.m.). In summary, we estimate OLS regressions with robust standard errors clustered by region[19], separate for Aral and Shell, according the following equation:

$$LI_{it} = \beta_0 + \beta_1 OwnShare_{it} + \sum_j \gamma_j OtherShare_{jt} + \sum_k \delta_k Control_{kt} + \varepsilon_{it} \tag{4.3}$$

with: i=region; t=daily at 11 p.m., 12 a.m.; OwnShare=market share of Aral/Shell; j=OtherShare of Aral/Shell, Jet, NO1, NO2; Control=metropolis/city, fuel type, price pattern, average wholesale price, weekdays, 11 p.m./12 a.m.

[19] In addition, we used bootstrapped standard errors, which are also clustered at the region level. This method returns similar values. The results of these regressions are available on request of the author.

Table 4.6: Descriptive Statistics

	Aral					Shell				
Variable	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Lerner Index	317634	0.09	0.04	0	0.19	264915	0.09	0.03	0	0.20
Aral's Market Share	317634	28.54	12.08	7.69	100	264915	26.30	12.14	0	71.43
Shell's Market Share	317634	17.03	12.34	0	66.67	264915	22.73	10.87	6.25	100
Jet's Market Share	317634	7.35	9.55	0	50.00	264915	6.20	8.27	0	33.33
NO1's Market Share	317634	14.61	15.42	0	66.67	264915	12.30	12.84	0	66.67
NO2's Market Share	317634	19.31	14.46	0	75.00	264915	18.36	14.49	0	55.56
Metropolis	317634	0.12		0	1	264915	0.14		0	1
Diesel	317634	0.33		0	1	264915	0.33		0	1
Super E5	317634	0.33		0	1	264915	0.33		0	1
Super E10	317634	0.33		0	1	264915	0.33		0	1
Price pattern 2	317634	0.45		0	1	264915	0.45		0	1
Price pattern 3	317634	0.35		0	1	264915	0.35		0	1
Price pattern 4	317634	0.20		0	1	264915	0.20		0	1
Average wholesale price	317634	118.01	10.74	91.81	138.87	264915	118.00	10.75	91.81	138.87
Monday	317634	0.13		0	1	264915	0.13		0	1
Tuesday	317634	0.14		0	1	264915	0.14		0	1
Wednesday	317634	0.14		0	1	264915	0.14		0	1
Thursday	317634	0.14		0	1	264915	0.14		0	1
Friday	317634	0.14		0	1	264915	0.14		0	1
Saturday	317634	0.14		0	1	264915	0.14		0	1
Sunday	317634	0.14		0	1	264915	0.14		0	1
Holiday	317634	0.03		0	1	264915	0.03		0	1
Lerner 12 a.m.	317634	0.50		0	1	264915	0.48		0	1

Table 4.7 presents the estimation results for Aral and Shell. Separated step-by-step estimations are reported in detail in Table 4.12 and 4.13. Starting with Aral, an increase in own market share of ten percentage points increases the index by 0.001 units. This means that the average Lerner Index would increase from 0.09 to 0.091. The coefficient is not only economically insignificant, it is also statistically insignificant. We conclude the same result for all other market shares. In the case of Shell, there are also no economically significant coefficients in terms of market shares. Stations located in a metropolis also have no statistically significant coefficient. In Section 4.3, we already saw that Gasoline E5 and E10 have a lower index compared to diesel, which is confirmed here by the estimations.

Table 4.7: OLS Regression – Lerner Index of Aral/Shell

	Aral Lerner Index	Shell Lerner Index
Aral's Market Share	0.000120	-0.00000927
	(0.000247)	(0.0000974)
Shell's Market Share	0.0000660	-0.0000147
	(0.000228)	(0.0000886)
Jet's Market Share	-0.000253	-0.000290**
	(0.000303)	(0.000105)
NO1's Market Share	-0.000121	-0.000154*
	(0.000211)	(0.0000700)
NO2's Market Share	-0.0000756	-0.0000660
	(0.000201)	(0.0000627)
Metropolis	0.00450	0.00157
	(0.00430)	(0.00221)
E5[1]	-0.0266***	-0.0298***
	(0.00257)	(0.00137)
E10[1]	-0.0244***	-0.0242***
	(0.00235)	(0.00121)
Price pattern 3[2]	-0.00193	0.00126
	(0.00122)	(0.00112)
Price pattern 4[2]	-0.0721***	-0.0704***
	(0.00250)	(0.00172)
Average wholesale price	0.000593***	0.000432***
	(0.000130)	(0.0000711)
Tuesday[3]	-0.00148***	0.000708***
	(0.000184)	(0.000115)
Wednesday[3]	0.00110***	0.00121***
	(0.000191)	(0.000121)
Thursday[3]	0.00149***	0.00230***
	(0.000179)	(0.000144)
Friday[3]	-0.000771**	0.00191***
	(0.000281)	(0.000236)
Saturday[3]	-0.00231***	-0.00282***
	(0.000408)	(0.000462)
Sunday[3]	-0.00403***	-0.00720***
	(0.000342)	(0.000641)
Holiday[3]	-0.00383***	-0.00349***
	(0.000524)	(0.000664)
Lerner 12 a.m.	0.0000147	0.000908
	(0.00120)	(0.000747)
Constant	0.0507*	0.0770***
	(0.0217)	(0.0108)
Observations	317634	264915
Adjusted R^2	0.508	0.700
F	274.4	584.9

Note: All models were estimated by OLS with the Lerner index of Aral/Shell at 11 p.m. and 12 a.m. as the dependent variable. Robust standard errors clustered by region in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. [1]Compared to Diesel. [2]Compared to Price pattern 2 (see Figure 4.1). [3]Compared to Monday.

In the considered period, three different price cycles occurred (see Figure 4.1). Compared to Price Pattern 2, which has a daily cycle with price increases at noon and in the evening, the index is not different in Price Pattern 3, even with an additional increase in the evening. The Price Pattern 4 index, observed beginning in February 2018, is much lower (-0.07 for Aral and Shell), as expected, because the price increase in the evening is comparatively low and continues after a break in the morning. The daily average wholesale price has no economically relevant influence on the exercise of market power. All other weekdays and holidays also have economically insignificant effects compared to Monday, just like the distinction between 11 p.m. and midnight. Both estimation models are highly statistically significant but can only explain roughly half to two thirds of the variance of the Lerner Indices.

It is of course possible that the opportunity to achieve high prices in the evening creates incentives to enter regional markets. To address this problem of reverse causality, we have run estimations with lagged variables. One can assume that yesterday's Lerner Index does not determine today's market share, but yesterday's market share determines today's index, because prices can be quickly adjusted in comparison to market shares. Therefore, we have made estimations with lagged variables of market shares. The results show that the coefficients and their statistical as well as economic significance are not influenced, so we conclude that our causal interpretation is appropriate[20].

Our multivariate results are not surprising because descriptive results show a small variance of values. More or less, all open stations behave equally within the night market. If the new development of increasing prices continues, especially in the early morning hours, the Lerner Indices will be lower in the evening hours and will refute the idea price gouging.

4.5. Robustness Checks

Until now, the analysis of Lerner Indices in the evening hours has been performed under the assumption that marginal costs are equivalent to the lowest daily retail price. To verify the sensitivity of our results, we alternatively use wholesale prices, including all taxes and fees, as marginal costs. Due to very low regional price differences and a lack of information about exact delivery routes, we use data from one of eight trading venues in Germany. Thus, we have no station-specific relationship between retail prices and their according wholesale prices. Since the selling price is rarely below the purchase price and because we do not consider other costs, such as transport from the refinery and the operation costs of the station, we know that we overestimated the indices. In this way, we can analyze whether there are identical patterns as when using the daily lowest prices as marginal costs. We give descriptive values for diesel within this section. Descriptions

[20] The estimation results are available on request of the author.

for Gasoline E5 and E10 are in the appendix in Figures 4.10-4.11 and 4.13-4.14, as well as Tables 4.10-4.11.

Figures 4.5 and 4.6 show a boxplot of the Lerner Indices for diesel if we use the highest or lowest daily wholesale price as marginal costs. As expected, the values are higher than those in Section 3. In the early hours of the evening from 7 p.m. to 10 p.m., the median of the index for all companies (except Total S.A.) is between 0.05 and 0.07. Negative indices show that prices below marginal costs are exceptions. By midnight, the values rise to over 0.1. The previously reported patterns are clearly visible here. Aral, Shell, and Total S.A. have reached a higher price level by 11 p.m. The other companies follow later. The price increases are smaller and the values of the indices are lower.

Figure 4.5: Lerner Index by brand – Diesel – maximum wholesale price is used for marginal costs

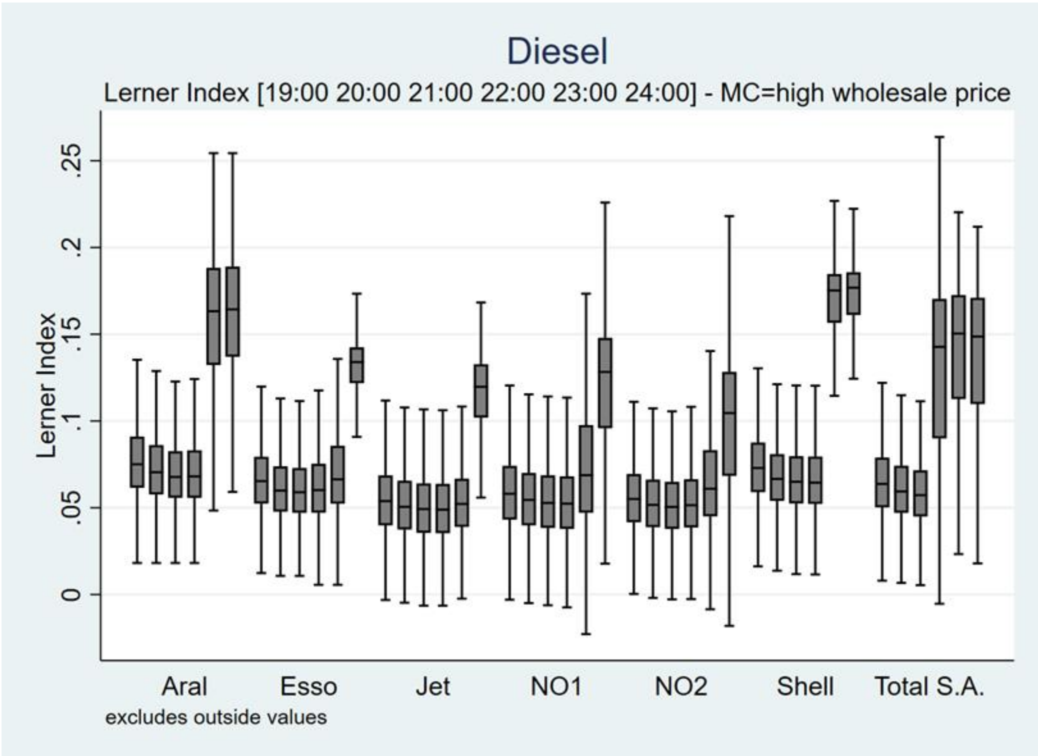


Table 4.8 shows the mean and the standard deviation of the Lerner Indices for diesel if the daily maximum (shown on the left) or minimum wholesale prices (shown on the right) are assumed to be the marginal costs. The values do not differ greatly. At midnight, Aral and Shell reach their highest levels of 0.16 and 0.16/0.17 respectively. For comparison, when we use the lowest retail price as the marginal cost, the index was 0.1. Jet and the Non-Oligopolists group 2 have the least amount of market power, with an index of 0.11 and 0.10 (in the case of retail prices 0.06 and 0.05). An analysis of gasoline prices shows no significant differences. Using the lowest daily price as the marginal costs, the values are slightly lower (see Tables 4.10 and 4.11).

Figure 4.6: Lerner Index by brand – Diesel – min. wholesale price is used for the marginal costs

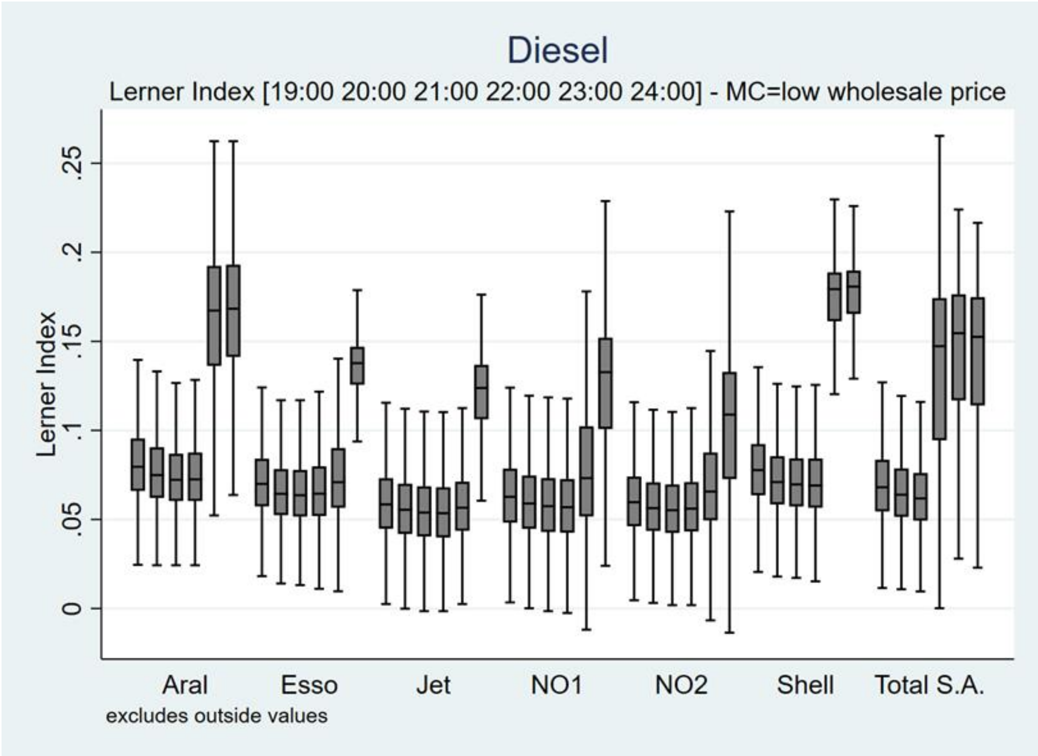


Table 4.8: Descriptive Statistics for Diesel – Lerner Index with Max./Min. Wholesale Price

	MC:	Max. Wholesale Price			Min. Wholesale Price		
		10 p.m.	11 p.m.	12 a.m.	10 p.m.	11 p.m.	12 a.m.
Aral	mean	0.071	0.158	0.159	0.075	0.162	0.163
Aral	sd	0.021	0.043	0.042	0.021	0.043	0.042
Shell	mean	0.069	0.161	0.163	0.074	0.165	0.167
Shell	sd	0.027	0.039	0.038	0.027	0.038	0.038
Esso	mean	0.064	0.071	0.127	0.068	0.075	0.131
Esso	sd	0.024	0.027	0.026	0.024	0.027	0.026
Total S.A.	mean	0.129	0.140	0.138	0.133	0.144	0.142
Total S.A.	sd	0.049	0.041	0.041	0.049	0.041	0.041
Jet	mean	0.050	0.054	0.112	0.055	0.058	0.116
Jet	sd	0.022	0.022	0.031	0.021	0.022	0.031
NO1	mean	0.054	0.079	0.120	0.059	0.083	0.124
NO1	sd	0.023	0.043	0.044	0.023	0.043	0.044
NO2	mean	0.054	0.067	0.101	0.058	0.072	0.105
NO2	sd	0.022	0.033	0.042	0.022	0.033	0.041
Overall	mean	0.068	0.108	0.134	0.072	0.112	0.138
Overall	sd	0.035	0.058	0.046	0.035	0.057	0.046

The robustness checks, which are based on maximum and minimum wholesale prices, show no overall difference in the Lerner Indices in the timing patterns and pricing of the companies. We are convinced that the use of minimum daily retail price gives a better picture about marginal costs than using wholesale prices without factoring for any additional costs.

4.6. Conclusion

Due to the introduction of the Market Transparency Unit for Fuels, extensive price data on German fuel prices over a long period of time are now available. Analysing the volatility of these prices leads to interesting patterns and cycles that change overtime. These cycles typically contain low retail prices in the early evening and have sharp price increases until midnight. Charging high prices in the late evening might indicate a type of price gouging due to market power. We analysed the price increases using the well-known concept of Lerner Indices, to measure market power.

Calculating Lerner Indices can be a challenge due to crucial missing data: how do we quantify marginal costs? The use of wholesale prices as a substitute for marginal costs neglects the transport or operating costs of petrol stations and thus overestimates the Lerner Index. To adjust for the overestimation, we use the lowest daily retail price as the marginal cost. We can show that the difference between the lowest retail price and the wholesale price roughly equals an additional cost of about 6 to 8 cents per litre, which roughly corresponds to the approximate transport and operating costs according to studies, so we are convinced our approximation of marginal costs is appropriate. This method makes it possible for the first time to calculate the Lerner Index for German gasoline prices. Our study focuses on gas stations in eight metropolises and 65 medium-sized German cities from summer of 2016 to summer of 2018.

Our descriptive analysis shows that the Lerner Indices of the premium brands Aral, Shell, and Total S.A. rise after 10 p.m., that is, after a large part of the price-aggressive gas stations have closed. The results are about 0.1 for diesel and 0.08 for gasoline. Other companies raise their prices after 11 p.m. and reach levels of 0.05-0.07 (diesel) and 0.05-0.06 (gasoline). Compared to other studies that deal with the fuel market, we find the same level of indices, but only for few hours and not for the whole day. Thus, price gouging does not seem to be a problem, especially when we consider other markets and industries.

To conduct robustness checks, we use the wholesale price as marginal cost to calculate the Lerner Index. As expected, the values are higher, but the time and company-specific patterns are still visible. OLS regressions show that the market share, and market shares of other companies in the different regions, do not affect the level of the Aral and Shell indices at 11 p.m. and midnight. As well, we do not find large differences in prices during the days of the week, for gas stations in a metropolis, or for changing wholesale prices. We confirm that the indices for gasoline are lower compared to diesel. In addition, it is clear that since February of 2018, less market power has been exercised in the evening hours as the new price cycle has emerged.

Our conclusions for economic policy are that all stations charge higher prices late at night, but only to a limited extent. Compared to other markets and recent anecdotal evidence of price increases for consumer goods on internet marketplaces (Marktwächter 2018), executing market power in the late evenings is not remarkable. Hence, the gasoline market seems highly competitive, at least in a higher dimension, as publicly expected. If petrol station operators intend to merge in the future, the German competition authority cannot use the pricing in the evening as a counterargument against such a plan.

Appendix

Figure 4.7: Average daily minimum retail price, minimum and maximum wholesale price for E5

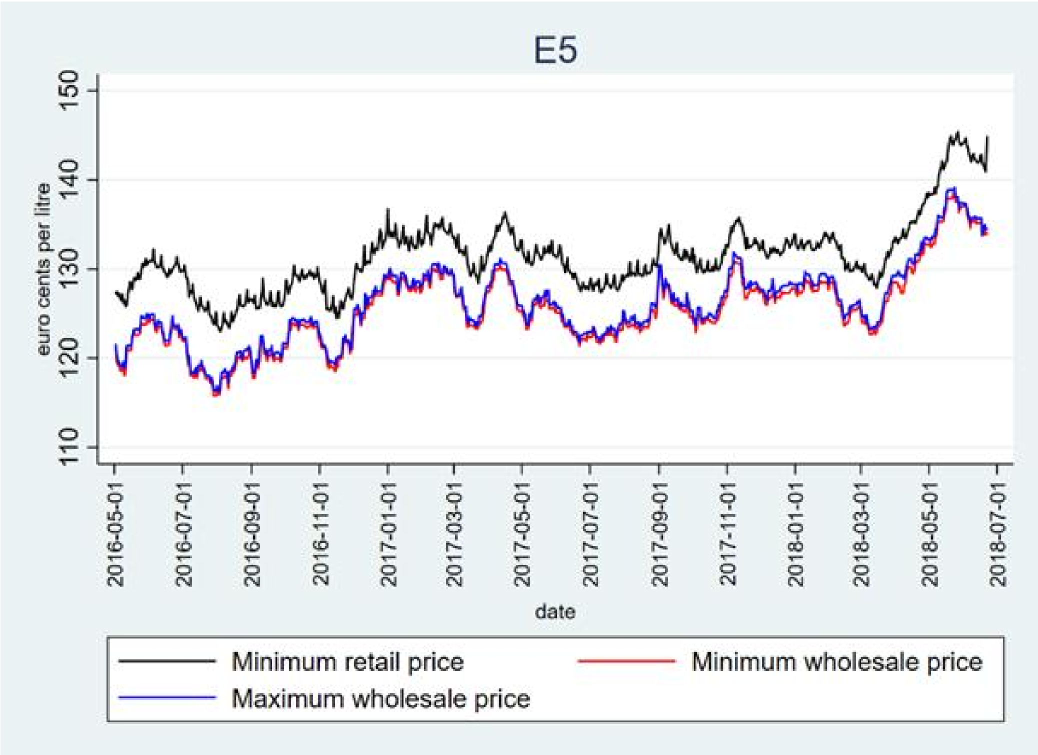


Figure 4.8: Average daily minimum retail price, minimum and maximum wholesale price for E10

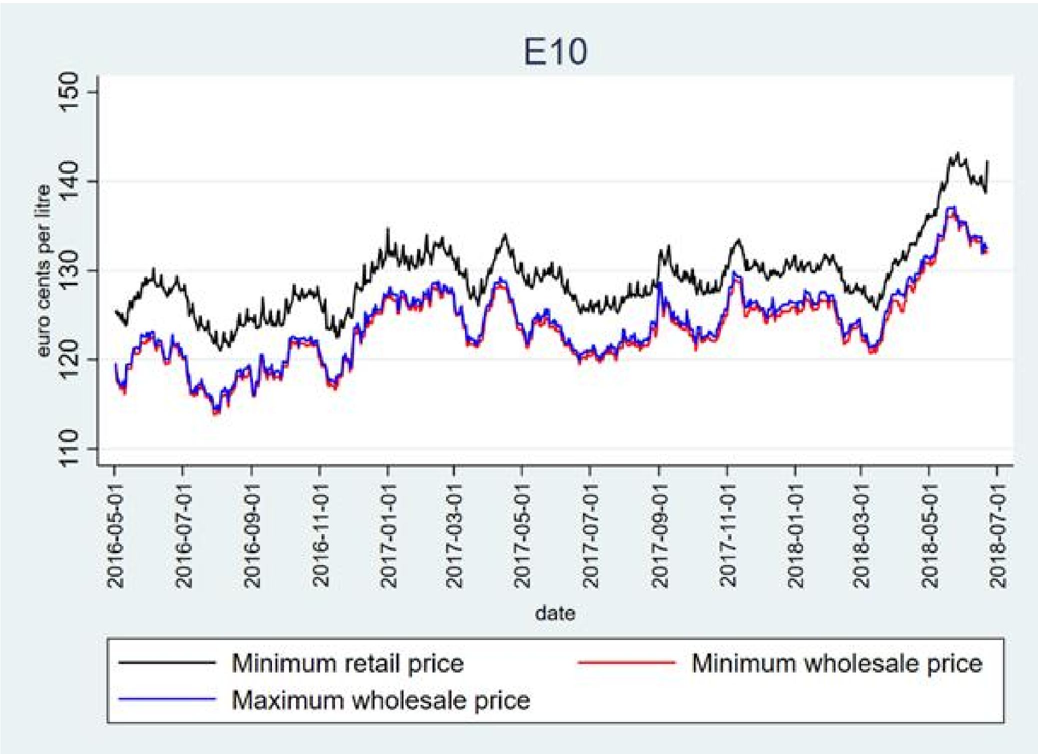


Figure 4.9: Lerner Index by brand – E5 – minimum retail price is used for the marginal costs

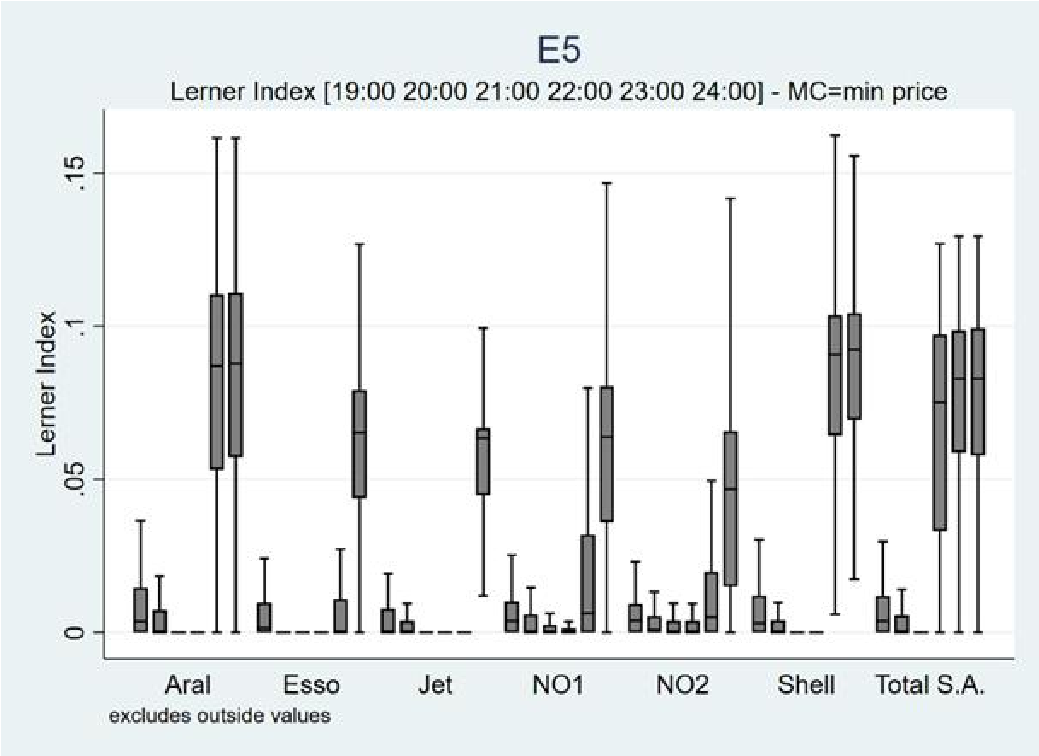


Figure 4.10: Lerner Index by brand – E5 – maximum wholesale price is used for the marginal costs

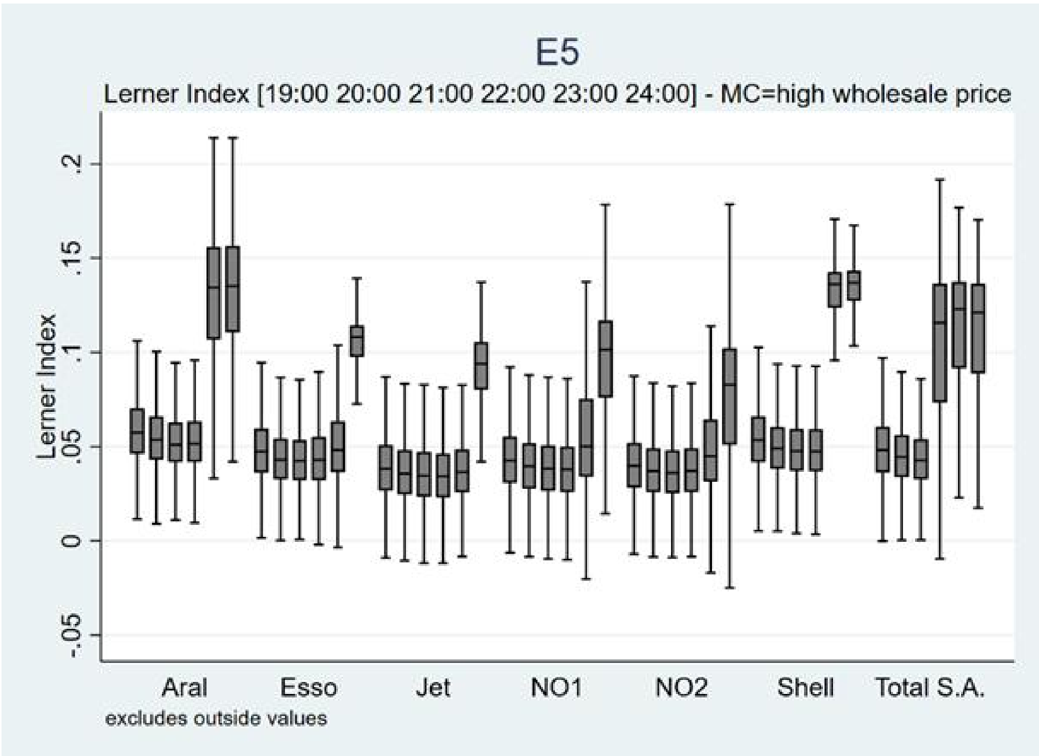


Figure 4.11: Lerner Index by brand – E5 – minimum wholesale price is used for the marginal costs

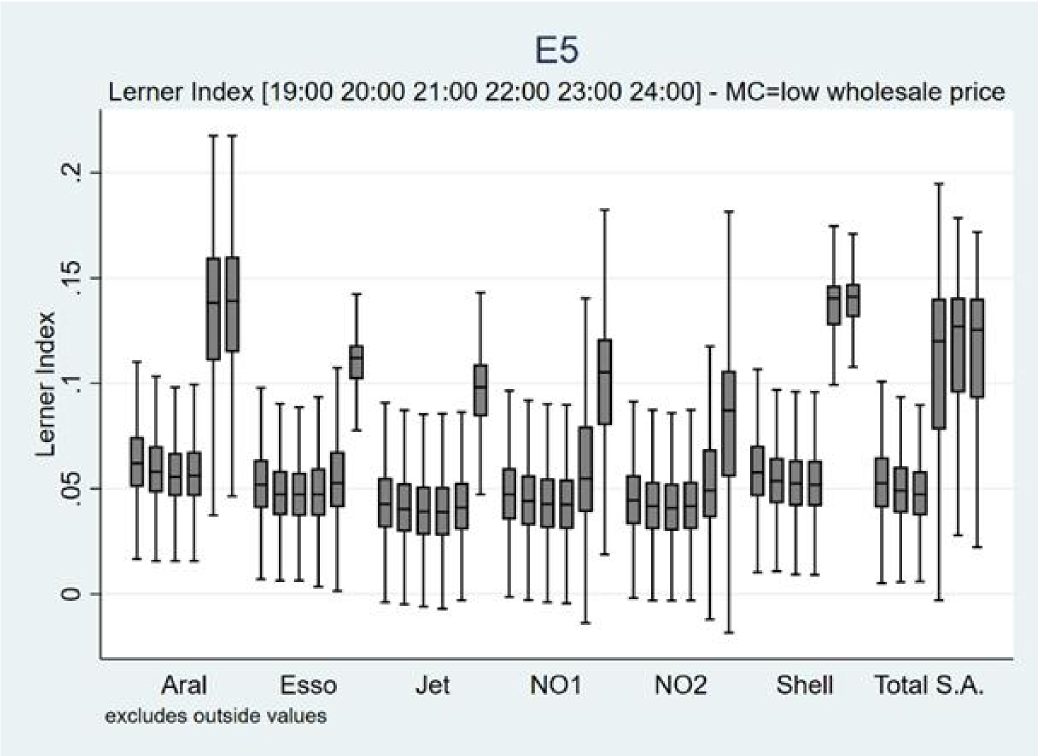


Figure 4.12: Lerner Index by brand – E10 – minimum retail price is used for the marginal costs

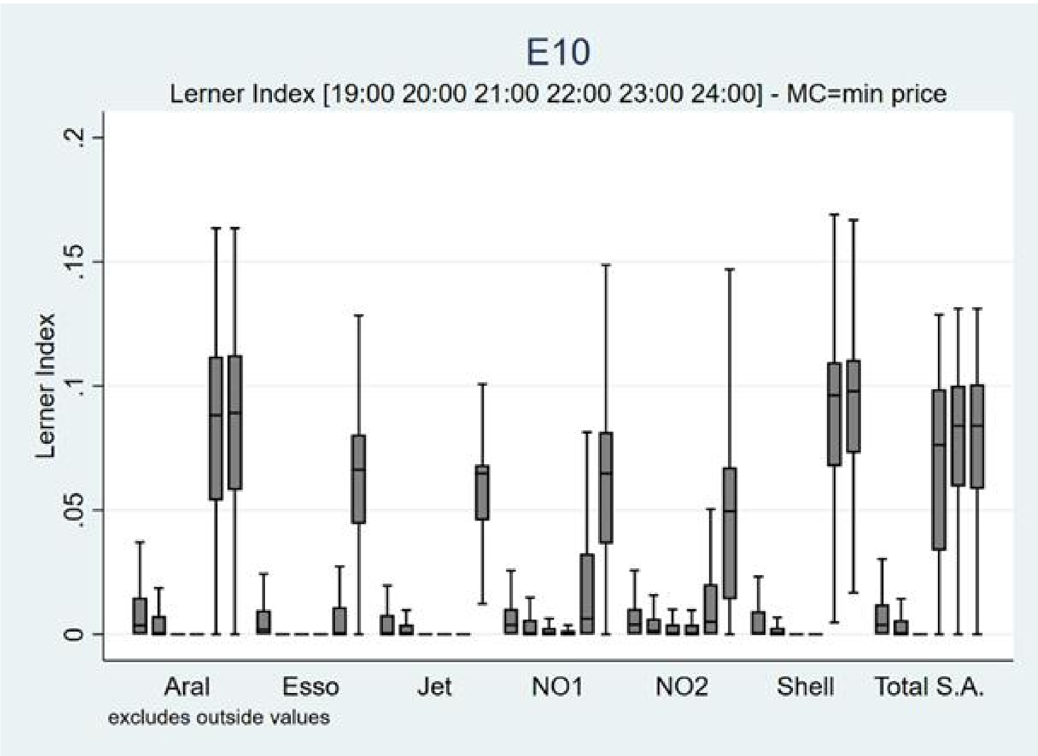


Figure 4.13: Lerner Index by brand – E10 – maximum wholesale price is used for the marginal costs

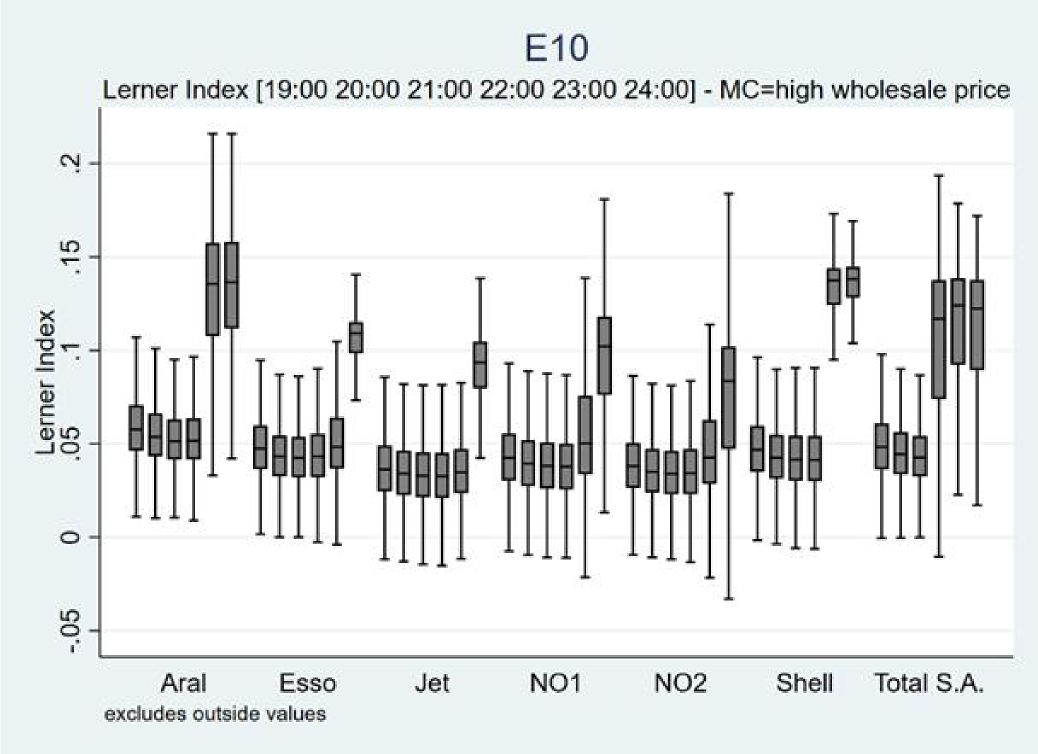


Figure 4.14: Lerner Index by brand – E10 – minimum wholesale price is used for the marginal costs

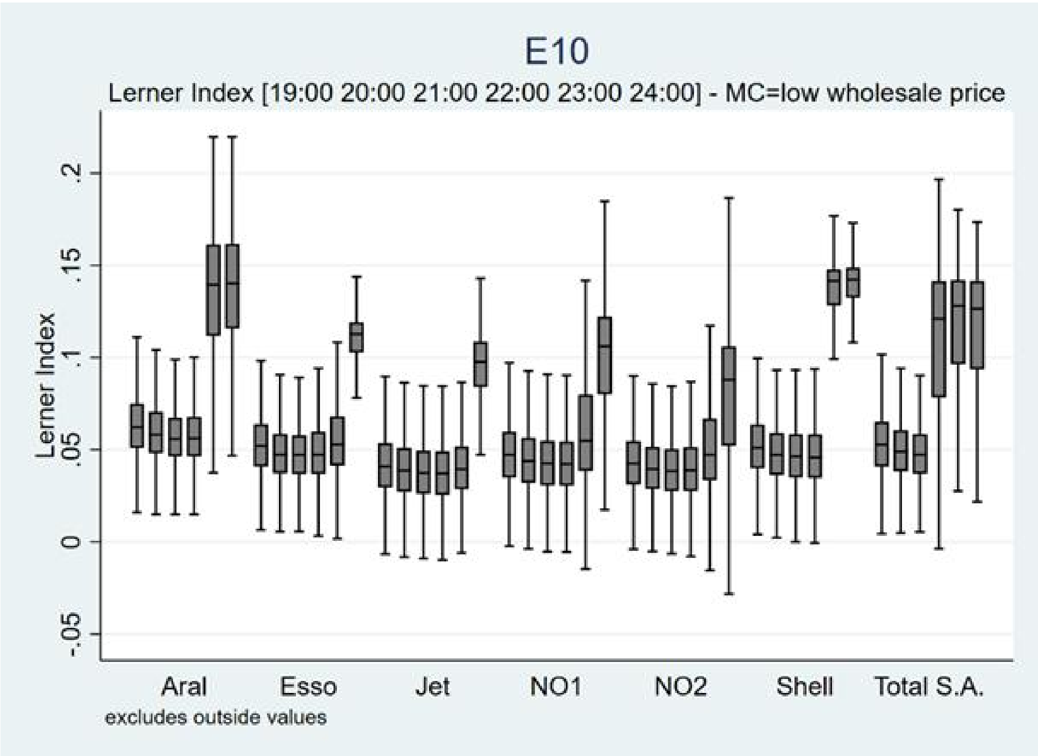


Table 4.9: Number of Petrol Stations – Diesel/E5/E10

Cities/Brands	Aral	Shell	Esso	Jet	Total S.A.	NO1	NO2	Sum
Aalen	2/2/2	1/1/1	1/1/1	0/0/0	0/0/0	5/5/5	7/7/6	16/16/15
Arnsberg	3/3/3	1/1/1	0/0/0	0/0/0	1/1/1	1/1/1	12/12/12	18/18/18
Aschaffenburg	4/3/3	2/2/2	2/2/2	0/0/0	1/1/1	4/4/4	4/4/4	17/16/16
Bamberg	4/4/4	1/1/1	1/1/1	2/2/2	0/0/0	2/2/2	8/7/7	18/17/17
Bayreuth	1/1/1	1/1/1	3/3/3	2/2/2	0/0/0	4/4/4	11/11/9	22/22/20
Berlin	58/58/58	49/49/49	26/26/26	20/20/20	42/42/42	58/58/58	46/45/44	299/298/297
Bocholt	2/2/2	0/0/0	0/0/0	1/1/1	1/1/1	5/5/5	6/6/6	15/15/15
Brandenburg a. d. H.	2/2/2	2/2/2	1/1/1	0/0/0	3/3/3	1/1/1	4/4/4	13/13/13
Castrop-Rauxel	1/1/1	1/1/1	0/0/0	2/2/2	2/2/2	3/3/3	3/3/2	12/12/11
Celle	4/4/4	1/1/1	1/1/1	2/2/2	0/0/0	2/2/2	8/8/8	18/18/18
Cottbus	2/2/2	2/2/2	1/1/1	1/1/1	2/2/2	1/1/1	3/2/2	12/11/11
Delmenhorst	2/2/2	2/2/2	0/0/0	2/2/2	2/2/2	1/1/1	6/6/5	15/15/14
Dessau-Roßlau	3/3/3	2/2/2	1/1/1	1/1/1	1/1/1	2/2/2	2/2/2	12/12/12
Detmold	1/1/1	2/2/2	0/0/0	1/1/1	0/0/0	7/7/7	5/5/5	16/16/16
Dinslaken	0/0/0	2/2/2	0/0/0	1/1/1	1/1/1	4/4/4	0/0/0	8/8/8
Dormagen	1/1/1	3/3/3	1/1/1	0/0/0	0/0/0	1/1/1	3/3/1	9/9/7
Dorsten	1/1/1	3/3/3	1/1/1	0/0/0	1/1/1	6/6/6	5/5/4	17/17/16
Dresden	13/13/13	4/4/4	6/6/6	5/5/5	12/12/12	8/8/8	6/6/6	54/54/54
Düren	1/1/1	2/2/2	1/1/1	2/2/2	3/3/3	7/7/7	6/6/6	22/22/22
Esslingen	1/1/1	0/0/0	3/3/3	0/0/0	1/1/1	1/1/1	4/4/4	10/10/10
Flensburg	2/2/2	5/5/5	0/0/0	0/0/0	0/0/0	7/7/7	6/6/6	20/20/20
Frankfurt	15/15/15	15/15/15	11/11/11	1/1/1	5/5/5	4/4/4	14/14/14	65/65/65
Fulda	2/2/2	1/1/1	1/1/1	2/2/2	0/0/0	2/2/2	1/1/1	9/9/9
Gera	3/3/3	2/2/2	0/0/0	0/0/0	2/2/2	2/2/2	4/4/3	13/13/12
Giessen	3/3/3	3/3/3	2/2/2	4/4/4	0/0/0	0/0/0	8/8/8	20/20/20
Gladbeck	2/2/2	1/1/1	1/1/1	0/0/0	2/2/2	1/1/1	3/3/2	10/10/9
Grevenbroich	0/0/0	2/2/2	1/1/1	0/0/0	1/1/1	1/1/1	5/5/3	10/10/8
Gütersloh	1/1/1	4/4/4	2/2/2	1/1/1	1/1/1	10/9/8	3/3/3	22/21/20
Hamburg	44/44/44	44/44/44	26/25/25	20/21/21	10/10/10	39/39/38	36/36/34	219/219/216
Hanau	2/2/2	3/3/3	1/1/1	1/1/1	2/2/2	4/3/4	4/5/4	17/17/17
Herford	3/3/3	1/1/1	3/3/3	1/1/1	2/2/2	5/4/4	2/2/2	17/16/16
Herten	1/1/1	0/0/0	1/1/1	0/0/0	1/1/1	2/2/2	2/2/2	7/7/7
Hildesheim	4/4/4	0/0/0	2/2/2	2/2/2	3/3/3	3/3/3	7/6/5	21/20/19
Iserlohn	3/3/3	2/2/2	0/0/0	0/0/0	1/1/1	0/0/0	5/5/5	11/11/11
Kaiserslautern	4/4/4	3/3/3	2/2/2	2/2/2	2/2/2	3/3/3	3/3/3	19/19/19
Kempten	2/2/2	1/1/1	1/1/1	1/1/1	0/0/0	3/3/3	6/6/5	14/14/13
Kerpen	3/3/3	0/0/0	2/2/2	0/0/0	0/0/0	4/4/4	4/4/4	13/13/13
Cologne	34/34/34	16/15/15	11/11/11	11/11/11	6/6/6	14/15/14	19/18/19	111/110/110
Landshut	1/1/1	2/2/2	1/1/1	1/1/1	1/1/1	7/7/7	5/5/4	18/18/17
Leipzig	10/10/10	3/3/3	1/1/1	4/4/4	8/8/8	11/11/10	11/11/12	48/48/48
Lippstadt	1/1/1	0/0/0	0/0/0	2/2/2	0/0/0	5/5/5	6/6/6	14/14/14
Ludwigsburg	3/3/3	1/1/1	2/2/2	2/2/2	1/1/1	1/1/1	2/2/2	12/12/12
Lüdenscheid	3/3/3	1/1/1	2/2/2	1/1/1	1/1/1	1/1/1	5/5/3	14/14/12
Luneburg	4/4/4	3/3/3	1/1/1	0/0/0	0/0/0	2/2/2	5/5/5	15/15/15
Luenen	4/4/4	2/2/2	1/1/1	1/1/1	0/0/0	2/2/2	6/6/6	16/16/16
Marburg	4/4/4	1/1/1	2/2/2	2/2/2	0/0/0	1/1/1	4/4/4	14/14/14
Marl	2/2/2	1/1/1	2/2/2	0/0/0	0/0/0	4/4/4	2/2/2	11/11/11
Minden	1/1/1	2/3/3	0/0/0	1/1/1	0/0/0	7/7/7	7/6/6	18/18/18
Munich	29/29/28	17/17/15	14/14/13	11/11/11	5/5/5	27/27/27	30/30/27	133/133/126
Neubrandenburg	2/2/2	1/1/1	0/0/0	1/1/1	1/1/1	4/4/4	5/5/4	14/14/13
Neumünster	2/2/2	2/2/2	0/0/0	2/2/2	3/3/3	1/1/1	9/9/8	19/19/18
Neuwied	1/1/1	2/2/2	0/0/0	0/0/0	2/2/2	1/1/1	3/3/3	9/9/9
Norderstedt	3/3/3	2/2/2	1/1/1	1/1/1	1/1/1	5/5/5	1/1/1	14/14/14
Plauen	2/2/2	2/2/2	0/0/0	0/0/0	1/1/1	2/2/2	3/2/2	10/9/9
Ratingen	2/2/2	2/2/2	2/2/2	0/0/0	1/1/1	2/2/2	3/3/3	12/12/12
Rheine	2/2/2	0/0/0	0/0/0	2/2/2	0/0/0	3/3/3	9/8/8	16/15/15
Rosenheim	1/1/1	2/2/2	1/1/0	2/2/2	0/0/0	2/2/2	2/2/2	10/10/9
Rüsselsheim	3/3/3	3/3/3	0/0/0	0/0/0	1/1/1	0/0/0	3/3/3	10/10/10
Salzgitter	2/2/2	4/4/4	1/1/1	0/0/0	0/0/0	5/5/5	5/5/4	17/17/16
Schwerin	5/5/5	1/1/1	1/1/1	0/0/0	4/4/4	4/3/3	5/5/5	20/19/19
Sindelfingen	1/1/1	3/3/3	3/3/3	0/0/0	0/0/0	2/2/2	2/2/2	11/11/11
Stuttgart	13/13/13	15/15/15	10/10/10	6/6/6	3/3/3	16/16/16	9/9/9	72/72/72
Troisdorf	2/2/2	1/1/1	0/0/0	0/0/0	0/0/0	1/1/1	6/6/6	10/10/10
Tübingen	2/2/2	0/0/0	3/3/3	2/2/2	1/1/1	1/1/1	2/2/2	11/11/11
Velbert	2/2/2	2/2/2	2/2/2	1/1/1	1/1/1	4/4/4	3/3/3	15/15/15
Viersen	2/2/2	1/1/2	0/0/0	1/1/1	0/0/0	0/0/0	7/7/6	11/11/11
Villingen-Schw.	3/3/3	4/4/4	2/2/2	1/1/1	0/0/0	2/2/2	5/5/5	17/17/17
Weimar	2/2/2	1/1/1	0/0/0	2/2/2	0/0/0	3/3/3	1/1/1	9/9/9
Wesel	2/2/2	3/3/3	0/0/0	1/1/1	1/1/1	2/2/2	3/3/3	12/12/12
Wilhelmshaven	3/3/3	1/1/1	0/0/0	1/1/1	1/1/1	6/6/6	3/2/2	15/14/14
Witten	4/4/4	1/1/1	2/2/2	1/1/1	0/0/0	2/2/2	5/5/5	15/15/15
Worms	5/5/5	2/2/2	2/2/2	2/2/2	0/0/0	0/0/0	4/4/4	15/15/15
Zwickau	6/6/6	2/2/2	0/0/0	1/1/1	2/2/2	2/2/2	3/2/2	16/15/15
Sum	368/367/366	274/274/273	172/171/169	140/141/141	150/150/150	365/362/359	465/456/430	1934/1921/1888

Note: The number of gasoline stations varies because not all of them supply Diesel or Super E5/E10. Because of brand changes, openings and closures the number of stations can vary during the period.

Table 4.10: Descriptive Statistics for E5 – Lerner Index

	MC:	Min. Retail Price			Max. Wholesale Price			Min. Wholesale Price		
E5		10 p.m.	11 p.m.	12 a.m.	10 p.m.	11 p.m.	12 a.m.	10 p.m.	11 p.m.	12 a.m.
Aral	mean	0.002	0.082	0.084	0.054	0.130	0.131	0.058	0.134	0.135
Aral	Sd	0.007	0.037	0.036	0.017	0.037	0.036	0.017	0.036	0.035
Shell	mean	0.003	0.082	0.083	0.051	0.125	0.127	0.055	0.130	0.131
Shell	Sd	0.012	0.030	0.030	0.022	0.030	0.029	0.022	0.030	0.029
Esso	mean	0.004	0.009	0.061	0.046	0.052	0.102	0.050	0.057	0.107
Esso	Sd	0.011	0.016	0.022	0.021	0.023	0.022	0.020	0.023	0.022
Total S.A.	mean	0.064	0.074	0.074	0.103	0.112	0.111	0.107	0.116	0.115
Total S.A.	Sd	0.037	0.030	0.030	0.039	0.032	0.032	0.039	0.032	0.032
Jet	mean	0.001	0.002	0.053	0.035	0.038	0.088	0.040	0.043	0.092
Jet	Sd	0.004	0.007	0.023	0.018	0.018	0.026	0.017	0.018	0.025
NO1	mean	0.002	0.022	0.059	0.039	0.059	0.095	0.044	0.064	0.099
NO1	Sd	0.005	0.032	0.034	0.019	0.036	0.037	0.018	0.035	0.036
NO2	mean	0.004	0.016	0.045	0.039	0.050	0.079	0.043	0.055	0.083
NO2	Sd	0.008	0.024	0.034	0.018	0.028	0.036	0.018	0.028	0.036
Overall	mean	0.009	0.044	0.067	0.050	0.084	0.107	0.055	0.089	0.111
Overall	Sd	0.024	0.044	0.035	0.029	0.048	0.038	0.029	0.048	0.038

Table 4.11: Descriptive Statistics for E10 – Lerner Index

	MC:	Min. Retail Price			Max. Wholesale Price			Min. Wholesale Price		
E10		10 p.m.	11 p.m.	12 a.m.	10 p.m.	11 p.m.	12 a.m.	10 p.m.	11 p.m.	12 a.m.
Aral	mean	0.002	0.083	0.085	0.054	0.131	0.132	0.059	0.135	0.136
Aral	Sd	0.007	0.038	0.036	0.017	0.037	0.036	0.017	0.037	0.036
Shell	mean	0.003	0.086	0.088	0.045	0.125	0.127	0.049	0.129	0.131
Shell	Sd	0.013	0.032	0.031	0.024	0.034	0.033	0.024	0.033	0.032
Esso	mean	0.004	0.009	0.062	0.046	0.053	0.103	0.051	0.057	0.107
Esso	Sd	0.011	0.016	0.022	0.021	0.023	0.022	0.020	0.023	0.022
Total S.A.	mean	0.064	0.075	0.075	0.104	0.113	0.112	0.108	0.117	0.116
Total S.A.	Sd	0.037	0.030	0.030	0.040	0.033	0.033	0.040	0.032	0.032
Jet	mean	0.001	0.002	0.055	0.034	0.036	0.087	0.038	0.041	0.092
Jet	Sd	0.004	0.007	0.023	0.018	0.019	0.026	0.018	0.018	0.025
NO1	mean	0.002	0.022	0.060	0.039	0.059	0.095	0.043	0.064	0.100
NO1	Sd	0.005	0.032	0.034	0.019	0.036	0.037	0.019	0.036	0.037
NO2	mean	0.004	0.015	0.046	0.036	0.047	0.077	0.041	0.052	0.081
NO2	Sd	0.008	0.021	0.034	0.019	0.027	0.036	0.019	0.027	0.036
Overall	mean	0.009	0.045	0.069	0.049	0.084	0.107	0.054	0.088	0.112
Overall	Sd	0.024	0.045	0.036	0.030	0.050	0.039	0.030	0.049	0.039

Table 4.12: Aral – Full OLS-Estimations

Lerner Index	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Aral's Market Share	0.000208	0.000168	0.0000512	0.0000707	0.0000795	0.000120	0.000121	0.000120
	(0.000185)	(0.000188)	(0.000238)	(0.000237)	(0.000238)	(0.000241)	(0.000241)	(0.000247)
Shell's Market Share	0.000191	0.000140	-0.00000315	0.00000950	0.0000136	0.0000672	0.0000670	0.0000660
	(0.000171)	(0.000167)	(0.000231)	(0.000232)	(0.000231)	(0.000228)	(0.000228)	(0.000228)
Jet's Market Share		-0.000246	-0.000382	-0.000371	-0.000364	-0.000252	-0.000253	-0.000253
		(0.000271)	(0.000298)	(0.000298)	(0.000295)	(0.000302)	(0.000302)	(0.000303)
NO1's Market Share			-0.000205	-0.000191	-0.000188	-0.000120	-0.000121	-0.000121
			(0.000216)	(0.000218)	(0.000215)	(0.000211)	(0.000211)	(0.000211)
NO2's Market Share			-0.0000657	-0.0000372	-0.0000556	-0.0000720	-0.0000715	-0.0000756
			(0.000196)	(0.000199)	(0.000199)	(0.000201)	(0.000201)	(0.000201)
Metropolis				0.00480	0.00465	0.00453	0.00454	0.00450
				(0.00425)	(0.00423)	(0.00430)	(0.00430)	(0.00430)
E5[1]					-0.0139***	-0.0140***	-0.0263***	-0.0266***
					(0.000485)	(0.000486)	(0.00255)	(0.00257)
E10[1]					-0.0128***	-0.0130***	-0.0242***	-0.0244***
					(0.000579)	(0.000591)	(0.00233)	(0.00235)
Price pattern 3[2]						-0.000689	-0.00195	-0.00193
						(0.00137)	(0.00122)	(0.00122)
Price pattern 4[2]						-0.0675***	-0.0720***	-0.0721***
						(0.00321)	(0.00250)	(0.00250)
Average wholesale price							0.000582***	0.000593***
							(0.000129)	(0.000130)
Tuesday[3]								-0.00148***
								(0.000184)
Wednesday[3]								0.00110***
								(0.000191)
Thursday[3]								0.00149***
								(0.000179)
Friday[3]								-0.000771**
								(0.000281)
Saturday[3]								-0.00231***
								(0.000408)
Sunday[3]								-0.00403***
								(0.000342)
Holiday[3]								-0.00383***
								(0.000524)
Lerner 12 a.m.								0.0000147
								(0.00120)
Constant	0.0786***	0.0824***	0.0935***	0.0913***	0.100***	0.110***	0.0508*	0.0507*
	(0.00662)	(0.00721)	(0.0155)	(0.0156)	(0.0155)	(0.0156)	(0.0216)	(0.0217)
Observations	317634	317634	317634	317634	317634	317634	317634	317634
Adjusted R^2	0.007	0.011	0.014	0.015	0.041	0.503	0.506	0.508

Note: All models were estimated by OLS with the Lerner Index of Aral at 11 p.m. and 12 a.m. as the dependent variable. Robust standard errors clustered by region in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. [1]Compared to Diesel. [2]Compared to Price pattern 2 (see Figure 4.1). [3]Compared to Monday.

Table 4.13: Shell – Full OLS-Estimations

Lerner Index	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Aral's Market Share	0.000120	0.0000869	0.0000134	0.0000179	0.0000218	-0.00000138	-0.00000165	-0.00000927
	(0.0000914)	(0.0000923)	(0.000113)	(0.000113)	(0.000113)	(0.0000966)	(0.0000965)	(0.0000974)
Shell's Market Share	-0.00000162	-0.0000721	-0.000127	-0.000111	-0.000105	-0.00000407	-0.00000403	-0.0000147
	(0.0000961)	(0.0001000)	(0.000113)	(0.000115)	(0.000113)	(0.0000886)	(0.0000886)	(0.0000886)
Jet's Market Share		-0.000369***	-0.000406***	-0.000405***	-0.000405***	-0.000292**	-0.000293**	-0.000290**
		(0.0000934)	(0.000107)	(0.000108)	(0.000108)	(0.000106)	(0.000106)	(0.000105)
NO1's Market Share			-0.000173*	-0.000169*	-0.000171*	-0.000150*	-0.000151*	-0.000154*
			(0.0000836)	(0.0000844)	(0.0000836)	(0.0000701)	(0.0000701)	(0.0000700)
NO2's Market Share			0.000000209	0.0000119	-0.0000136	-0.0000568	-0.0000565	-0.0000660
			(0.0000596)	(0.0000604)	(0.0000604)	(0.0000630)	(0.0000629)	(0.0000627)
Metropolis				0.00178	0.00166	0.00169	0.00169	0.00157
				(0.00236)	(0.00233)	(0.00219)	(0.00219)	(0.00221)
E5[1]					-0.0206***	-0.0207***	-0.0296***	-0.0298***
					(0.000610)	(0.000606)	(0.00138)	(0.00137)
E10[1]					-0.0157***	-0.0158***	-0.0240***	-0.0242***
					(0.000619)	(0.000611)	(0.00121)	(0.00121)
Price pattern 3[2]						0.00212	0.00121	0.00126
						(0.00114)	(0.00112)	(0.00112)
Price pattern 4[2]						-0.0671***	-0.0704***	-0.0704***
						(0.00182)	(0.00173)	(0.00172)
Average wholesale price							0.000422***	0.000432***
							(0.0000711)	(0.0000711)
Tuesday[3]								0.000708***
								(0.000115)
Wednesday[3]								0.00121***
								(0.000121)
Thursday[3]								0.00230***
								(0.000144)
Friday[3]								0.00191***
								(0.000236)
Saturday[3]								-0.00282***
								(0.000462)
Sunday[3]								-0.00720***
								(0.000641)
Holiday[3]								-0.00349***
								(0.000664)
Lerner 12 a.m.								0.000908
								(0.000747)
Constant	0.0878***	0.0926***	0.0981***	0.0971***	0.109***	0.120***	0.0772***	0.0770***
	(0.00341)	(0.00379)	(0.00618)	(0.00636)	(0.00645)	(0.00631)	(0.0109)	(0.0108)
Observations	264915	264915	264915	264915	264915	264915	264915	264915
Adjusted R^2	0.002	0.009	0.012	0.013	0.077	0.690	0.692	0.700

Note: All models were estimated by OLS with the Lerner Index of Shell at 11 p.m. and 12 a.m. as the dependent variable. Robust standard errors clustered by region in parentheses. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$. [1]Compared to Diesel. [2]Compared to Price pattern 2 (see Figure 4.1). [3]Compared to Monday.

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5. Effects of a local supply shock on gasoline price cycles

Arne Neukirch

Abstract

The study of gasoline price cycles has long been part of economic research and much of the literature examines where the so-called Edgeworth price cycles occur and how their shape is influenced. Studies for Canadian and Australian cities have shown that these cycles can be interrupted or halted by supply shocks or regulatory interventions. The extremely hot temperatures in Europe in 2018 reduced the water level of the Rhine to a record low, leading to restrictions on inland navigation, which in turn resulted in fuel shortages in some regions of Germany and caused prices to rise sharply. I use this natural experiment to investigate the effects of this supply shock on intraday gasoline price cycles. Using a difference-in-differences approach, I find that the cycles did not disappear, but the premium brands reduced the intensity and changed the timing of price increases and decreases. When the supply was unrestricted again, the cycles returned in their initial shape.

JEL Classification: L11, L81, L91, Q41

Keywords: Edgeworth price cycles, Retail gasoline, Supply shocks

5.1. Introduction

In a market with a relatively homogeneous good, one would theoretically expect prices to follow costs. In many fuel markets, however, asymmetric price cycles can be observed that cannot be explained by cost fluctuations. These cycles are characterized by a high price increase followed by many small price reductions until the price is increased again in one big step. This behaviour then repeats within a day, a week or a month. As a result of this and further antitrust aspects, this sector has often been regulated[21] or investigated by competition authorities (Bundeskartellamt 2011; Federal Trade Commission 2011). This special price-setting behaviour has also been investigated in economic research, where a large part of the literature refers to the so-called Edgeworth price cycles. Maskin and Tirole (1988) formalized these cyclical pricing patterns as a possible outcome of a dynamic duopoly game, in which the firms alternately undercut each other in small steps in price until the marginal cost level is reached and the firms are in a zero profit situation. In the expectation that the other player will immediately slightly undercut the price, it is nevertheless beneficial to increase the price significantly, as it is profitable for both. Thus, the cycle begins again without a shock in demand, supply or costs. Cycles, which closely resemble these, have been empirically observed in retail fuel markets in the U.S., Canada, Australia, Norway and Germany (Noel 2007a; Zimmerman et al. 2013; Foros and Steen 2013; Byrne and Roos 2019; Bundeskartellamt 2019). This special type of pricing is usually persistent for years or decades, with the exception that supply shocks or regulatory interventions can permanently or temporarily stop it (Wang 2009; Atkinson et al. 2014).

I use a weather-related supply shock in Germany as a natural experiment to analyse the effect on intraday price cycles. The year 2018 was the warmest since 1881 in Germany and the water level of many rivers reached record lows at the end of the year[22] . Inland navigation in the Rhine region was therefore particularly affected, leading to rising transport costs and supply shortages. A large part of the fuel in this region is shipped from the refineries to tank farms and then had to be transported by road or rail. As a result, retail prices for gasoline and diesel rose sharply. The supply shortages in southwest Germany were so severe that the Federal Ministry for Economic Affairs and Energy released fuel from the strategic oil reserve at the end of October, which is to ensure supply for 90 days in the event of an energy crisis[23]. This was used only three times since the

[21] West Australia: Prices must be announced one day in advance and then cannot be changed for 24 hours; Austria: Prices can only be raised once a day; Canada: Provinces (Quebec and the Atlantic provinces) regulate prices directly or indirectly through minimum or maximum prices; Germany: Prices must be reported in real time to the Cartel Office and are published on the Internet.

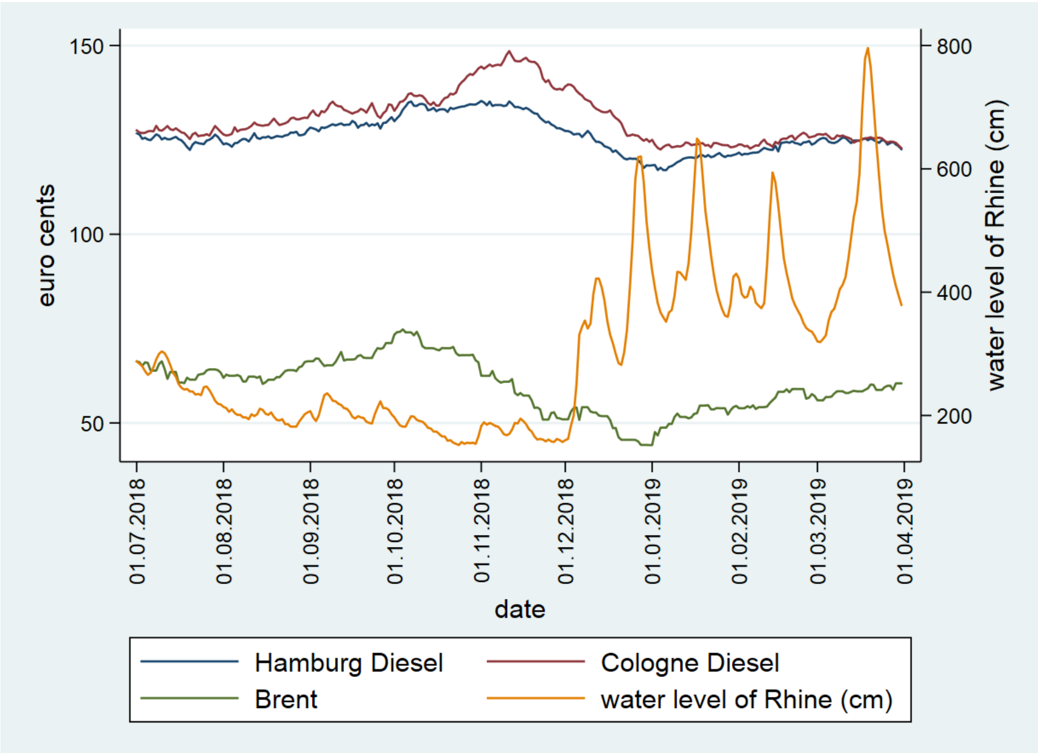
[22] https://www.dwd.de/DE/presse/pressemitteilungen/DE/2018/20181228_deutschlandwetter_jahr2018_news.html?nn=495078 and https://www.elwis.de/DE/dynamisch/gewaesserkunde/wasserstaende/index.php?target=2&pegelId=a6ee8177-107b-47dd-bcfd-30960ccc6e9c

[23] https://www.bundesanzeiger.de/ebanzwww/wexsservlet?session.sessionid=f2a28dfaa76a0d0b3aa6c45b4c57ea79&page.navid=detailsearchlisttodetailsearchdetail&fts_search_list.selected=932da7420dbfcdde&fts_search_list.destHistoryId=44371

establishment in 1978: the Gulf War in 1991, Hurricane Katrina/Rita in 2005 and the Libyan Civil War in 2011.

Figure 5.1 shows the development of diesel prices in Cologne (a city close to the Rhine), Hamburg (a city not close to the Rhine) as well as the Brent crude oil price and the water level of the Rhine. Looking at the period before mid-October, the difference between the retail prices remained relatively stable and they followed a similar trend as the Brent crude oil price. After the Rhine level fell well below two metres, prices in Cologne rose sharply, even though the price of crude oil fell. Accordingly, the gap to Hamburg increased remarkably, which can be attributed to the low water and the higher logistical effort. The German media reported nationwide on this development until the Rhine was unrestrictedly navigable again and the two retail prices converged until January 2019.

Figure 5.1: Price of Diesel (Hamburg/Cologne), Brent and the water level of the Rhine

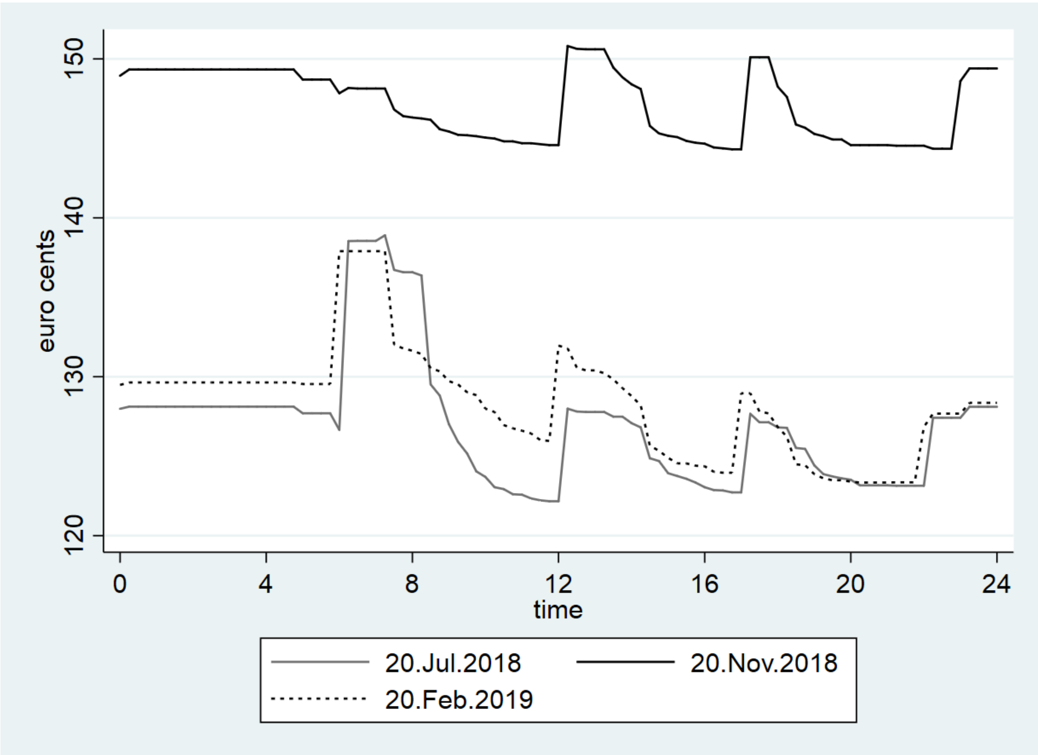


Note: Average unweighted daily diesel price in euro cents per litre for Hamburg and Cologne (tankerkoenig.de). Brent crude oil price in euro per barrel (Federal Reserve Bank of St. Louis). Water level of Rhine at kilometre 780.8 in cm [Pegel Duisburg-Ruhrort] (Bundesanstalt für Gewässerkunde).

A study of a fire at a refinery in Canada showed, for instance, that this supply shock ended decades of price cycles and stabilised prices (Atkinson et al. 2014). The described situation in the Rhine region is therefore an appropriate way to investigate the effects of a supply shock on intraday price cycles. The particular feature of the German fuel market is that persistent nationwide intraday price cycles have been observed since 2014. For illustration purposes, Figure 5.2 shows the development of diesel prices in Cologne for the brand Aral over three days. Once before (grey), during (black) and after (dashed) the low water. The former and the latter show a daily cycle with four large price peaks followed by many small decreases. During the supply shortage there still exists an intraday cycle, but there are only three price peaks, the maximum price level is reached much later and the difference between the highest and lowest price is a lot smaller. To test if this first impression also applies to other days as well as brands and to verify whether this is a nationwide phenomenon, I use a difference-in-differences approach to compare the period before, during and after the low water. In order to measure the effects, one needs a "treated" city, that is one located on the Rhine – Cologne – and a "control" group that is as far as possible unaffected by the event, but as similar as possible to the treated city – Hamburg.

To preview results, I show that the intraday price cycles did not disappear due to the local shock, but mainly premium brands reduced the intensity and changed the timing of the highest price during the day. When the supply was unrestricted again, the cycles returned in their original form. I proceed as follows: Section 5.2 reviews the relevant literature and Section 5.3 discusses the data as well as the methodology. Section 5.4 reports results and Section 5.5 considers issues of robustness. Section 5.6 concludes.

Figure 5.2: Three price cycles of Aral in Cologne (Diesel)



Note: Average diesel price every 15 minutes of Aral in euro cents per litre for Cologne (tankerkoenig.de).

5.2. Literature

The theory of Edgeworth price cycles goes back to Edgeworth (1925), who argued that in a oligopolistic market with capacity constrained firms, price cycles would be more likely than stable prices. This is because two firms would undercut each other's prices until they were so low that it would be more profitable for one firm to raise the price and serve the remaining demand that the other firm can no longer satisfy. Maskin and Tirole (1988) formalized these cyclical pricing pattern as a possible outcome of a dynamic duopoly game. They assume two identical firms that sell a homogeneous good, compete in price and the demand is constant. The firms' pricing is sequential and the costs are zero, where the one with the lowest price serves the entire market and they share the market equally when they charge the same price. This setting results into two possible types of equilibrium. The first shows stable prices over time, while the other reveals asymmetric cycles – the so-called Edgeworth price cycles. The process is as follows: Starting from a high price level, the duopolists alternately undercut each other in small steps in order to serve the entire market ("gradual price war") until the price reaches marginal cost and the firms are in a zero profit situation. In this situation, there is no incentive to reduce the price further, though a higher level would be beneficial for both. The other company would, however, react to an increase with a slightly lower increase and then serve the entire demand. Maskin and Tirole (1988) describe this situation as a "war of attrition", in which the firms play a mixed strategy, mixing between a price hike and keeping the price at the marginal cost level. The price remains at the low level until a player, given a certain probability, deviates from it and the undercutting of each other begins again. Thus, the cycle starts anew without an exogenous demand, supply or cost shock.

Eckert (2003) extends the model by varying the relative size of the duopolists. In the case of price equality, the firms no longer divide the market equally, instead they divide it according to their size. It shows that the more asymmetrically the sizes are distributed, the more likely it is that cycles will occur, with price reductions being initiated by the smaller firm and increases by the larger. In a framework that allows for fluctuating marginal costs, Noel (2008) shows that Edgeworth price cycles continue to exist in the model if symmetrical or asymmetrical capacity constraints exist, products are slightly differentiated, the elasticity of demand or the discount factor is varied and a triopoly is assumed instead of a duopoly. He proves, among other things, that the form of the cycles changes with the parameter values. With less elastic demand curves, his simulations show more aggressive undercutting and cycles that are more rapid and less asymmetric. Noel (2008) also shows that Edgeworth cycles continue to exist as a possible equilibrium solution when the number of firms is increased to three, but coordination problems appear. The two suppliers no longer necessarily follow a price increase of the other one. Instead, delayed price adjustments and false starts occur. This means that the suppliers initially continue to undercut each other's prices, but then follow the increase later or the price leader itself takes back the increase. There is no further expansion of the number of suppliers, but Noel (2008) considers that the coordination problems with a larger number of suppliers may lead to a situation where price increases are no longer applied and cycles do not occur. The most important model extension for this paper is the introduction of capacity constraints. If both firms are symmetrically capacity constrained – as in the case of a negative supply shock, the cycles will be less fast, more asymmetric and the minimum prices will be higher. This means that there are more price reductions during the phase of undercutting and the difference between the minimum and maximum price becomes smaller. However, if the constraints become too tight, the cycles are destabilised and more stable, non-cyclical pricing occurs. Further extensions were carried out by Wallner (1999), who introduced a finite time horizon, and Bloch and Wills-Johnson (2010), who demonstrated how Edgeworth cycles could emerge in a market where spatial competition is important.

At an empirical level, Allvine and Patterson (1974) first observed asymmetric price cycles in the U.S. retail gasoline market in southern and western cities in the early 1970s, and Castanias and Johnson (1993) were the first to link this to the theory of Maskin and Tirole (1988). Since then, the existence of price cycles has been documented in retail gasoline markets in the U.S. (Zimmerman et al. 2013; Doyle et al. 2010), Canada (Eckert 2003; Noel 2007a, 2007b), Australia (Byr-ne and Roos 2019; Wang 2009), Norway (Foros and Steen 2013) and Germany (Siekmann 2017; Eibelshäuser and Wilhelm 2018). Even if the temporal duration differs from region to region, the characteristic shape of the Edgeworth price cycles in oligopoly markets (with more than three suppliers) was evident, contrary to the coordination problems expected in theory.

Several researchers have investigated in which markets price cycles are more likely to occur and which factors influence the shape of the cycles. Eckert (2003) and Noel (2007a) show for Canadian as well as Lewis (2009) and Zimmerman et al. (2013) for U.S. cities that price cycles are more prevalent where the share of independent retail stations is larger, the market concentration is lower and the population density is greater. Furthermore, it has been shown that the duration of the undercutting phase is shortened when there are more small firms, so that cycles are faster and less asymmetric (Noel 2007a). Finally, price undercutting is initiated by small firms and price restoration by large, which is also in line with the theoretical model and its extensions (Noel 2007b; Atkinson 2009).

Atkinson et al. (2014) show that a local supply shock, a refinery fire in Ontario, Canada, in 2007, caused the decade-long retail price cycles in several cities to come to a standstill. When the refinery returned to normal operation, the cycles did not return in the market. In more distant cities, no change in pricing before or after the fire could be observed. The cessation of cycles is consistent with the theoretical model of Edgeworth cycles in the case of relatively strong capacity constraints and the fact that they did not reappear is in line with the multiple equilibrium character of the theory (Noel 2008). In Western Australia, retailers have been obliged since 2001 to report the next day's price, which is then set at 6 a.m. and remains unchanged for the next 24 hours. This regulatory intervention caused the cycles to lose their rhythm in the short run, but they rebounded after four months. Thus, price cycles can continue to exist even with simultaneous pricing and price commitment (Wang 2009).

The German fuel market was also examined by government institutions and was the subject of scientific analyses. The Federal Cartel Office (Bundeskartellamt 2011) observed daily and weekly price cycles from early 2007 to mid-2010 as well as a dominant oligopoly consisting of Aral (BP), Shell, Esso (ExxonMobil), Total S.A. and Jet (Phillips 66). As a result, the Market Transparency Unit for Fuels was established to reduce information asymmetry between suppliers and consumers and thus enhance competition. Since December 2013, all petrol stations in Germany have been obliged to report their prices, which are made available to consumers online in real time. With these new data, several studies could reveal fixed intraday pricing patterns that occurred nationwide with all brands carrying them out. From the beginning of 2014, firms started the day with a high price level, which was reduced during the day in small steps and returned to its start-ing level in the early evening. A first change in the cycle has been observed from July 2015, with all providers implementing a further small price hike at noon. From April 2017, an additional small increase was made in the afternoon. Since February 2018, there has been a significant change. The overnight price level is no longer the highest, the largest price increase is now observed in the morning and three further price peaks over the course of the day are followed by many small decreases (see Figure 5.2). Nevertheless, even this cycle does not seem to be stable, there are indications that the pattern has changed again after March 2019. A cost shock or any other reason that explains these adjustments has not yet been identified. But it has been observed that in the transition to a new pattern Aral is the first company to implement it, with all others, especially Shell, Esso and Total, adapting rapidly. However, the ever shorter and more pronounced fuel price cycles have some common characteristics, where the basic pattern of a strong price increase followed by many small price reductions is maintained. The increases are initially carried out by Aral, Shell or Total. Jet and smaller companies follow later and have a significantly lower overall price level (Bundeskartellamt 2014, 2015, 2017, 2018, 2019; Neukirch and Wein 2016a, 2016b).

Thus, a different adjustment behaviour of the brands must be taken into account in the analysis of changing price cycles. Siekmann (2017) observed in the German market that the asymmetry and intensity of the cycle is stronger in more concentrated markets, but decreases with a higher share of smaller brands. He concludes that intraday cycles are a sign of competition with a price-reducing effect. Linder (2018) uses a Markov switching regression model to study pricing behaviour from October 2013 to June 2015. She can show that the price increasing phases of all brands are shorter than the price decreasing phases, which is in line with the theory of Edgeworth price cycles. However, the author concludes that the fixed timetable for nationwide daily price increases is part of a strategy of dynamic price discrimination. Haucap et al. (2017) investigate whether increased transparency has intensified competition and changed the refuelling behaviour of the consumers. On the supply side, the authors note that the number of price changes, in particular price reductions, and the spread between the highest and lowest daily price has increased. They assess the acceleration of price cycles as an increase in competition. On the demand side, they find that consumers refuelled more frequently at low prices, i.e. adjusted their refuelling behaviour to the daily price cycles. Therefore, it is important in this analysis to consider whether the oil companies deviate from the well-known time of the highest or lowest daily price in the event of a supply shock.

The paper closest to mine is de Haas (2019). This study uses the same natural experiment and the cities of Cologne and Hamburg as treatment and control group. With a difference-in-differences analysis, the author shows that the maximum and minimum prices in Hamburg, the control group, have also increased. He concludes that the rise in minimum prices is not consistent with the theory of Edgeworth price cycles, as the costs in Hamburg have not changed because of the shock. Furthermore, he notes that the number of daily price adjustments in Cologne has fallen, the pattern of the cycles have been disturbed and that this effect is persistent. In Hamburg, on the other hand, the price cycle is stable. By using hourly data, the author ignores many observations and a precise statement about the number of adjustments and their change is problematic. The exact extent, to which the cycle has changed, especially the chronological sequence of high and low price phases, is not explained. Nor is the different behaviour of the individual companies addressed. The restriction to the year 2018 makes it difficult to make a statement on the persistence of the effects. In contrast to de Haas (2019), I use 15-minute price data and thus capture substantially more price changes. This allows me to more accurately capture the change in cycle asymmetry that the model with capacity constraints of Noel (2008) describes. I also show the results of Super E5 and look at the individual providers separately, so I can identify differences between premium and low-cost providers. In order to be able to make a statement about whether the previous shape will reappear, I use data up to April 2019 and can thus determine if a new nationwide cycle will emerge. To what extent the periods of maximum and minimum daily prices change, I will also discuss.

5.3. Data and Methodology

In this article, I use a natural experiment – the low water in the Rhine – in combination with a difference-in-differences framework, which allows me to estimate the effect of a cost shock on the shape of price cycles. In order to measure the effect, one needs a "treated" city, that is one located on the Rhine, and a city that is as far as possible unaffected by the event, but as similar as possible to the treated city. I take Cologne for the former – the city on the Rhine – and Hamburg for the latter. Both cities belong to the four largest cities in Germany, have a comparable per capita gross domestic product and an equivalent number of motor vehicles per person[24]. In addition, these cities are included in the annual investigations by the Federal Cartel Office since 2014 and have

[24] See Federal Statistical Office (Statistisches Bundesamt) https://www.destatis.de for the population (Cologne: 1,080,394; Hamburg: 1,830,584); Statistic departments of the federation and the federal states (Statistische Ämter des Bundes und der Länder 2016) for the per capita gross domestic product (59,407/62,793); Federal Motor Vehicle and Transport Authority (Kraftfahrt-Bundesamt) https://www.kba.de for the number of motor vehicles per person (0.44/0.43).

consistently shown identical price patterns (Bundeskartellamt 2014, 2015, 2017, 2018, 2019). I group the fuel stations as follows: The nationwide and vertically integrated companies Aral (BP), Shell, Esso (ExxonMobil), TOTAL (Total S.A.) and Jet (Phillips 66) are considered individually. These companies are described by the German Federal Cartel Office as a dominant oligopoly, although Jet operates as a low-price provider whose pricing differs from the premium brands (Bundeskartellamt 2011; Neukirch and Wein 2016b). All other brands represented nationwide are assigned to the group non-oligopolists 1 (NO1[25]) and the independent petrol stations to non-oligopolists 2 (NO2). Table 5.1 shows that the total number of petrol stations is greater in Hamburg, which can be explained by the larger area, the higher population and the number of registered cars, but the share of brands is comparable to that in Cologne. As similar as the cities are, they use different supply routes for crude oil as well as refinery capacities and are more than 400 km apart, so they represent different markets for motorists.

Table 5.1: Number of petrol stations

Brand/City	Cologne	Hamburg	Total
Aral	34 (30%)	44 (20%)	78 (23%)
Shell	16 (14%)	44 (20%)	60 (18%)
Esso	11 (10%)	25 (11%)	36 (11%)
TOTAL	6 (5%)	12 (5%)	18 (5%)
Jet	11 (10%)	21 (10%)	32 (10%)
NO1	15 (13%)	39 (18%)	54 (16%)
NO2	20 (18%)	36 (16%)	56 (17%)
Total	113 (100%)	221 (100%)	334 (100%)

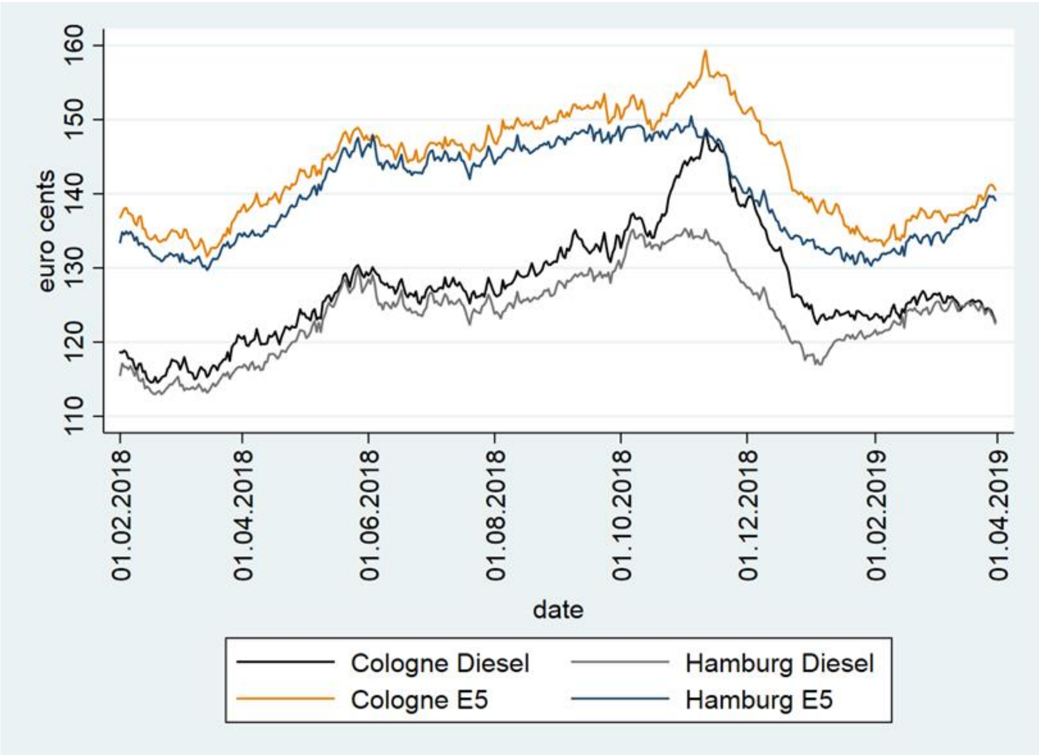
The price data were collected by the aforementioned Market Transparency Unit for Fuels and were provided by the app provider *Tankerkoenig.de*[26]. The dataset contains all price changes of a fuel station for diesel and petrol (Super E5). Petrol and diesel represent different markets, at least in the medium run, as consumers cannot switch between the two types of fuel due to the technical specifications of the engines (Bundeskartellamt 2011). The release of diesel from the strategic reserve was nearly twice as high as that of petrol, as seasonal demand for heating oil, which is chemically very close to diesel, was stronger. Since the expected impact on diesel prices will therefore be greater, I will first analyse this type of fuel and then present the results for petrol. I calculate the average price for all 15 minutes of the seven brands from 1 February 2018 to 31 March 2019 (424 days). De Haas (2019), in contrast, uses hourly prices from 1 June 2018 to 31 December 2018 (214 days), which means that many price changes within one day are ignored on the one hand and the period after the shock is disregarded on the other. The unit of all retail price data

[25] NO1: Star, AVIA, HEM, OIL!, Agip, OMV and Westfalen.
[26] See https://creativecommons.tankerkoenig.de

throughout the paper is euro cents per litre including all taxes. Data on quantities sold are unfortunately not available.

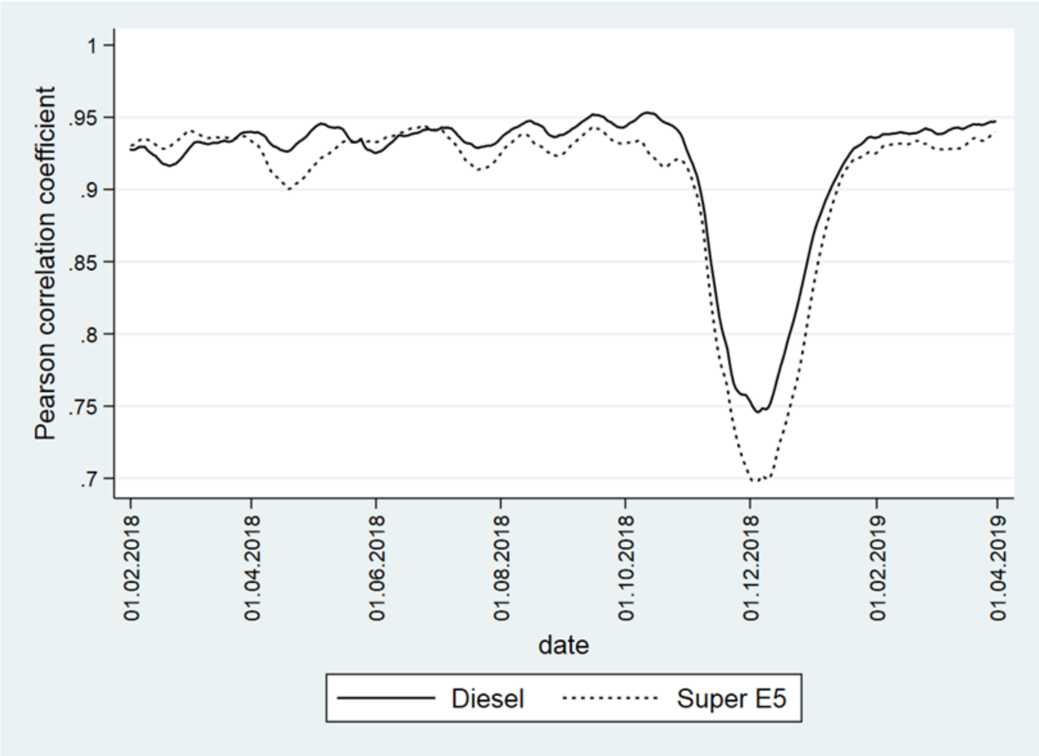
To implement a difference-in-differences model an unambiguous period of the treatment must be defined. It is obvious that the low water level influenced the supply to fuel stations, but it is not possible to determine exactly when this effect occurred and then ceased. Figure 5.3 clearly shows that fuel prices in Cologne and Hamburg followed a parallel trend from the beginning of 2018 until they diverged from the end of October, when inland navigation on the Rhine was restricted. As the water level rose again at the beginning of 2019, prices began to converge and the previous price differences reappeared. This diverging and converging is illustrated in Figure 5.4 by the correlation between prices in Cologne and Hamburg. From the end of October onwards, this fell sharply and returned to the previous level of 0.9 in early 2019.

Figure 5.3: Price of Diesel and Super E5 (Hamburg/Cologne)



Note: Average unweighted daily prices in euro cents per litre for Hamburg and Cologne.

Figure 5.4: Correlation between the prices in Hamburg and Cologne



Note: Pearson correlation coefficient (double-exponential smoothed) calculated from 15-minute average prices across all brands for Hamburg and Cologne.

Accordingly, I define the following three periods:

- Pre-treatment period (PTP): 1 February 2018 – 24 October 2018 (266 days)
- Treatment period (TP): 25 October 2018 – 25 December 2018 (62 days)
- After treatment period (ATP): 26 December 2018 – 31 March 2019 (96 days)

To test the assumption of equal trends before the supply shock, I perform a "placebo" test by shifting the treatment period in the pre-treatment period. There, no or only minimal effects should occur. Another robustness check uses the event window of de Haas (2019), who defined the period of low water from 12 October 2018 – 2 December 2018.

The goal of the empirical analysis is to better understand changes in the shape of a price cycle that occur following a market shock. I perform a set of OLS-estimations for each brand with the following basic equation:

$$y_{mt} = \beta_0 + \beta_1 Cologne_m + \beta_2 TP_t + \beta_3 ATP_t + \beta_4 Cologne_m * TP_t + \beta_5 Cologne_m * ATP_t + \varepsilon_{mt} \tag{5.1}$$

where $Cologne_m$ is the treatment market *(m)* variable, TP_t the treatment period (the low water), $Cologne_m * TP_t$ the interaction of the two, ATP_t the after treatment period and $Cologne_m * ATP_t$ the interaction after the treatment. First, I do not use any other control variables, because the constant represents the mean price in Hamburg before the low water, which helps to interpret the magnitude of the effects. Additional estimations include the Brent crude oil price in euro per barrel[27] and dummies for the weekdays as well as holidays. In order to investigate the price development and the influence on the shape of the cycles, I consider different outcome variables y_{mt}. First, I use the 15-minute average prices of each brand to quantify the price increase during the low water in Cologne compared to Hamburg. These estimates also show whether the shock is persistent or temporary. Second, I use the daily spread between the highest and lowest price as dependent variable to investigate the intensity of the cycle. The theory shows that the spread decreases or even stable prices occur as capacity constraints increase. By using the daily minimum and maximum price as dependent variables, I am able to explain whether an increase in the minimum or a reduction in the maximum price is responsible for a change in the spread. Since the beginning of 2018, it has been characteristic of the price cycles in the German market that the highest price was observed at 6 a.m. and the lowest in the evening, independently of the brand. Therefore, I further investigate if the timing of the maximum/minimum price has shifted and whether this is maintained after the treatment period. The observed price cycles show a strong asymmetry, there are much more price reductions than price increases. Noel (2008) shows that capacity constraints (as in the case of the low water) increase the asymmetry of the cycles. To examine the extent to which this asymmetry changes during the shock, I use the ratio of decreases to increases. If this ratio rises, the asymmetry of the cycles increases accordingly. To illustrate percentage changes and thus simplifying the quantitative interpretation of the results, I will perform log transformations for the price, spread and ratio variables. The summary statistics of the variables can be found in Table 5.11 in the Appendix.

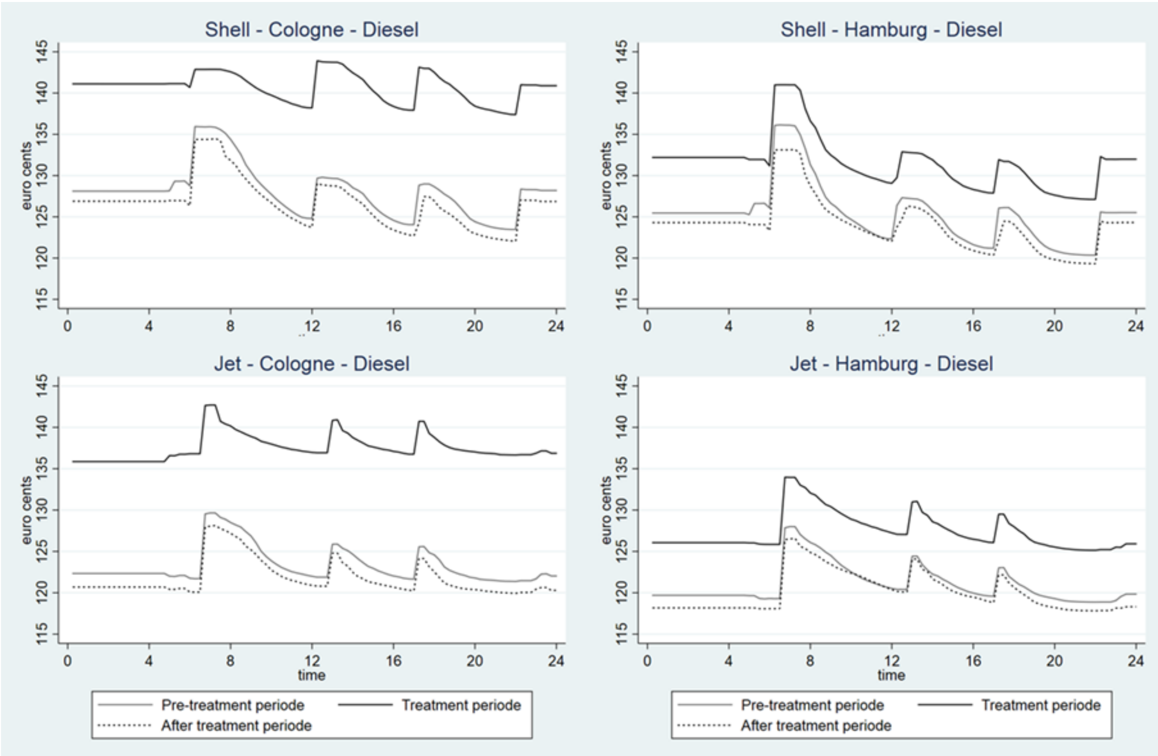
5.4. Results

Before I present the results of the estimations, I give a visual impression of how the price patterns in Hamburg and Cologne looked before, during and after the treatment. Figure 5.5 shows the price setting for diesel of the premium brand Shell in the upper and that of the low-cost supplier Jet in the lower part. The graphs on the right illustrate that prices rose during the low water in Hamburg, but the characteristic shape of the cycles remains unchanged for both firms during and afterwards. In contrast, the price increase for Shell and Jet during the treatment in Cologne (left side) was stronger and the spread narrowed. In the case of Shell it is also noticeable that the first price increase of the day was much smaller and the daily maximum price was set at noon. After 25 December 2018, so in the after treatment period, the initial price patterns were restored by both suppliers. The price patterns of the other five operators are shown in Figure 5.2 in the Appendix and give a similar impression. In Hamburg, prices rose and the shape of the cycles remained nearly unchanged. A stronger price increase and narrower spread was observed for all

[27] Source: Federal Reserve Bank of St. Louis (https://fred.stlouisfed.org)

brands in the city on the Rhine. Besides Shell, only Aral charged the maximum daily price during the treatment at noon. Finally, it is remarkable that the price cycles after the low water almost resembled those before in shape and magnitude, regardless of the supplier.

Figure 5.5: Price cycles in the three periods (Shell, Jet – Diesel)



Note: Average price every 15 minutes in the three periods by brand calculated from daily price data in euro cents per litre.

Starting with the average diesel price as dependent variable in Equation 5.1, Table 5.2 shows that the prices in Hamburg of Aral, Shell, Esso and TOTAL are on average 3–4 cents higher than those of Jet, NO1 and NO2 (*Constant*). In addition, it is evident that the price level in Cologne is slightly higher compared to Hamburg before the low water (*Cologne*). During the treatment, this difference increases between 6.4 and 8.4 cents (*Cologne*TP*). Since prices in the control group have also risen by 5% on average (*TP*), this means an average increase of more than 10% in the city on the Rhine. Table 5.12 in the Appendix shows the percentage changes using log transformations of the variables. However, there is no statistically or economically significant price difference between the pre-treatment and after treatment period (*Cologne*ATP*), which indicates that the shock is not persistent.

Table 5.2: Price development – Diesel

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	2.102***	2.752***	2.463***	0.611***	2.259***	3.981***	3.686***
	(0.0636)	(0.0621)	(0.0579)	(0.0651)	(0.0575)	(0.0580)	(0.0571)
TP	5.809***	6.224***	5.614***	5.812***	6.356***	6.300***	6.012***
	(0.0909)	(0.0869)	(0.0840)	(0.0879)	(0.0789)	(0.0824)	(0.0810)
ATP	-1.398***	-1.335***	-0.202***	-1.338***	-0.968***	-0.907***	-1.052***
	(0.0614)	(0.0603)	(0.0590)	(0.0614)	(0.0525)	(0.0546)	(0.0533)
Cologne*TP	7.588***	6.423***	8.354***	7.785***	7.919***	7.581***	7.888***
	(0.135)	(0.125)	(0.125)	(0.128)	(0.125)	(0.123)	(0.122)
Cologne*ATP	-0.235**	-0.0771	-0.401***	0.130	-0.542***	-0.0316	-0.234**
	(0.0841)	(0.0820)	(0.0784)	(0.0826)	(0.0716)	(0.0735)	(0.0712)
Constant	125.8***	125.3***	123.2***	126.2***	121.0***	120.7***	120.5***
	(0.0446)	(0.0440)	(0.0401)	(0.0462)	(0.0400)	(0.0404)	(0.0397)
Observations	81408	81408	81408	81408	81328[1]	81408	81408
Adjusted R^2	0.292	0.304	0.335	0.270	0.363	0.389	0.389

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001; [1]Due to a temporary closure on four days in April 2018 there was no Jet petrol station open before 5 a.m.

During the treatment period, it was not only the price difference that increased, price patterns also changed. Turning to the daily spread of the two cities in Table 5.3, it can be seen that the premium brands (Aral, Shell, Esso and TOTAL) have a larger difference between the minimum and maximum price before the low water, which is slightly lower in Cologne. During the shock, the spread difference of these brands declines by 2.6 to 4 cents compared to Hamburg. This means a reduction of 29% to 46% can be observed in Cologne (see Table 5.13 in the Appendix). Accordingly, these price adjustments confirm the theoretical results of Noel (2008), but the capacity constraints are not so severe that the daily cycles come to a cessation. When the supply shortage was over, the decline in the spread difference is smaller in the case of Esso and Total. For Aral and Shell, the positive coefficient of the interaction term shows that the difference is even smaller compared to the pre-treatment period. For NO1 and NO2 the decline is smaller and after the shock the initial level is restored. In the case of the low-cost provider Jet, there are no substantial changes between the two regions in comparison. In conclusion, premium brands especially reduce the intensity of price cycles during the supply shock, thus have a similar spread value compared to other market participants, and then return to their previous intensity. The narrowing of the spread is driven by a lower increase in the daily maximum prices (Table 5.14 in the Appendix: 3.6 to 7.3 cent) and a higher increase in minimum prices in Cologne (Table 5.15 in the Appendix: 7.1 to 9 cent), which is in line with the Edgeworth price cycle model (Noel 2008). Before the treatment, the difference between the average minimum price of the premium brands and the other providers was 1.66 cents in Cologne, between 25 October and 25 December 2018 it fell marginally to 1.57 cents. In contrast, the difference in maximum prices fell from 5.2 to 2.39 cents. This suggests that the consumer price sensitivity has increased in this situation due to media reporting and that the brands Aral, Shell, Esso as well as TOTAL react to this rise by setting their maximum prices more moderately.

Table 5.3: Spread – Diesel

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-2.162***	-3.207***	-0.353***	0.372*	-0.458***	-0.363***	-0.647***
	(0.216)	(0.179)	(0.0948)	(0.186)	(0.0811)	(0.0807)	(0.0766)
TP	-1.475***	-1.823***	0.232	-0.803***	-0.432***	-0.392***	0.191
	(0.302)	(0.246)	(0.133)	(0.217)	(0.0952)	(0.0924)	(0.0984)
ATP	-1.527***	-1.935***	2.305***	-0.829***	-0.385***	-0.425***	-0.360***
	(0.209)	(0.187)	(0.183)	(0.155)	(0.0853)	(0.0939)	(0.0783)
Cologne*TP	-3.968***	-3.555***	-2.568***	-3.074***	-0.649*	-1.427***	-1.903***
	(0.343)	(0.298)	(0.236)	(0.336)	(0.263)	(0.162)	(0.168)
Cologne*ATP	1.413***	1.754***	-1.424***	-1.573***	0.0434	-0.0112	0.0953
	(0.308)	(0.319)	(0.251)	(0.252)	(0.117)	(0.154)	(0.123)
Constant	14.80***	15.85***	10.50***	13.00***	9.335***	9.709***	8.526***
	(0.172)	(0.133)	(0.0610)	(0.117)	(0.0547)	(0.0402)	(0.0480)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.428	0.574	0.435	0.259	0.148	0.265	0.361

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

In addition to the intensity, the timing of price increases and decreases also changed. Using the time when the highest respectively lowest price level is reached in Equation 5.1 as the dependent variable, different effects occur. The time is given in hours and decimal minutes[28], meaning that a value of 6.5 stands for 6.30 a.m. Table 5.4 illustrates that before the low water, the highest price level on the day is reached in both cities between 6 and 7.30 a.m. In the control city Hamburg, nothing changes in the further observation period, as is the case of Esso, NO1 and NO2 in Cologne. In contrast, Aral and Shell are shifting the high price level by 4 respectively 5 hours to the late morning during the low water period and are thus changing their pricing behaviour markedly. For TOTAL and Jet, the shifts are much smaller with 1.3 and 1.7 hours respectively. The deviating companies return to their initial time patterns from 26 December, so this is not a persistent adjustment. This means that only Aral and Shell temporarily changed their price pattern, which was familiar to consumers since February 2018.

[28] 100 decimal minutes = 60 minutes

Table 5.4: Time of maximum price – Diesel

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	0.214**	0.0592	-0.255*	-0.492***	0.0865	-0.0742**	0.204***
	(0.0672)	(0.106)	(0.120)	(0.0863)	(0.0550)	(0.0270)	(0.0253)
TP	0.0193	0.366	-0.210*	-0.0762	-0.0863**	-0.0220	0.000364
	(0.0304)	(0.285)	(0.0963)	(0.0715)	(0.0310)	(0.0148)	(0.0207)
ATP	0.200	0.225**	-0.249*	0.0189	-0.0686*	-0.0244	-0.00241
	(0.183)	(0.0763)	(0.111)	(0.0964)	(0.0315)	(0.0150)	(0.0195)
Cologne*TP	3.979***	4.957***	0.343	1.271***	1.680***	0.0823*	-0.349**
	(0.780)	(0.570)	(0.283)	(0.362)	(0.412)	(0.0332)	(0.106)
Cologne*ATP	-0.511*	-0.184	0.283	0.381***	0.0177	0.0925**	0.0721
	(0.216)	(0.114)	(0.166)	(0.114)	(0.0586)	(0.0313)	(0.0530)
Constant	6.279***	6.239***	6.811***	6.617***	6.852***	6.808***	7.213***
	(0.0132)	(0.0681)	(0.0863)	(0.0694)	(0.0300)	(0.00960)	(0.0102)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.243	0.444	0.002	0.069	0.154	0.009	0.109

Note: Dependent variable in hours and decimal minutes; Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

By contrast, a narrow time window when the minimum price level is reached cannot be identified (see Table 5.5). Before the shock, it lies between noon and 9 p.m., with the difference between Hamburg and Cologne for the individual brands fluctuating between -3.6 and 4.3 hours. During the treatment this difference does not change for Aral, Esso and NO1. However, for Jet and NO2 this difference decreases by 7.6 and 4.3 hours, both significant at the 0.1% level. For the former company the time in Cologne shifts from noon to morning and for the latter the change in Hamburg is mainly responsible for the effect. For Shell and TOTAL, the time of the daily minimum price shifts forward by 1 to 2 hours. Looking at the difference between Hamburg and Cologne after the low water, there is no uniform trend either. The previous adjustments of Jet, NO2 and TOTAL can no longer be observed, with NO2 now shifting the time of the minimum price in Cologne. For Aral, Shell, Esso and NO1 the difference increases between 48 minutes and almost four hours, with different statistical significance.

Table 5.5: Time of minimum price – Diesel

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-2.729***	-1.550***	-3.555***	0.752**	-3.206***	4.319***	4.272***
	(0.275)	(0.236)	(0.293)	(0.281)	(0.695)	(0.643)	(0.582)
TP	0.722***	0.315**	0.386	0.835**	2.131*	2.637*	3.798***
	(0.215)	(0.121)	(0.232)	(0.301)	(0.951)	(1.215)	(0.976)
ATP	0.952***	0.294*	-0.162	0.681**	-0.981	-1.193	-0.488
	(0.178)	(0.143)	(0.199)	(0.261)	(1.022)	(1.107)	(1.026)
Cologne*TP	-0.976	-1.305*	-0.482	-1.925**	-7.597***	-1.992	-4.308***
	(0.624)	(0.607)	(0.615)	(0.674)	(1.608)	(1.397)	(1.148)
Cologne*ATP	1.544***	0.792*	1.239**	-0.747	1.367	3.692**	2.390*
	(0.424)	(0.351)	(0.453)	(0.665)	(1.397)	(1.226)	(1.065)
Constant	19.62***	21.20***	21.01***	17.81***	16.33***	12.31***	14.76***
	(0.145)	(0.0902)	(0.138)	(0.181)	(0.479)	(0.569)	(0.538)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.199	0.103	0.226	0.007	0.084	0.113	0.117

Note: Dependent variable in hours and decimal minutes; Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

In addition to a decrease in the amplitude of the cycles in the case of a capacity constraint, the model also shows that the asymmetry increases, i.e. the number of price reductions rises in comparison to the increases. To investigate this, I use the ratio of the number of price reductions to increases, which grows as the asymmetry becomes greater. If I use the natural logarithm of the ratio in Equation 5.1 as dependent variable, Table 5.6 shows that for all suppliers the number of price reductions is higher than the number of increases (see Table 5.16 in the Appendix for absolute values). During the low water period a treatment effect of 20% occurs at the Aral fuel stations, while in the control region a decrease of 5% can be observed. Thus the asymmetry of the cycles in Cologne is increasing. This effect remains to a reduced extent even after the shock. For Shell, the difference between the cities increases after the shock, driven by a decline in Hamburg and a slight increase in Cologne. In contrast, negative treatment effects occur during the low water for Esso, TOTAL and Jet, which means a decrease in asymmetry. This applies to all of them thereafter, with the positive coefficient of Esso being caused by a relatively strong decline in Hamburg. For the non-oligopolists (NO1) there is no change overall.

In summary, all brands show asymmetric price cycles over the whole observation period, but they adjust the number of price reductions and increases differently in both regions and in the respective periods. Thus, no uniform significant change during and after the treatment can be observed. Therefore I can neither confirm the results of de Haas (2019), who observed a decrease in the number of price changes in Cologne, nor the theoretical predictions.

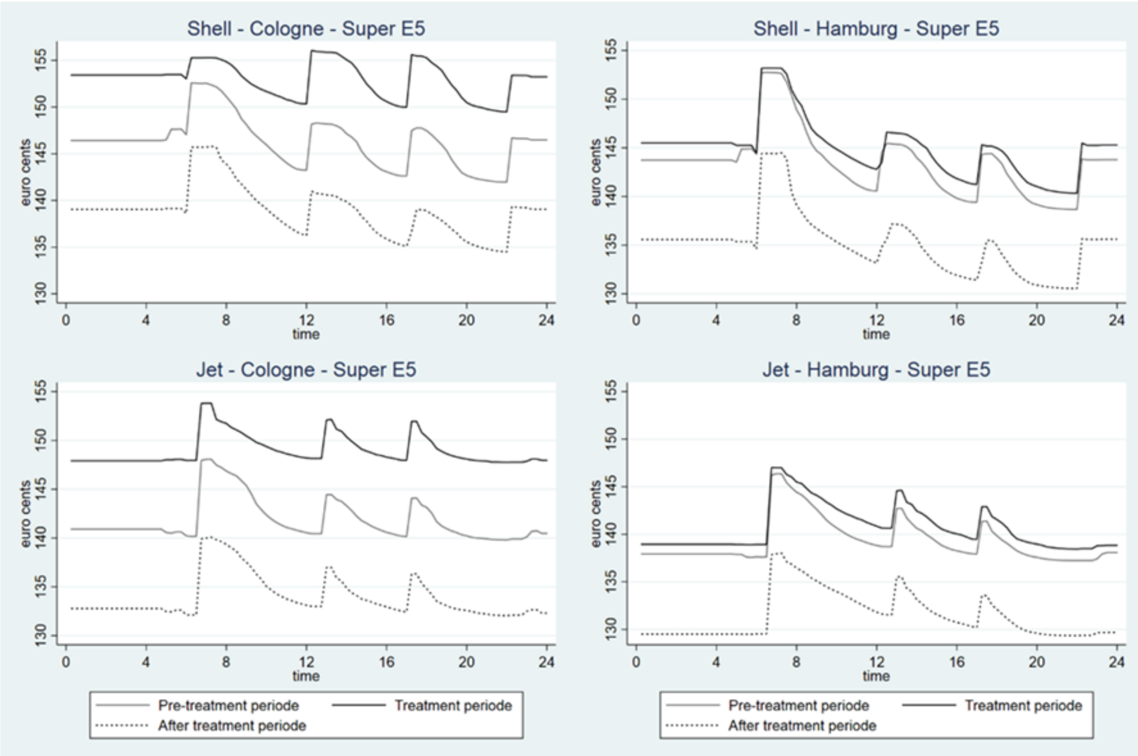
Table 5.6: Log ratio of number of price reductions to increases – Diesel

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-0.372***	-0.0449*	-0.0628**	0.226***	-0.209***	-0.315***	-0.308***
	(0.0130)	(0.0190)	(0.0229)	(0.0200)	(0.0212)	(0.0149)	(0.0146)
TP	-0.0508**	-0.0848***	0.0657*	0.106***	0.0312	-0.0380	0.0711**
	(0.0190)	(0.0210)	(0.0315)	(0.0200)	(0.0224)	(0.0258)	(0.0218)
ATP	-0.0835***	-0.181***	-0.199***	-0.0997***	0.0997***	0.0200	0.136***
	(0.0159)	(0.0211)	(0.0272)	(0.0184)	(0.0229)	(0.0231)	(0.0238)
Cologne*TP	0.197***	0.0482	-0.131**	-0.462***	-0.143***	0.0111	0.0313
	(0.0270)	(0.0337)	(0.0455)	(0.0438)	(0.0367)	(0.0364)	(0.0315)
Cologne*ATP	0.169***	0.278***	0.177***	-0.369***	-0.136***	-0.0487	-0.101**
	(0.0270)	(0.0309)	(0.0382)	(0.0353)	(0.0353)	(0.0275)	(0.0308)
Constant	2.153***	2.262***	1.627***	1.375***	1.942***	1.695***	1.184***
	(0.00777)	(0.0121)	(0.0148)	(0.0136)	(0.0140)	(0.0118)	(0.0107)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.527	0.086	0.069	0.332	0.267	0.473	0.495

Note: Robust standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

I will now turn to the analysis of petrol prices (Super E5). Since consumers cannot switch between the two types of fuel, they represent different markets. Due to the winter months the seasonal demand for heating oil, which is chemically very similar to diesel, was stronger, it can be expected that the impact on petrol prices was smaller. This is also reflected in the release of diesel from the strategic reserve, which was almost twice as high as that of petrol. Figure 5.6 shows the average pricing in the three periods of Shell and Jet (see Figure 5.4 in the Appendix for the other brands). Overall, the cyclical price-setting behaviour is also evident for petrol. In Hamburg the price level and the shape of the cycles before and during the low water did not change significantly. By contrast, in Cologne prices rose during the treatment period and the spread narrowed for both companies. In addition, the timing of the maximum price at Shell fuel stations was shifted from morning to midday. After 25 December 2018, lower price levels were observed in both regions as well as for the two suppliers, and the former shape of the cycles returned.

Figure 5.6: Price cycles in the three periods (Shell, Jet – Super E5)



Note: Average price every 15 minutes in the three periods by brand calculated from daily price data in euro cents per litre.

This first impression is confirmed by using the average petrol price as dependent variable in Equation 5.1. Table 5.7 shows that during the treatment the price increases in Hamburg are much lower with 0.8 to 1.6 cent per litre than for the diesel prices (5.6 to 6.4 cent). Thus, the diesel price increases in Hamburg cannot only be attributed to the supply shock, the reason for this could be the increased demand for heating oil. The prices in Cologne are slightly higher in the initial situation (0.6 to 4.1 cents) and the subsequent increases in these prices, which are between 5.2 and 6.7 cents, are lower than for the diesel prices, but nevertheless they result in a price hike between 3.4 and 4.5 percent compared to the control region (see Table 5.17 in the Appendix). After the low water, the prices in both regions fall considerably, although the level in Cologne remains marginally higher. Overall, this means that in Cologne, a temporary price increase occurs, but this is not persistent.

Table 5.7: Price development – Super E5

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	2.230***	2.839***	2.478***	0.570***	2.487***	4.080***	3.923***
	(0.0621)	(0.0629)	(0.0579)	(0.0635)	(0.0574)	(0.0576)	(0.0572)
TP	1.080***	1.549***	0.926***	0.803***	1.402***	1.383***	1.197***
	(0.0921)	(0.0890)	(0.0889)	(0.0897)	(0.0846)	(0.0873)	(0.0852)
ATP	-8.161***	-8.327***	-7.044***	-7.981***	-7.825***	-7.781***	-7.912***
	(0.0602)	(0.0614)	(0.0576)	(0.0609)	(0.0531)	(0.0536)	(0.0523)
Cologne*TP	5.562***	5.162***	6.277***	6.648***	5.779***	6.087***	6.028***
	(0.124)	(0.118)	(0.118)	(0.119)	(0.116)	(0.116)	(0.114)
Cologne*ATP	0.592***	0.940***	0.251**	0.974***	-0.0238	0.820***	0.292***
	(0.0835)	(0.0838)	(0.0789)	(0.0836)	(0.0742)	(0.0743)	(0.0719)
Constant	144.1***	143.4***	141.7***	144.6***	139.3***	139.1***	138.9***
	(0.0441)	(0.0449)	(0.0410)	(0.0459)	(0.0408)	(0.0407)	(0.0406)
Observations	81408	81408	81408	81408	81328[1]	81408	81408
Adjusted R^2	0.317	0.332	0.323	0.288	0.366	0.397	0.404

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001; [1]Due to a temporary closure on four days in April 2018 there was no Jet petrol station open before 5 a.m.

Regarding the price spread, similar adjustments can be observed to that of diesel and as predicted by the theory, but the effects are in general weaker as expected. Before the supply shock, the price spread in Cologne is smaller than in Hamburg and almost identical to that of diesel (see Table 5.8). In Hamburg, a relatively small decline can be observed during the treatment for the brands Aral, Shell and TO-TAL, but none for Esso and the companies not belonging to the oligopoly. On the other hand, the difference between the maximum and minimum price decreases for all suppliers in Cologne. More pronounced is this in the case of the Aral, Shell and TOTAL, which previously had the highest values. This change is caused by a stronger increase of the daily minimum price (see Table 5.19 in the Appendix) compared to the maximum price (see Table 5.18 in the Appendix). But in Hamburg no statistically significant adjustment of these values can be found in this period, which contradicts the thesis of de Haas (2019), since there is no increase in daily minimum petrol prices compared to diesel. After the period of the low water, the fuel station operators Aral, Shell, Jet and the companies not belonging to the alleged oligopoly adjust their price range back to the pre-level. Only Esso and TOTAL remain at a slightly higher spread in Hamburg and a marginally lower one in Cologne. In summary, all suppliers are reducing the intensity of cycles in the petrol market in the affected region, especially the premium brands.

Table 5.8: Spread – Super E5

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-2.169***	-3.349***	-0.886***	0.411**	-0.488***	-0.746***	-0.722***
	(0.184)	(0.162)	(0.104)	(0.149)	(0.0947)	(0.0870)	(0.0798)
TP	-1.108***	-1.143***	0.283	-0.464**	-0.666***	-0.103	-0.155
	(0.226)	(0.204)	(0.146)	(0.172)	(0.101)	(0.109)	(0.0996)
ATP	0.0728	-0.138	2.499***	0.501***	-0.434***	-0.480***	-0.301***
	(0.179)	(0.202)	(0.185)	(0.146)	(0.0997)	(0.103)	(0.0767)
Cologne*TP	-2.667***	-2.251***	-1.453***	-1.942***	-1.069***	-1.355***	-1.410***
	(0.281)	(0.257)	(0.222)	(0.325)	(0.287)	(0.165)	(0.167)
Cologne*ATP	0.516	0.823**	-1.291***	-1.168***	0.0327	0.164	-0.0196
	(0.268)	(0.297)	(0.267)	(0.235)	(0.136)	(0.154)	(0.131)
Constant	13.11***	14.13***	10.67***	11.20***	9.382***	9.687***	8.438***
	(0.142)	(0.121)	(0.0641)	(0.0866)	(0.0677)	(0.0505)	(0.0450)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.425	0.564	0.422	0.128	0.206	0.279	0.329

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

Concerning the timing of the daily maximum or minimum price, the effects are also very close to those of the diesel prices. Table 5.20 in the Appendix shows that all operators charge the highest price before the supply shock between 6 and 7 am. In Hamburg no changes occur during the rest of the observation period. However, in Cologne, Aral and Shell shift the time by over 4 hours as well as TOTAL and Jet by 2 hours into the late morning. After the inland navigation on the Rhine was unrestricted again, all deviating providers return to the highest price level in the morning. Esso, NO1 and NO2 make no adjustments overall.

The lowest price (Table 5.21 in the Appendix) is set by the service station operators over a longer period between 12 noon and 9 p.m. In general, during and after the treatment there are mainly statistically and economically (less than one hour) insignificant changes. Only TOTAL and NO2 shift the time point in Hamburg during the shock from 5:30 p.m. to 7 p.m. and from 2 p.m. to 5 p.m. respectively, which increases the difference to Cologne by 3 – 3.5 hours. However, the firms are reversing this adjustment in the last considered period. In the after treatment period, the time difference be-tween the two regions increases by 1.5 hours in case of Aral and by 4 hours in case of NO1. Overall, no uniform development can be observed at the timing of the lowest price level, as is the case with diesel prices.

Analogous to the analysis of diesel price cycles, I use the log ratio of the number of price reductions to the increases to determine a change in asymmetry (see Table 5.9 and Table 5.22 in the Appendix for the absolute values). The initial values in Cologne and Hamburg are all positive, i.e. there are more price reductions than increases in the petrol market and the respective amounts correspond to the values of diesel. But again, I cannot observe any uniform changes in the case of the premium brands or the low-cost suppliers, which can be attributed to the supply shock in the Rhine region. The asymmetric price cycles, however, persist for all filling station operators and there is no complete standstill of price cycles.

Table 5.9: Log ratio of number of price reductions to increases – Super E5

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-0.366***	-0.0441**	-0.0828***	0.220***	-0.231***	-0.263***	-0.310***
	(0.0134)	(0.0169)	(0.0229)	(0.0205)	(0.0202)	(0.0162)	(0.0144)
TP	-0.0312	-0.0670***	-0.00424	0.0800***	0.0585*	0.0454	0.112***
	(0.0173)	(0.0169)	(0.0290)	(0.0190)	(0.0248)	(0.0271)	(0.0219)
ATP	-0.0982***	-0.154***	-0.186***	-0.116***	0.0629**	0.0534*	0.142***
	(0.0161)	(0.0233)	(0.0278)	(0.0205)	(0.0199)	(0.0232)	(0.0203)
Cologne*TP	0.190***	0.0657*	-0.105*	-0.377***	-0.00123	-0.0853*	0.0119
	(0.0268)	(0.0303)	(0.0424)	(0.0399)	(0.0407)	(0.0341)	(0.0293)
Cologne*ATP	0.157***	0.259***	0.185***	-0.329***	-0.0464	-0.0516	-0.123***
	(0.0261)	(0.0311)	(0.0396)	(0.0358)	(0.0340)	(0.0277)	(0.0269)
Constant	2.157***	2.226***	1.660***	1.358***	1.950***	1.651***	1.186***
	(0.00767)	(0.0115)	(0.0157)	(0.0143)	(0.0124)	(0.0136)	(0.0108)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.524	0.080	0.064	0.308	0.238	0.400	0.545

Note: Robust standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

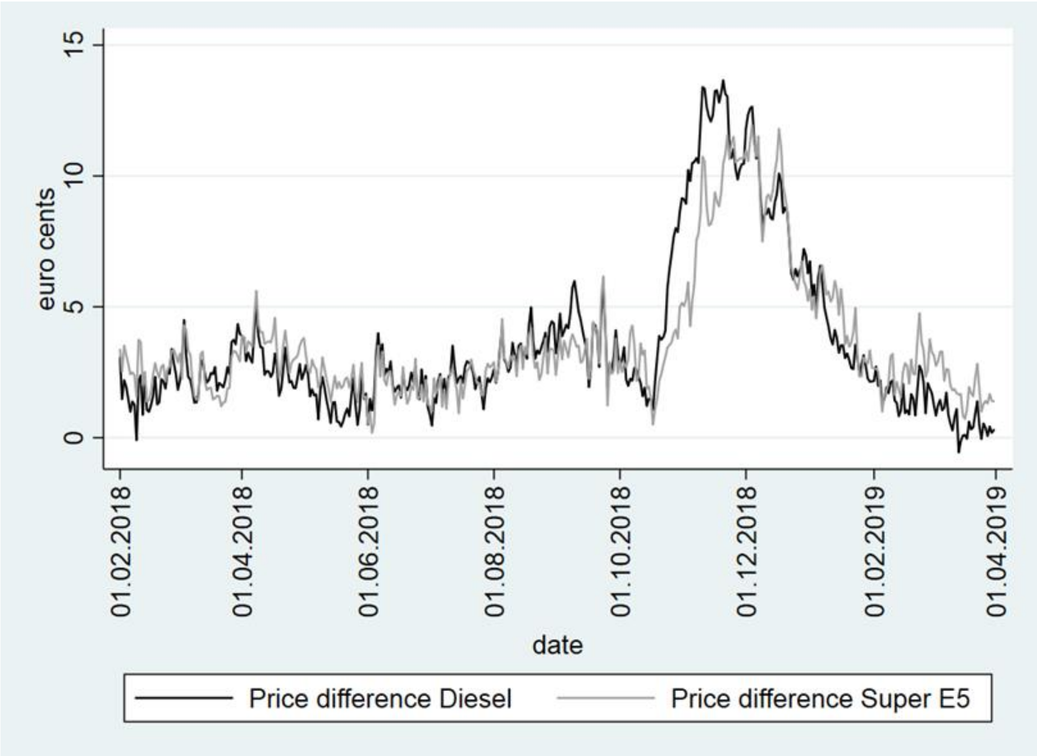
In summary, the analysis of fuel prices also confirms that the low water did not lead to stable prices within one day, nor did it trigger a persistent change in the nationwide cycles, but it changed temporarily the shape and the timing of the price structures, in particular of premium brands.

5.5. Robustness Checks

To scrutinise my results further, I perform several checks of robustness. First, I run a placebo test to prove whether there was a parallel trend between the two cities before the low water. Second, I use additional control variables in the estimates, such as the Brent crude oil price and the days of the week. Finally, I use the period of low water used by Haas to validate my results.

That fuel prices in Hamburg and Cologne followed a similar trend before 25 October and then drifted strongly in the opposite direction was already shown in Figures 5.3 and 5.4. Until they converge again at the end of December 2018 and resume a similar course. In Figure 5.7 this behaviour is underpinned by the price difference between Cologne and Hamburg for diesel and petrol respectively. This difference was less than 5 cents per litre before the treatment and then increased to more than 10 euro cents. Thereafter, the price difference fell below the 5 euro cent threshold.

Figure 5.7: Price difference between Hamburg and Cologne (Diesel/Super E5)



Note: Average unweighted daily price difference in euro cents per litre of all brands between Hamburg and Cologne.

To confirm that there was a parallel trend between the two cities before the low water in the Rhine, I split the former pre-treatment period into three periods[29] and run the analysis again. In these periods there should be no or only minimal differences in the prices or the shape of the cycles. Table 5.10 shows that the difference between the diesel prices in Cologne and Hamburg is between 1.2 and 3.7 cents per litre in the first period (*Cologne*) and that it decreases by only 0 to 2.2 cents in period 2 (*Cologne*P2*). In the third period (*Cologne*P3*) it increases between 0.5 to 1.2 cents. However, these variations are relatively small compared to the period of the low water (6.4 to 8.4 cents see *Cologne*TP* in Table 5.2). The estimates for petrol (Super E5) show comparable results. In the second period (*Cologne*P2*), prices fall by 0.1 to 2.4 cents and in the third period (*Cologne*P3*) they rise by a maximum of 0.5 cents (see Table 5.23 in the Appendix). In contrast, price jumps of between 5.2 and 6.6 cents occur during the low water period (see Table 5.7). For the spread, the changes in the pre-treatment period are also much smaller compared to the period of the natural experiment (compare for diesel Table 5.2 with Table 5.24 in the Appendix and for petrol Table 5.8 and Table 5.25 in the Appendix). It is therefore reasonable to assume that there is an equal trend between the prices before treatment.

[29] Period 1: 1 February to 30 April 2018; Period 2 (*P2*): 1 May to 31 July 2018; Period 3 (*P3*): 1 August to 24 October 2018

Table 5.10: Placebo – Price development – Diesel

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	1.793***	2.506***	2.292***	1.224***	2.131***	3.659***	3.409***
	(0.0595)	(0.0607)	(0.0569)	(0.0623)	(0.0515)	(0.0517)	(0.0468)
P2	9.291***	9.053***	8.871***	11.40***	8.909***	8.881***	9.009***
	(0.0625)	(0.0640)	(0.0532)	(0.0619)	(0.0481)	(0.0495)	(0.0459)
P3	13.24***	12.91***	12.47***	14.11***	12.89***	12.97***	13.00***
	(0.0713)	(0.0721)	(0.0602)	(0.0669)	(0.0565)	(0.0582)	(0.0540)
Cologne*P2	-0.234**	-0.294***	-0.480***	-2.189***	-0.496***	0.0924	-0.175**
	(0.0866)	(0.0864)	(0.0756)	(0.0866)	(0.0689)	(0.0696)	(0.0635)
Cologne*P3	1.221***	1.090***	1.056***	0.452***	0.865***	0.909***	1.056***
	(0.0975)	(0.0961)	(0.0862)	(0.0945)	(0.0807)	(0.0807)	(0.0752)
Constant	118.4***	118.1***	116.2***	117.7***	113.8***	113.5***	113.2***
	(0.0412)	(0.0445)	(0.0382)	(0.0459)	(0.0343)	(0.0358)	(0.0324)
Observations	51072	51072	51072	51072	50992[1]	51072	51072
Adjusted R^2	0.642	0.642	0.687	0.674	0.723	0.741	0.768

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001; [1]Due to a temporary closure on four days in April 2018 there was no Jet petrol station open before 5 a.m.

In addition to the results shown so far, I use the Brent crude oil price and the weekdays as control variables in the estimations. Table 5.26 in the Appendix demonstrates that the coefficients of interests, the interaction terms, do not change when I use the average price as dependent variable. However, this approach reveals that the price increase in Hamburg is even stronger due to the low Rhine level, as the Brent crude oil price tended to decrease during this period (see Figure 5.1). It is also obvious that there are only marginal differences between the days of the week. The maximum values of the statistically significant coefficients are between 0.3 and 0.7 cents on Sundays and public holidays. Table 5.27 in the Appendix shows for Hamburg that the small changes of the spread during the treatment are now even smaller overall and that the Brent price has almost no influence. As far as weekdays are concerned, the spread for Aral and Shell on weekends and holidays is lower compared to Mondays. No differences or differences of less than one cent can be found for the other brands. There is also no change in the timing of the maximum/minimum daily price due to the inclusion of additional explanatory variables[30].

As further robustness check, I use the treatment time window of de Haas (2019), who defined the period of low water from 12 October to 2 December 2018. This shows that the price level in Hamburg increased more strongly during the low water period, while the price increase in Cologne was still 5 to 7 cents higher (see Table 5.28 in the Appendix). However, the increased price difference between the two cities remains after the treatment to a limited extent, which is not the case in the definition used so far. Therefore, it can be assumed that the period was chosen too narrowly by this author. The changes in the spread during the low water show similar values, whereby the variations between the brands are maintained (see Table 5.29 in the Appendix). Thereafter the initial difference between Cologne and Hamburg is almost restored. Additionally, it reveals that the temporal shift of the highest price level from Aral and Shell is less pronounced and that there

[30] The results of these regressions are available on request of the author.

is still no uniform pattern regarding the timing of the minimum price and the ratio of the number of price reductions to increases[31].

All in all, the results are confirmed by further control variables, a different fuel type and an alternative treatment window.

5.6. Conclusion

Since 2014, intraday price cycles have been observed in the German retail fuel market, which occur nationwide and have so far taken on four different patterns. In this article, I exploit a natural experiment to identify the effects of a cost shock on the occurrence and shape of theses price cycles. A study for Canada shows that such a shock, a refinery fire in this case, caused the decades-long cycles in several cities to cease (Atkinson et al. 2014). In contrast, a regulatory intervention in Western Australia only led to a temporary disappearance of the cycles (Wang 2009). I focus on the low water in the Rhine at the end of 2018, which severely restricted inland navigation between refineries and tank farms. As a result, transport costs as well as retail fuel prices rose sharply in the affected regions.

Using a difference-in-differences approach, I analyse the effects on pricing in Cologne, a city on the Rhine, compared to Hamburg, the control city. During the low water period, prices increased by almost 5% in Hamburg and by 10% in Cologne. The price difference between the two cities thus rose from 0.6–4 cents to 6.4–8.4 cents, depending on the brand. After the river level had recovered, the initial price difference reappeared. In the high-price period, the intensity of the cycles of the premium brands in Cologne, measured by the price spread, fell sharply by 2.6–4 cents. No or only a slight decline could be observed in the case of the low-cost providers. This means that the premium brands adjust their price spread to that of the low-cost providers by increasing the daily maximum prices less than the minimum price. Greater competitive pressure, due to increased consumer price sensitivity, e.g. through media coverage, can explain this behaviour. After the shock, all brands almost return to the pre-treatment period spread.

Furthermore, I show that only Aral and Shell modify the timing of the cycle during the treatment, these companies have shifted the time of the highest price level by 4 and 5 hours respectively to be more competitive in the morning hours. For the others no or only minor adjustments were found. Another feature is that after the water level has recovered, the initial timing returned. Using the ratio of the number of price decreases to the increases, I can show that there was a strong asymmetry of cycles over the whole observation period. However, I did not find a uniform change during and after the low water for the seven brands.

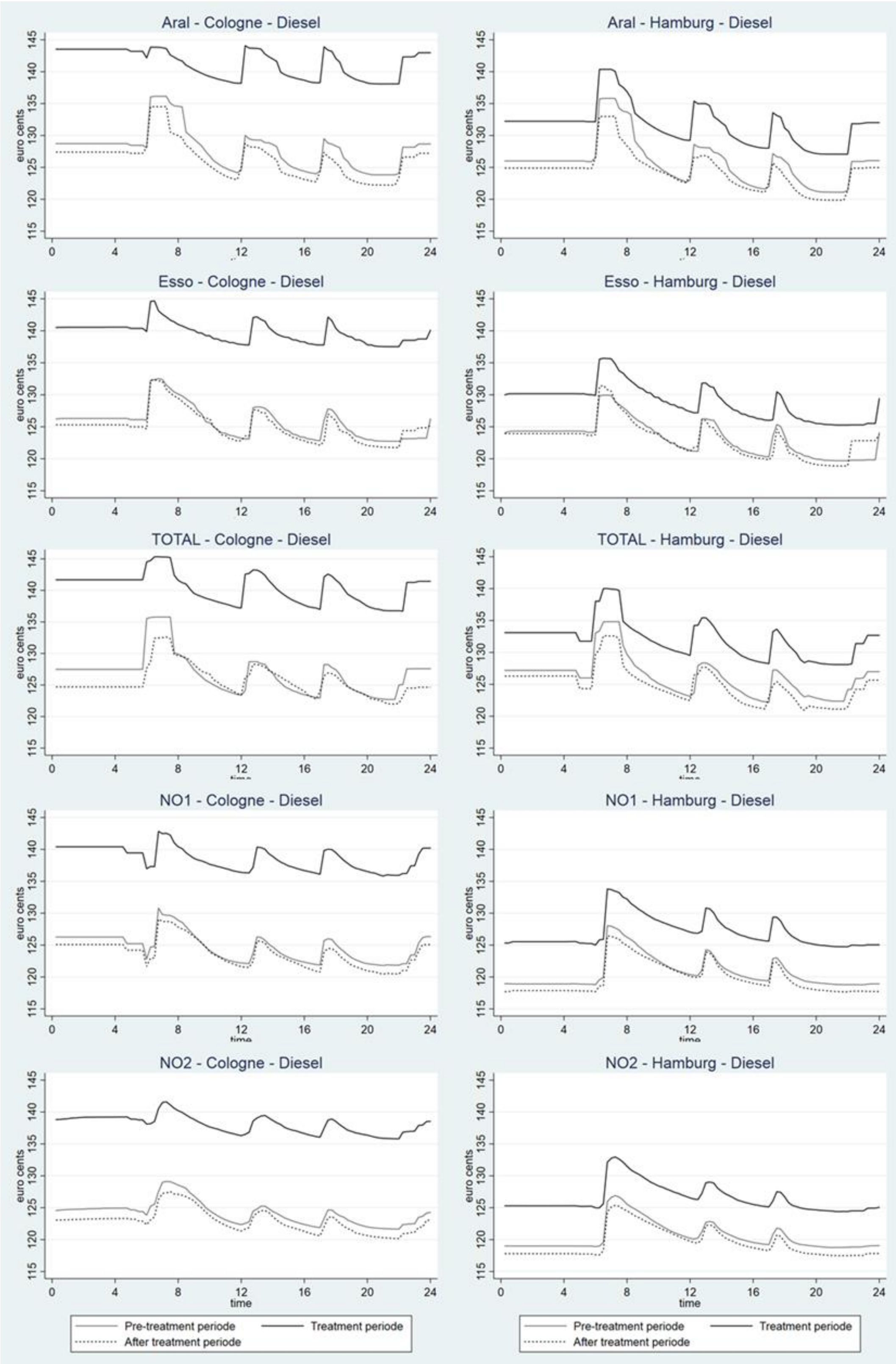
Overall, I show that the intraday price cycles did not disappear due to the local shock, but a few firms reduce the intensity and change the timing. When the supply was unrestricted again, the

[31] The results of these regressions are available on request of the author.

cycles returned in their original form. Thus, no new nationwide price cycle was established. The four cycle changes observed in Germany since 2014 can therefore not be explained by a local cost shock. Further research is therefore needed to determine whether these changes are triggered by demand or nationwide supply shocks or whether market participants are implementing these themselves.

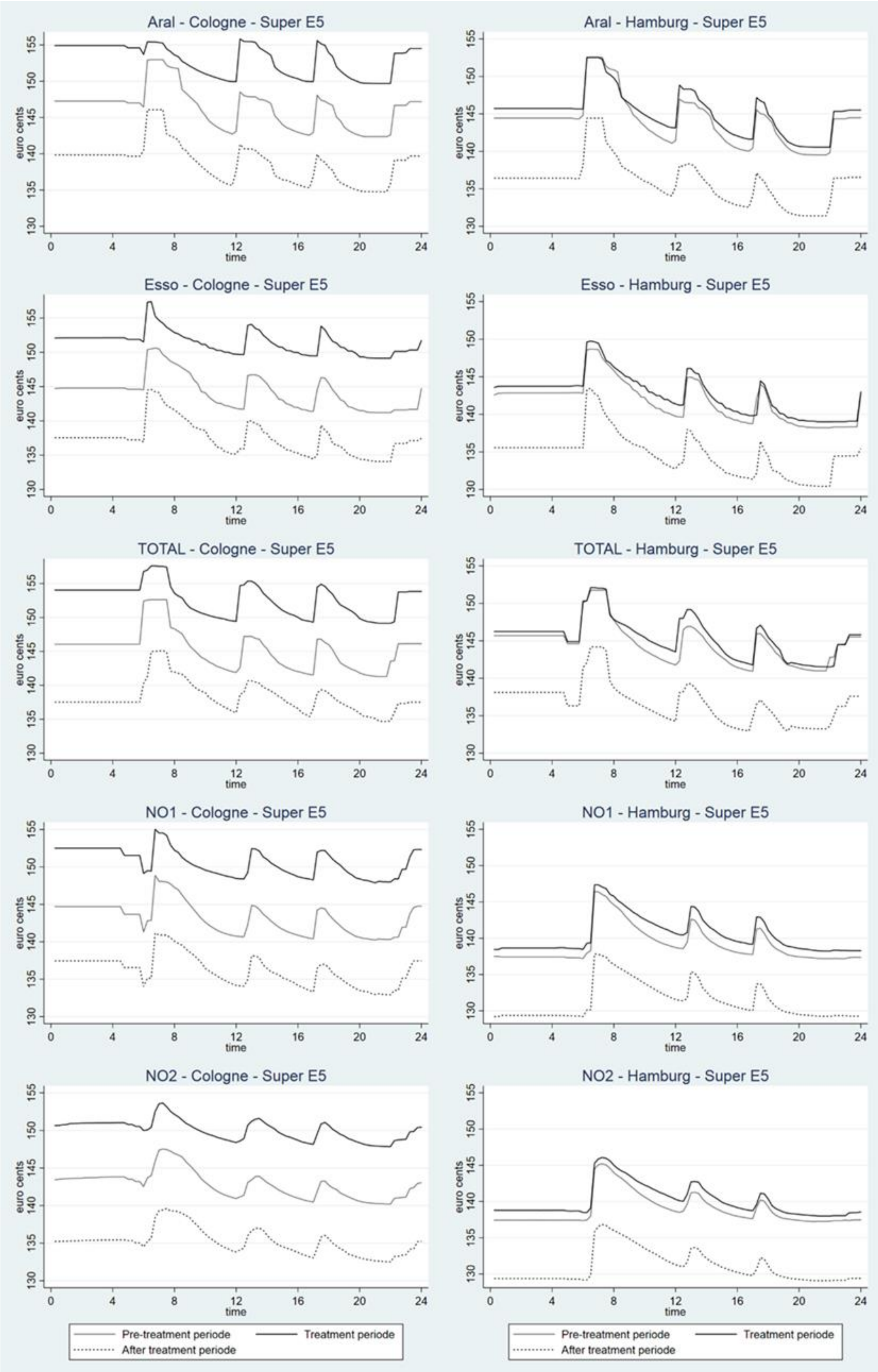
Appendix

Figure 5.8: Price cycles in the three periods (Diesel)



Note: Average price every 15 minutes in the three periods by brand calculated from daily price data in euro cents per litre.

Figure 5.9: Price cycles in the three periods (Super E5)



Note: Average price every 15 minutes in the three periods by brand calculated from daily price data in euro cents per litre.

Table 5.11: Summary statistics – Diesel and Super E5

		Diesel					Super E5				
		N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Aral	Average price	81408	127.92	7.68	110.31	155.25	81408	143.98	7.57	126.22	165.16
	Spread	848	13.02	2.87	6.15	20.18	848	11.74	2.45	5.91	18.66
	Max. time	848	6.67	2.17	0.25	23.25	848	6.76	2.22	0.25	23.25
	Min. time	848	18.68	3.32	9.50	22.00	848	18.67	3.42	9.75	21.75
	Max. price	848	136.50	7.33	120.31	155.25	848	151.38	7.18	137.51	165.16
	Min. price	848	123.48	7.05	110.31	147.51	848	139.64	6.97	126.22	158.72
	Ratio	848	7.36	1.53	2.86	10.40	848	7.40	1.53	3.43	10.40
Shell	Average price	81408	127.77	7.48	109.62	152.53	81408	143.68	7.66	125.32	163.50
	Spread	848	13.48	2.94	1.66	19.52	848	12.19	2.65	1.26	17.54
	Max. time	848	6.71	2.07	0.25	22.50	848	6.82	2.27	0.25	22.50
	Min. time	848	20.53	2.75	0.25	23.25	848	20.48	2.64	0.25	23.25
	Max. price	848	136.57	6.96	122.90	152.53	848	151.36	7.09	137.90	163.50
	Min. price	848	123.09	7.06	109.62	145.90	848	139.17	7.14	125.32	156.50
	Ratio	848	9.40	1.80	0.75	14.75	848	9.12	1.65	1.67	14.75
Esso	Average price	81408	125.81	7.27	109.09	155.01	81408	141.99	7.14	126.30	166.01
	Spread	848	10.53	1.66	4.64	18.36	848	10.58	1.73	4.64	20.54
	Max. time	848	6.65	1.28	6.25	24.00	848	6.55	1.27	0.25	24.00
	Min. time	848	19.36	3.56	0.25	23.25	848	19.38	3.43	0.25	23.25
	Max. price	848	132.87	6.43	119.98	155.01	848	149.10	6.30	137.04	166.01
	Min. price	848	122.34	7.07	109.09	145.70	848	138.51	6.95	126.30	156.90
	Ratio	848	4.96	1.22	0.56	9.20	848	5.05	1.25	0.75	9.75
TOTAL	Average price	81408	127.63	7.58	109.20	154.40	81408	143.84	7.47	126.70	165.40
	Spread	848	12.47	2.19	6.30	18.20	848	11.18	1.72	6.00	17.17
	Max. time	848	6.50	1.15	0.25	23.25	848	6.54	1.22	6.00	22.50
	Min. time	848	18.24	3.51	0.25	23.25	848	18.19	3.62	0.25	23.25
	Max. price	848	135.87	7.47	119.60	154.40	848	150.96	7.33	135.60	165.40
	Min. price	848	123.39	6.87	109.20	144.23	848	139.78	6.87	126.70	155.23
	Ratio	848	4.23	1.19	1.70	8.50	848	4.16	1.15	1.63	9.75
Jet	Average price	81328	123.36	7.27	108.29	153.40	81328	139.39	7.22	124.52	164.63
	Spread	848	8.91	1.03	4.27	13.18	848	8.87	1.22	4.16	13.55
	Max. time	848	6.99	1.09	6.50	17.25	848	7.06	1.30	6.50	17.25
	Min. time	848	14.42	8.47	0.25	23.75	848	14.27	8.47	0.25	23.75
	Max. price	848	129.96	6.50	117.90	153.40	848	145.92	6.46	134.09	164.63
	Min. price	848	121.05	6.95	108.29	144.90	848	137.05	6.89	124.52	153.65
	Ratio	848	6.51	1.79	1.83	17.33	848	6.57	1.62	1.57	12.67
NO1	Average price	81408	123.94	7.48	108.18	150.52	81408	140.08	7.43	123.73	162.07
	Spread	848	9.27	1.05	4.35	12.60	848	9.11	1.12	4.28	13.50
	Max. time	848	6.78	0.26	0.25	8.25	848	6.82	0.62	6.75	23.50
	Min. time	848	14.86	7.75	0.25	23.25	848	14.79	7.82	0.25	23.25
	Max. price	848	130.44	6.64	116.77	150.52	848	146.42	6.70	133.95	162.07
	Min. price	848	121.17	7.03	108.18	144.61	848	137.31	7.00	123.73	155.33
	Ratio	848	4.76	1.16	2.36	9.83	848	4.73	1.15	2.55	10.17
NO2	Average price	81408	123.50	7.36	108.07	152.84	81408	139.70	7.37	124.32	162.21
	Spread	848	8.02	1.04	3.71	11.39	848	7.88	1.05	3.51	11.88
	Max. time	848	7.30	0.37	1.25	9.00	848	7.30	0.32	6.25	9.00
	Min. time	848	17.29	6.84	0.25	24.00	848	16.91	7.28	0.25	24.00
	Max. price	848	129.15	6.64	116.60	152.84	848	145.18	6.74	132.96	162.21
	Min. price	848	121.13	7.06	108.07	145.12	848	137.29	7.07	124.32	155.78
	Ratio	848	2.98	0.73	1.08	6.11	848	2.99	0.73	1.30	6.33

(continued)

Table 5.11: Continued

	Diesel					Super E5				
	N	Mean	SD	Min	Max	N	Mean	SD	Min	Max
Brent price	424	59.45	6.54	44.14	74.79	424	59.45	6.54	44.14	74.79
Monday	424	0.14		0	1	424	0.14		0	1
Tuesday	424	0.13		0	1	424	0.13		0	1
Wednesday	424	0.14		0	1	424	0.14		0	1
Thursday	424	0.14		0	1	424	0.14		0	1
Friday	424	0.14		0	1	424	0.14		0	1
Saturday	424	0.14		0	1	424	0.14		0	1
Sunday	424	0.14		0	1	424	0.14		0	1
Holiday	424	0.02		0	1	424	0.02		0	1

Table 5.12: Log transformation of the price – Diesel

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	0.0166***	0.0218***	0.0197***	0.00490***	0.0185***	0.0325***	0.0301***
	(0.000502)	(0.000490)	(0.000467)	(0.000517)	(0.000472)	(0.000475)	(0.000469)
TP	0.0457***	0.0491***	0.0449***	0.0458***	0.0517***	0.0514***	0.0492***
	(0.000699)	(0.000669)	(0.000663)	(0.000678)	(0.000632)	(0.000662)	(0.000653)
ATP	-0.0101***	-0.00964***	-0.000850	-0.00941***	-0.00700***	-0.00654***	-0.00778***
	(0.000489)	(0.000481)	(0.000480)	(0.000491)	(0.000435)	(0.000454)	(0.000445)
Cologne*TP	0.0543***	0.0457***	0.0608***	0.0567***	0.0580***	0.0546***	0.0573***
	(0.00101)	(0.000938)	(0.000957)	(0.000963)	(0.000967)	(0.000952)	(0.000948)
Cologne*ATP	-0.00149*	-0.000287	-0.00282***	0.00122	-0.00409***	0.000205	-0.00139*
	(0.000665)	(0.000648)	(0.000632)	(0.000657)	(0.000589)	(0.000603)	(0.000587)
Constant	4.833***	4.829***	4.813***	4.836***	4.794***	4.792***	4.790***
	(0.000354)	(0.000351)	(0.000327)	(0.000370)	(0.000331)	(0.000336)	(0.000331)
Observations	81408	81408	81408	81408	81328[1]	81408	81408
Adjusted R^2	0.276	0.290	0.316	0.254	0.342	0.369	0.369

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001; [1]Due to a temporary closure on four days in April 2018 there was no Jet petrol station open before 5 a.m.

Table 5.13: Log transformation of the spread – Diesel

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-0.154***	-0.228***	-0.0366***	0.0226	-0.0516***	-0.0432***	-0.0823***
	(0.0166)	(0.0163)	(0.0103)	(0.0151)	(0.00881)	(0.00873)	(0.00983)
TP	-0.0966***	-0.116***	0.0221	-0.0596**	-0.0452***	-0.0412***	0.0236*
	(0.0229)	(0.0191)	(0.0152)	(0.0183)	(0.0104)	(0.00975)	(0.0116)
ATP	-0.0934***	-0.121***	0.194***	-0.0579***	-0.0401***	-0.0472***	-0.0413***
	(0.0154)	(0.0151)	(0.0160)	(0.0128)	(0.00925)	(0.0114)	(0.00955)
Cologne*TP	-0.457***	-0.431***	-0.293***	-0.282***	-0.109**	-0.175***	-0.273***
	(0.0285)	(0.0274)	(0.0291)	(0.0313)	(0.0341)	(0.0194)	(0.0248)
Cologne*ATP	0.0877***	0.104***	-0.112***	-0.131***	0.00486	0.00131	0.0106
	(0.0251)	(0.0272)	(0.0226)	(0.0217)	(0.0129)	(0.0174)	(0.0156)
Constant	2.675***	2.750***	2.346***	2.553***	2.229***	2.271***	2.139***
	(0.0124)	(0.0116)	(0.00660)	(0.00952)	(0.00585)	(0.00428)	(0.00599)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.505	0.561	0.414	0.267	0.177	0.287	0.383

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 5.14: Maximum price – Diesel

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	0.342	-0.155	2.533***	0.969	1.733***	2.746***	2.452***
	(0.677)	(0.636)	(0.509)	(0.684)	(0.491)	(0.527)	(0.521)
TP	4.531***	4.812***	5.753***	5.143***	5.942***	5.725***	6.038***
	(0.948)	(0.890)	(0.730)	(0.871)	(0.684)	(0.705)	(0.743)
ATP	-2.719***	-2.964***	1.436**	-2.089***	-1.427***	-1.529***	-1.557***
	(0.583)	(0.563)	(0.525)	(0.558)	(0.392)	(0.416)	(0.437)
Cologne*TP	4.123**	3.560**	6.468***	4.624***	7.344***	6.338***	6.301***
	(1.330)	(1.237)	(1.071)	(1.268)	(1.183)	(1.115)	(1.146)
Cologne*ATP	1.216	1.415	-1.457*	-1.015	-0.169	-0.105	-0.0989
	(0.790)	(0.769)	(0.667)	(0.758)	(0.540)	(0.592)	(0.591)
Constant	135.8***	136.2***	130.1***	134.9***	128.0***	128.1***	126.9***
	(0.494)	(0.454)	(0.354)	(0.480)	(0.336)	(0.349)	(0.359)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.144	0.156	0.330	0.187	0.388	0.356	0.360

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 5.15: Minimum price – Diesel

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	2.504***	3.052***	2.885***	0.597	2.191***	3.108***	3.099***
	(0.542)	(0.547)	(0.536)	(0.566)	(0.534)	(0.536)	(0.535)
TP	6.006***	6.635***	5.521***	5.946***	6.374***	6.116***	5.847***
	(0.757)	(0.727)	(0.752)	(0.750)	(0.730)	(0.753)	(0.752)
ATP	-1.192**	-1.029*	-0.869	-1.260**	-1.042*	-1.104*	-1.197**
	(0.451)	(0.443)	(0.448)	(0.479)	(0.428)	(0.442)	(0.446)
Cologne*TP	8.091***	7.115***	9.037***	7.699***	7.993***	7.764***	8.204***
	(1.207)	(1.149)	(1.179)	(1.135)	(1.160)	(1.177)	(1.183)
Cologne*ATP	-0.197	-0.339	-0.0333	0.558	-0.213	-0.0938	-0.194
	(0.619)	(0.608)	(0.609)	(0.634)	(0.585)	(0.603)	(0.605)
Constant	121.0***	120.3***	119.6***	121.9***	118.7***	118.4***	118.4***
	(0.366)	(0.375)	(0.360)	(0.405)	(0.367)	(0.364)	(0.362)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.382	0.391	0.402	0.323	0.395	0.398	0.401

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 5.16: Ratio of number of price reductions to increases – Diesel

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-2.658***	-0.392*	-0.273*	1.043***	-1.310***	-1.525***	-0.886***
	(0.0876)	(0.156)	(0.110)	(0.0954)	(0.151)	(0.0758)	(0.0435)
TP	-0.419**	-0.878***	0.329	0.372***	0.0942	-0.215	0.230**
	(0.150)	(0.188)	(0.168)	(0.0880)	(0.168)	(0.142)	(0.0790)
ATP	-0.683***	-1.647***	-0.958***	-0.451***	0.660***	0.113	0.500***
	(0.127)	(0.188)	(0.123)	(0.0737)	(0.184)	(0.127)	(0.0832)
Cologne*TP	1.320***	0.474	-0.711**	-1.851***	-0.798***	0.134	0.0316
	(0.195)	(0.292)	(0.221)	(0.179)	(0.234)	(0.175)	(0.0990)
Cologne*ATP	1.231***	2.524***	0.764***	-1.434***	-0.932***	-0.247	-0.414***
	(0.181)	(0.282)	(0.174)	(0.142)	(0.246)	(0.139)	(0.0947)
Constant	8.674***	9.776***	5.231***	4.054***	7.169***	5.544***	3.317***
	(0.0633)	(0.112)	(0.0749)	(0.0586)	(0.112)	(0.0656)	(0.0363)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.552	0.101	0.074	0.305	0.227	0.452	0.492

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 5.17: Log transformation of the price – Super E5

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	0.0154***	0.0197***	0.0174***	0.00406***	0.0178***	0.0290***	0.0279***
	(0.000431)	(0.000439)	(0.000410)	(0.000444)	(0.000413)	(0.000413)	(0.000411)
TP	0.00774***	0.0112***	0.00668***	0.00601***	0.0103***	0.0101***	0.00884***
	(0.000638)	(0.000618)	(0.000627)	(0.000621)	(0.000605)	(0.000626)	(0.000612)
ATP	-0.0575***	-0.0590***	-0.0503***	-0.0558***	-0.0570***	-0.0568***	-0.0578***
	(0.000429)	(0.000440)	(0.000418)	(0.000435)	(0.000392)	(0.000396)	(0.000387)
Cologne*TP	0.0372***	0.0344***	0.0425***	0.0447***	0.0395***	0.0413***	0.0410***
	(0.000845)	(0.000805)	(0.000819)	(0.000811)	(0.000817)	(0.000816)	(0.000800)
Cologne*ATP	0.00522***	0.00802***	0.00280***	0.00724***	0.000837	0.00775***	0.00383***
	(0.000592)	(0.000595)	(0.000567)	(0.000594)	(0.000543)	(0.000542)	(0.000525)
Constant	4.969***	4.965***	4.953***	4.973***	4.936***	4.934***	4.932***
	(0.000308)	(0.000316)	(0.000292)	(0.000323)	(0.000296)	(0.000295)	(0.000295)
Observations	81408	81408	81408	81408	81328[1]	81408	81408
Adjusted R^2	0.316	0.331	0.319	0.285	0.364	0.393	0.401

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001; [1]Due to a temporary closure on four days in April 2018 there was no Jet petrol station open before 5 a.m.

Table 5.18: Maximum price – Super E5

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	0.454	-0.0885	1.978***	0.860	1.778***	2.437***	2.500***
	(0.648)	(0.632)	(0.524)	(0.650)	(0.474)	(0.512)	(0.515)
TP	-0.0362	0.401	1.028	0.307	0.614	0.925	0.817
	(0.884)	(0.832)	(0.783)	(0.846)	(0.732)	(0.737)	(0.769)
ATP	-8.001***	-8.250***	-5.284***	-7.459***	-8.356***	-8.506***	-8.420***
	(0.530)	(0.520)	(0.474)	(0.543)	(0.393)	(0.400)	(0.427)
Cologne*TP	3.571**	3.604**	5.689***	4.841***	5.362***	5.229***	5.208***
	(1.171)	(1.108)	(1.033)	(1.129)	(1.108)	(1.034)	(1.055)
Cologne*ATP	1.188	1.418*	-0.619	0.0282	0.293	0.889	0.485
	(0.709)	(0.709)	(0.652)	(0.747)	(0.564)	(0.593)	(0.593)
Constant	152.6***	152.8***	148.8***	151.8***	146.4***	146.5***	145.3***
	(0.476)	(0.452)	(0.363)	(0.459)	(0.324)	(0.342)	(0.360)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.221	0.239	0.290	0.244	0.418	0.410	0.408

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 5.19: Minimum price – Super E5

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	2.623***	3.261***	2.864***	0.449	2.267***	3.183***	3.222***
	(0.534)	(0.549)	(0.529)	(0.565)	(0.528)	(0.528)	(0.533)
TP	1.071	1.544*	0.745	0.771	1.281	1.028	0.972
	(0.799)	(0.772)	(0.793)	(0.793)	(0.772)	(0.790)	(0.787)
ATP	-8.074***	-8.112***	-7.783***	-7.960***	-7.922***	-8.026***	-8.120***
	(0.452)	(0.461)	(0.437)	(0.507)	(0.437)	(0.437)	(0.440)
Cologne*TP	6.238***	5.855***	7.143***	6.783***	6.431***	6.584***	6.618***
	(1.101)	(1.062)	(1.091)	(1.045)	(1.064)	(1.084)	(1.081)
Cologne*ATP	0.672	0.595	0.672	1.196	0.260	0.725	0.504
	(0.641)	(0.644)	(0.621)	(0.671)	(0.613)	(0.619)	(0.623)
Constant	139.5***	138.7***	138.1***	140.6***	137.0***	136.8***	136.8***
	(0.368)	(0.386)	(0.363)	(0.417)	(0.371)	(0.364)	(0.369)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.396	0.409	0.407	0.331	0.406	0.420	0.423

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 5.20: Time of maximum price – Super E5

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	0.282**	0.303*	-0.0282	-0.492***	0.131	0.00940	0.223***
	(0.0871)	(0.149)	(0.135)	(0.0413)	(0.0672)	(0.0640)	(0.0259)
TP	0.0230	0.259	-0.267**	0.0594	0.0204	-0.00746	0.0400
	(0.0301)	(0.288)	(0.0920)	(0.105)	(0.105)	(0.0163)	(0.0215)
ATP	0.339	0.109	-0.241**	-0.00625	-0.0641*	-0.0327*	0.0341
	(0.250)	(0.0843)	(0.0879)	(0.0344)	(0.0316)	(0.0147)	(0.0204)
Cologne*TP	4.670***	4.278***	-0.0363	2.069***	2.184***	0.0793	-0.255***
	(0.654)	(0.572)	(0.140)	(0.485)	(0.465)	(0.120)	(0.0492)
Cologne*ATP	-0.714*	0.296	0.153	0.414***	-0.0369	0.00362	0.0351
	(0.280)	(0.251)	(0.163)	(0.0531)	(0.0692)	(0.0658)	(0.0538)
Constant	6.275***	6.261***	6.642***	6.582***	6.851***	6.814***	7.190***
	(0.0127)	(0.0792)	(0.0862)	(0.0286)	(0.0300)	(0.00946)	(0.0111)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.326	0.285	0.002	0.179	0.209	-0.004	0.127

Note: Dependent variable in hours and decimal minutes; Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 5.21: Time of minimum price – Super E5

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-2.475***	-0.914***	-2.849***	1.407***	-1.911**	3.984***	4.905***
	(0.295)	(0.225)	(0.298)	(0.307)	(0.710)	(0.624)	(0.615)
TP	1.053***	0.602***	0.810***	1.754***	0.770	0.813	2.848**
	(0.246)	(0.130)	(0.243)	(0.326)	(1.182)	(1.373)	(1.086)
ATP	0.772***	0.224	0.270	0.776**	-2.523*	-2.655*	0.0143
	(0.198)	(0.169)	(0.200)	(0.297)	(1.091)	(1.116)	(1.087)
Cologne*TP	-1.364*	-1.574**	-0.671	-2.996***	-0.118	0.0966	-3.462**
	(0.658)	(0.556)	(0.574)	(0.647)	(1.740)	(1.519)	(1.215)
Cologne*ATP	1.584***	-0.399	0.630	-1.066	3.054*	4.313***	1.415
	(0.424)	(0.393)	(0.450)	(0.642)	(1.455)	(1.264)	(1.161)
Constant	19.50***	20.96***	20.61***	17.39***	15.34***	12.79***	14.13***
	(0.168)	(0.102)	(0.158)	(0.216)	(0.500)	(0.547)	(0.574)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.162	0.061	0.172	0.027	0.009	0.112	0.114

Note: Dependent variable in hours and decimal minutes; Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 5.22: Ratio of number of price reductions to increases – Super E5

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-2.620***	-0.394**	-0.411***	0.990***	-1.400***	-1.293***	-0.892***
	(0.0900)	(0.140)	(0.113)	(0.0935)	(0.131)	(0.0810)	(0.0422)
TP	-0.269	-0.714***	-0.0882	0.238**	0.386*	0.210	0.378***
	(0.143)	(0.145)	(0.154)	(0.0787)	(0.188)	(0.154)	(0.0800)
ATP	-0.799***	-1.310***	-0.947***	-0.495***	0.400**	0.255	0.502***
	(0.125)	(0.206)	(0.130)	(0.0778)	(0.150)	(0.133)	(0.0756)
Cologne*TP	1.271***	0.674**	-0.493*	-1.507***	-0.104	-0.366*	-0.0674
	(0.194)	(0.261)	(0.207)	(0.162)	(0.272)	(0.175)	(0.0960)
Cologne*ATP	1.157***	2.263***	0.888***	-1.279***	-0.354	-0.261	-0.461***
	(0.177)	(0.280)	(0.188)	(0.144)	(0.226)	(0.145)	(0.0866)
Constant	8.707***	9.411***	5.422***	3.993***	7.170***	5.341***	3.322***
	(0.0624)	(0.102)	(0.0800)	(0.0577)	(0.0906)	(0.0726)	(0.0350)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.549	0.084	0.069	0.290	0.217	0.380	0.536

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 5.23: Placebo – Price development – Super E5

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	2.244***	2.825***	2.613***	1.418***	2.808***	4.095***	4.078***
	(0.0602)	(0.0630)	(0.0595)	(0.0648)	(0.0544)	(0.0548)	(0.0508)
P2	10.26***	10.59***	9.995***	12.28***	10.24***	9.963***	10.19***
	(0.0586)	(0.0611)	(0.0543)	(0.0596)	(0.0492)	(0.0494)	(0.0464)
P3	13.94***	14.14***	13.19***	14.46***	13.57***	13.55***	13.77***
	(0.0599)	(0.0620)	(0.0521)	(0.0594)	(0.0467)	(0.0478)	(0.0439)
Cologne*P2	-0.422***	-0.415***	-0.677***	-2.365***	-0.989***	-0.190**	-0.549***
	(0.0818)	(0.0828)	(0.0770)	(0.0823)	(0.0708)	(0.0707)	(0.0655)
Cologne*P3	0.415***	0.493***	0.309***	-0.0955	-0.00968	0.158*	0.109
	(0.0835)	(0.0839)	(0.0753)	(0.0834)	(0.0690)	(0.0688)	(0.0635)
Constant	136.1***	135.3***	134.1***	135.8***	131.4***	131.3***	131.0***
	(0.0411)	(0.0451)	(0.0400)	(0.0486)	(0.0362)	(0.0365)	(0.0341)
Observations	51072	51072	51072	51072	50992[1]	51072	51072
Adjusted R^2	0.718	0.731	0.741	0.738	0.777	0.793	0.820

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001; [1]Due to a temporary closure on four days in April 2018 there was no Jet petrol station open before 5 a.m.

Table 5.24: Placebo – Spread – Diesel

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-0.983***	-2.715***	-0.00536	-0.426*	-0.428**	-0.823***	-0.479***
	(0.238)	(0.256)	(0.116)	(0.209)	(0.151)	(0.153)	(0.119)
P2	4.409***	2.595***	-0.201	2.663***	-0.850***	-0.236*	0.449***
	(0.255)	(0.212)	(0.144)	(0.209)	(0.118)	(0.101)	(0.116)
P3	5.099***	3.224***	-0.376**	2.572***	-1.208***	-0.548***	-0.337***
	(0.240)	(0.272)	(0.130)	(0.210)	(0.112)	(0.0903)	(0.0792)
Cologne*P2	-1.024**	-0.0858	-0.221	1.677***	-0.225	0.676***	-0.234
	(0.336)	(0.318)	(0.208)	(0.303)	(0.182)	(0.200)	(0.181)
Cologne*P3	-2.581***	-1.447***	-0.848***	0.682*	0.149	0.710***	-0.272
	(0.345)	(0.390)	(0.205)	(0.306)	(0.178)	(0.198)	(0.161)
Constant	11.64***	13.92***	10.69***	11.25***	10.02***	9.966***	8.478***
	(0.170)	(0.153)	(0.0711)	(0.133)	(0.0907)	(0.0750)	(0.0537)
Observations	532	532	532	532	532	532	532
Adjusted R^2	0.647	0.601	0.130	0.544	0.326	0.075	0.240

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 5.25: Placebo – Spread – Super E5

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-1.136***	-3.334***	-0.892***	-0.567**	-0.915***	-1.285***	-0.686***
	(0.244)	(0.260)	(0.182)	(0.201)	(0.159)	(0.178)	(0.134)
P2	2.881***	1.044***	0.0833	0.819***	-1.504***	-0.661***	-0.0642
	(0.217)	(0.223)	(0.148)	(0.168)	(0.123)	(0.119)	(0.112)
P3	4.320***	2.775***	-0.127	2.041***	-1.869***	-0.893***	-0.548***
	(0.202)	(0.272)	(0.149)	(0.179)	(0.119)	(0.117)	(0.0817)
Cologne*P2	-1.046**	0.495	0.140	1.753***	0.400*	0.568**	-0.0883
	(0.336)	(0.316)	(0.249)	(0.272)	(0.189)	(0.214)	(0.192)
Cologne*P3	-2.102***	-0.584	-0.134	1.164***	0.901***	1.072***	-0.0159
	(0.334)	(0.369)	(0.258)	(0.279)	(0.201)	(0.221)	(0.186)
Constant	10.73***	12.89***	10.68***	10.27***	10.50***	10.20***	8.635***
	(0.127)	(0.181)	(0.0842)	(0.126)	(0.101)	(0.0992)	(0.0583)
Observations	532	532	532	532	532	532	532
Adjusted R^2	0.569	0.611	0.128	0.447	0.402	0.182	0.185

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001.

Table 5.26: Price development – Diesel with control variables

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	2.102***	2.752***	2.463***	0.611***	2.249***	3.981***	3.686***
	(0.0372)	(0.0376)	(0.0312)	(0.0366)	(0.0294)	(0.0294)	(0.0275)
TP	11.22***	11.34***	10.78***	11.31***	11.43***	11.48***	11.23***
	(0.0647)	(0.0649)	(0.0564)	(0.0625)	(0.0535)	(0.0546)	(0.0511)
ATP	4.742***	4.468***	5.668***	4.904***	4.791***	4.969***	4.875***
	(0.0489)	(0.0512)	(0.0438)	(0.0478)	(0.0416)	(0.0414)	(0.0384)
Cologne*TP	7.588***	6.423***	8.354***	7.785***	7.928***	7.581***	7.888***
	(0.0945)	(0.0868)	(0.0843)	(0.0891)	(0.0880)	(0.0825)	(0.0797)
Cologne*ATP	-0.235***	-0.0771	-0.401***	0.130	-0.533***	-0.0316	-0.234***
	(0.0705)	(0.0717)	(0.0623)	(0.0714)	(0.0614)	(0.0614)	(0.0571)
Brent price	0.862***	0.815***	0.824***	0.876***	0.808***	0.825***	0.832***
	(0.00279)	(0.00285)	(0.00251)	(0.00286)	(0.00252)	(0.00248)	(0.00235)
Tuesday‡	-0.409***	-0.312***	-0.264***	-0.321***	-0.265***	-0.312***	-0.277***
	(0.0566)	(0.0558)	(0.0480)	(0.0551)	(0.0464)	(0.0460)	(0.0432)
Wednesday‡	-0.351***	-0.246***	-0.211***	-0.136*	-0.230***	-0.236***	-0.238***
	(0.0574)	(0.0565)	(0.0492)	(0.0560)	(0.0475)	(0.0471)	(0.0443)
Thursday‡	-0.275***	-0.163**	-0.181***	-0.145*	-0.148**	-0.164***	-0.155***
	(0.0572)	(0.0564)	(0.0490)	(0.0562)	(0.0476)	(0.0473)	(0.0444)
Friday‡	-0.314***	-0.190***	-0.210***	-0.210***	-0.188***	-0.190***	-0.229***
	(0.0574)	(0.0566)	(0.0494)	(0.0560)	(0.0480)	(0.0473)	(0.0445)
Saturday‡	0.167**	0.0337	-0.0310	0.0881	-0.0358	0.0495	-0.00848
	(0.0561)	(0.0553)	(0.0485)	(0.0551)	(0.0471)	(0.0465)	(0.0432)
Sunday‡	0.591***	0.417***	0.298***	0.424***	0.253***	0.397***	0.427***
	(0.0565)	(0.0559)	(0.0499)	(0.0559)	(0.0482)	(0.0476)	(0.0448)
Holiday‡	0.486***	0.565***	-0.0212	0.739***	0.408***	0.370**	0.426***
	(0.125)	(0.128)	(0.113)	(0.132)	(0.119)	(0.115)	(0.113)
Constant	72.43***	74.88***	72.24***	71.90***	70.97***	69.60***	68.95***
	(0.177)	(0.182)	(0.160)	(0.183)	(0.160)	(0.158)	(0.149)
Observations	81408	81408	81408	81408	81328	81408	81408
Adjusted R^2	0.693	0.681	0.744	0.695	0.755	0.776	0.795

Note: Robust standard errors in parentheses; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$; ‡Compared to Monday.

Table 5.27: Spread – Diesel with control variables

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-2.162***	-3.207***	-0.353***	0.372*	-0.458***	-0.363***	-0.647***
	(0.172)	(0.160)	(0.0894)	(0.153)	(0.0673)	(0.0773)	(0.0718)
TP	-0.203	-0.877***	0.0323	0.275	-0.814***	-0.593***	0.0364
	(0.224)	(0.183)	(0.132)	(0.187)	(0.0869)	(0.0966)	(0.0878)
ATP	-0.0717	-0.849***	2.086***	0.400*	-0.816***	-0.653***	-0.530***
	(0.203)	(0.172)	(0.183)	(0.161)	(0.0875)	(0.105)	(0.0793)
Cologne*TP	-3.968***	-3.555***	-2.568***	-3.074***	-0.649*	-1.427***	-1.903***
	(0.324)	(0.285)	(0.221)	(0.298)	(0.278)	(0.156)	(0.155)
Cologne*ATP	1.413***	1.754***	-1.424***	-1.573***	0.0434	-0.0112	0.0953
	(0.244)	(0.252)	(0.257)	(0.234)	(0.112)	(0.152)	(0.119)
Brent price	0.204***	0.152***	-0.0305***	0.172***	-0.0605***	-0.0317***	-0.0241***
	(0.0115)	(0.0110)	(0.00760)	(0.00929)	(0.00542)	(0.00531)	(0.00474)
Tuesday‡	-0.106	-0.164	-0.478**	-0.311	-0.147	-0.252*	-0.316**
	(0.226)	(0.200)	(0.155)	(0.192)	(0.120)	(0.114)	(0.105)
Wednesday‡	-0.190	-0.170	-0.560***	-0.238	-0.152	-0.155	-0.341**
	(0.230)	(0.214)	(0.163)	(0.201)	(0.132)	(0.115)	(0.115)
Thursday‡	-0.126	-0.155	-0.638***	-0.275	-0.176	-0.172	-0.370***
	(0.222)	(0.205)	(0.162)	(0.214)	(0.120)	(0.111)	(0.0998)
Friday‡	-0.0332	-0.0608	-0.469**	-0.393	-0.159	-0.203	-0.334**
	(0.220)	(0.201)	(0.168)	(0.209)	(0.114)	(0.111)	(0.102)
Saturday‡	-1.081***	-0.782**	-0.472**	-0.579**	-0.241*	-0.134	-0.927***
	(0.219)	(0.240)	(0.153)	(0.195)	(0.116)	(0.117)	(0.101)
Sunday‡	-1.171***	-0.720***	-0.0914	-0.281	-0.207	0.228	-0.483***
	(0.220)	(0.198)	(0.149)	(0.192)	(0.126)	(0.143)	(0.109)
Holiday‡	-1.658***	-1.771***	-0.918**	-0.733*	-0.437*	-0.132	-0.630**
	(0.478)	(0.406)	(0.356)	(0.372)	(0.179)	(0.238)	(0.236)
Constant	2.584***	6.740***	12.79***	2.619***	13.25***	11.77***	10.42***
	(0.752)	(0.716)	(0.479)	(0.594)	(0.354)	(0.364)	(0.305)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.621	0.675	0.461	0.460	0.255	0.308	0.434

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001; ‡Compared to Monday.

Table 5.28: Price development – Diesel with different time window

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	2.089***	2.761***	2.437***	0.583***	2.280***	3.975***	3.673***
	(0.0629)	(0.0613)	(0.0569)	(0.0647)	(0.0564)	(0.0568)	(0.0560)
TP	9.801***	9.946***	9.415***	9.589***	10.13***	10.15***	9.844***
	(0.0751)	(0.0727)	(0.0641)	(0.0720)	(0.0581)	(0.0605)	(0.0589)
ATP	-0.636***	-0.421***	0.316***	-0.552***	-0.101*	-0.114*	-0.286***
	(0.0584)	(0.0577)	(0.0552)	(0.0590)	(0.0502)	(0.0520)	(0.0508)
Cologne*TP	6.473***	5.239***	7.040***	6.305***	6.654***	6.184***	6.564***
	(0.111)	(0.105)	(0.100)	(0.109)	(0.100)	(0.0970)	(0.0957)
Cologne*ATP	0.935***	0.929***	0.996***	1.465***	0.652***	1.204***	1.050***
	(0.0856)	(0.0837)	(0.0800)	(0.0864)	(0.0766)	(0.0774)	(0.0757)
Constant	125.3***	124.8***	122.7***	125.7***	120.5***	120.2***	120.0***
	(0.0441)	(0.0434)	(0.0395)	(0.0462)	(0.0390)	(0.0395)	(0.0389)
Observations	81408	81408	81408	81408	81328[1]	81408	81408
Adjusted R^2	0.379	0.381	0.420	0.338	0.444	0.469	0.470

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001; [1]Due to a temporary closure on four days in April 2018 there was no Jet petrol station open before 5 a.m. Pre-treatment period: 1 February 2018 – 11 October 2018; Treatment period (TP): 12 October 2018 – 02 December 2018; After treatment period (ATP): 03 December 2018 – 31 March 2019.

Table 5.29: Spread – Diesel with different time window

	Aral	Shell	Esso	TOTAL	Jet	NO1	NO2
Cologne	-2.115***	-3.193***	-0.286**	0.415*	-0.471***	-0.373***	-0.628***
	(0.225)	(0.186)	(0.0922)	(0.193)	(0.0843)	(0.0829)	(0.0790)
TP	-0.335	-0.774**	0.0269	-0.0675	-0.602***	-0.593***	0.0190
	(0.327)	(0.249)	(0.166)	(0.231)	(0.0931)	(0.0758)	(0.0956)
ATP	-1.618***	-2.069***	1.946***	-0.909***	-0.363***	-0.355***	-0.246**
	(0.216)	(0.188)	(0.169)	(0.157)	(0.0817)	(0.0871)	(0.0809)
Cologne*TP	-3.828***	-3.448***	-2.834***	-2.853***	0.0388	-0.968***	-1.695***
	(0.522)	(0.479)	(0.264)	(0.437)	(0.264)	(0.195)	(0.184)
Cologne*ATP	0.615	1.059**	-1.474***	-1.768***	-0.276*	-0.287	-0.232
	(0.345)	(0.337)	(0.234)	(0.254)	(0.136)	(0.148)	(0.127)
Constant	14.73***	15.82***	10.51***	12.95***	9.361***	9.728***	8.538***
	(0.180)	(0.139)	(0.0611)	(0.121)	(0.0567)	(0.0416)	(0.0500)
Observations	848	848	848	848	848	848	848
Adjusted R^2	0.313	0.473	0.417	0.213	0.131	0.217	0.329

Note: Robust standard errors in parentheses; * p < 0.05, ** p < 0.01, *** p < 0.001. Pre-treatment period: 1 February 2018 – 11 October 2018; Treatment period (TP): 12 October 2018 – 02 December 2018; After treatment period (ATP): 03 December 2018 – 31 March 2019.

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