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Abstract

Austria's regulatory policy on retail gasoline prices is a highly debated topic among energy experts and politicians, especially regarding its effectiveness and impact on consumer welfare. Since the policy's introduction in 2009 and its final implementation in 2011, firms have been allowed to raise their prices only once a day at noon. The policy's aim is to decrease gasoline price volatility and increase price transparency, hence lessen uncertainty, reduce search costs, and increase consumer surplus. In addition to a literature review, this thesis provides an empirical analysis using descriptive statistics and regression analysis, of high-frequency gasoline price data collected in 2008, before the implementation of the policy, and in 2015, after the implementation of the policy. The aim is to examine the effects of the regulatory policy on fuel prices, especially the intraday price patterns, and their indirect implications on consumer welfare. The results indicate that the implementation of the policy has caused the intertemporal price patterns to become "distorted", with fuel stations adapting their price-setting strategies to the policy restriction with a view to keeping their aggregate margin levels unaffected. When compared to the pre-policy period, midday price levels now show a significant increase, and afternoon-evening price levels remain relatively high. This might imply a negative welfare effect on consumers who are uninformed or lack purchase time flexibility.

Keywords: gasoline prices, fuel prices, gasoline price regulation, gasoline/fuel stations, retail gasoline market, price patterns, consumer welfare

Zusammenfassung

Die Spritpreisverordnung im österreichischen Tankstellenmarkt ist unter Energieexperten und in der Politik ein hoch diskutiertes Thema, besonders in Bezug auf seiner Wirksamkeit und Auswirkungen auf den Endverbraucher. Seit ihrer Einführung im Jahr 2009 und finalen Implementierung im Jahr 2011 dürfen Tankstellen ihre Preise nur einmal täglich um 12 Uhr Mittags erhöhen. Ziel der Verordnung ist die Preisvolatilität zu verringern und die Preistransparenz zu erhöhen. Dadurch kann die Unsicherheit beim Konsumenten verringert, die Kosten der Suche gesenkt und die Konsumentenrente erhöht werden. Zusätzlich zur Literaturrecherche bietet diese Arbeit eine empirische Analyse unter Verwendung deskriptiver Statistik und Regressionsanalyse von hochfrequenten Benzinpreisdaten aus dem Jahr 2008, vor der Einführung der Verordnung, und aus dem Jahr 2015, nach der finalen Umsetzung. Ziel der Arbeit ist es die Auswirkung der bestehenden Verordnung auf die Kraftstoffpreise, insbesonders die Intraday-Preisentwicklung, und ihre indirekten Auswirkungen auf den Endverbraucher zu untersuchen. Die Ergebnisse zeigen, dass das Preismuster durch die Umsetzung der Verordnung intertemporal "verzerrt" ist, wobei die Tankstellen ihre Preissetzungsstrategien so anpassen, dass ihre Margen nicht zu stark beeinträchtigt werden. Im Vergleich zur Vorperiode ist das Preisniveau um 12 Uhr deutlich gestiegen, und das Preisniveau am Nachmittag ist relativ hoch. Dieser Trend könnte einen negativen Wohlfahrtseffekt für Verbraucher darstellen, welche nicht über die Auswirkungen der Verordnung informiert sind oder keine Flexibilität bei der Kaufzeit haben.

Schlagwörter: Benzinpreise, Benzinpreisregulierung, Tankstellenpreisregulierung, Tankstellenmarkt, Preismuster, Verbraucherwohlfahrt

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List of Abbreviations

Abbreviation	*Explanation*
WBK	Wettbewerbskommission (Federal Competition Commission, Austria)
BMWFJ	Bundesministerium für Wirtschaft, Familie und Jugend (Austrian Federal Ministry of Economics, Family and Youth, Austria)
MTU	Markttransparenzstelle für Kraftstoffe (Market Transparency Unit for Fuels, Germany)
FVMI	Fachverband der Mineralölindustrie (Association of the Austrian Petroleum Industry, Austria)
CoFo	Company-owned and Franchise-operated stations
WTI	West Texas Intermediate crude oil
ÖAMTC	Der österreichische Automobil-, Motorrad- und Touringclub (Austrian Automobile, Motorcycle and Touring Club)

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1. Introduction

I. Globally homogenous fuel markets and signs of tacit collusion

Fuel prices have always been a topic closely followed and debated by consumers, the media, energy experts and politicians alike. The gasoline retail market is large and highly homogenous worldwide due to the homogeneity of its main products, *gasoline* and *diesel*. Consumers can easily substitute their demand for fuel across a huge number of fuel stations. However, switching costs can be significant depending on the physical distance to the next station. The gasoline market is characterized by an oligopolistic structure due to the small number of firms present and entry barriers arising from the high inventory costs. This might lead to a low level of competition and to tacit collusion (Haucap et al., 2012, Bundeskartellamt 2011). Due to the homogenous nature of gasoline products and the inelastic demand, fuel price fluctuations in the retail gasoline market have called for policy interventions in several industrialized countries. Different forms of regulatory policies have been adopted across the world in order to gain control of fuel price volatility and high prices, and eliminate tacit collusion among large corporations (Haucap et al., 2012).

II. Pre-regulation fuel-market characteristics in Austria

It was not unusual in Austria that gasoline prices hit record highs with the start of school and national holidays. In June 2008, for example, fuel prices shot to record highs: the price of *Super* rose by 20 %, and the price of *Diesel* by 43 % compared to 2007. ("AK: Dieselpreis", 2008) Consumers felt frustrated by such high price volatility, the unexplained high prices, and the lack of transparency. Austrian governmental organizations, the Austrian Federal Competition Authority (WBK) and the "Bundesministerium für Wirtschaft, Familie und Jugend" (BMWFJ), as well as automobile associations and consumer protection organizations, had all called for action to enhance the retail market's transparency and increase competition. In 2009, in response to the suspicion of collusive behavior among oil companies, WBK conducted an investigation into the retail market characteristics in Austria. The investigation found

that at the beginning of the holiday travel season, and in terms of the average daily price movements throughout the week, stations displayed identical price setting behaviors. Such oligopolistic price-setting patterns can result from the continuous observation of competitors' behavior, which cannot be seen as the result of a direct agreement among companies, or normal price competition either. Although oil companies did not admit to the charge of direct agreement, such price-setting patterns may indicate "silent" collusion among oil market participants. Furthermore, the report's results confirmed a lack of transparency in the market.[1] As a result, the WBK recommended governmental intervention in its report, concluding that efforts should be made to enhance market transparency, and hence, consumer surplus.

III. Objectives of the Austrian regulatory policy 2009

The initial version of the Austrian regulatory policy, Austrian Fuel Price Fixing Act, was introduced in 2009. This predecessor of today's policy, amended in 2011, restricted price increases to once a day for gasoline stations. However, the execution time was set during the opening hours of stations rather than exactly at 12 pm. The main objectives were the same as today: to create more price transparency for consumers and to foster competition in the gasoline market. The main motivations, as suggested by the WBK report, were to gain control of price volatility, and thereby reduce consumer uncertainty and increase transparency. In addition, by stimulating competition among gasoline market competitors, the Austrian policy aimed to facilitate lower price levels, hence, higher consumer surplus and higher social welfare.[2] Before the policy implementation, no one could know for sure whether the policy would indeed cause price levels to fall. In terms of the new rules adopted in 2009, the times when gas stations were allowed to increase prices depended on the type of the gas station. Those open round the clock were only allowed to increase their prices at midnight, whereas automatic stations could do so at 8:30 in the morning. The remaining gas stations were limited to raise prices at

[1] §32 of the German Competition Law: if there is suspicion for collusive behaviour in any sector, the German Competition Authority can review and investigate the sector to rule out illegal agreements among firms.

[2] BGBl II Nr. 484. (2010): Verordnung des BM für Wirtschaft, Familie und Jugend betreffend Standesregeln für Tankstellenbetreiber über den Zeitpunkt der Preisauszeichnung für Treibstoffe bei Tankstellen.

their respective opening hours. The 2009 policy framework also involved adopting a regulation on public price signaling. In addition to increasing market transparency, price signaling aims to mitigate price asymmetry created by multinational companies. Price asymmetry had come to dominate the market due to the sophisticated price information systems used by multinational companies (Bundeskartellamt, 2009).

IV. The "Austrian-type" framework 2011

The "Austrian-type" framework, an asymmetric regulatory policy adopted in January 2011, revised the 2009 regulation by allowing all gas stations to increase prices only once a day, at an identical hour, at noon. In contrast, prices may be lowered at any time during the daily price cycle. The main goal of the policy was to mitigate consumer uncertainty around fuel prices, gain control of price volatility, hence increase consumer surplus and positively impact consumer welfare. Another important government objective was to enhance price sector transparency for consumers by introducing a law on price transparency ('Preistransparenzverordnung Treibstoffpreise 2011'). To this end, an internet platform (http://www.spritpreisrechner.at) was established, where gasoline stations had to post their prices for the public by reporting price changes to the Austrian Energy Regulator (OECD, 2013).

Higher price transparency lets consumers compare prices more efficiently, which would in turn stimulate competition. Overall, these regulations were intended to reduce transaction costs and enhance social welfare.

V. Uncertainty about the effectiveness of regulatory policies

Research on the effectiveness of regulatory policies in the retail gasoline market has not yet been able to demonstrate conclusively the positive impact of such policies on prices. For example, in his analysis of the Austrian-type regulation, Obradovits (2014) finds that firms will distort their prices throughout the day to ensure that overall their expected profits will be the same as prior to the regulation. He argues that the policy could in fact be harmful for consumers, as distorted prices may lead to higher prices for the less flexible consumers at the beginning of the price cycle (starting at the point of

increase at noon). Having only an indirect impact on fuel prices, it is not clear how the Austrian policy rules affect the evolution of prices. Obradovits suggests that empirical research, using detailed Austrian price data, is needed to investigate intertemporal price effects.

VI. The aim of this study

Following Obradovits' (2014) call for future research with respect to conducting an empirical analysis of high-frequency Austrian gasoline price data, this study will investigate the intraday (within-day) and interday (within-week) price fluctuations and patterns to identify any distortive effects caused by firms' pricing policies. Whilst there has been a number of studies investigating interday price fluctuations, examinations of intraday price fluctuations in Austria before and after the policy's introduction are rare due to a lack of data. In addition, the implications of the price patterns on consumers and consumer welfare, hence the regulation's success will be analyzed.

The following variables will be examined in order to determine any price distorting effects of the regulation: first, using descriptive statistics and regression analysis, the average retail and wholesale price levels and their relationships will be examined. This will be followed by the analysis of temporal pricing patterns, such as interday and weekly price patterns. With the help of regression analysis, weekday effects (from Monday to Sunday) will be explored to determine whether weekdays have any significant effect on price levels and on the price-setting strategy of gasoline stations. Following this, special focus will be given to the intraday (within-day) price patterns. Finally, margin levels will be analyzed with a special focus on intraday (within-day) margin developments

We hypothesize that gasoline stations have adapted their price setting strategies to the policy's restrictions. We expect that a comparison of the price patterns in 2008 with those in 2015 will reveal that stations seek to distort their prices so that margin losses resulting from the policy`s restriction are minimized. This behavior will be reflected in a significant price increase at noon and relatively higher price levels throughout the

afternoon and evening hours, in order to counteract any margin losses and create room for price drops, required by competition, later in the day.

2. Literature Review

The following literature review covers the studies examining the impact on consumer surpluses of retail price regulation, with a special focus on the Austrian-type regulatory policy.

2.1 Negative Effect on Consumers

In one of the limited number of studies on this subject, "Austrian-style gasoline price regulation: How it may backfire" (2014), Obradovits uses a two-period duopoly model to analyze, under different purchase setups, the regulatory policy's effectiveness in terms of consumer welfare. According to Obradovits, the Austrian policy can be examined from two angles within the consumer search framework: (1) when consumers' intertemporal distribution is an exogenous variable, and (2) when it is an endogenous variable. If one takes consumers' demand, that is purchase time, as an exogenous factor, meaning that consumers cannot select their purchase time, consumer surplus will remain the same as without the policy. The author argues that consumer surplus is redistributed from consumers purchasing in the first period (the period starting at the midday price change and lasting several hours) to those who purchase in the second period (at decrease). As firms aim to keep their profits at the same level as it would be without the policy (hypothetically), this redistribution results in the policy having no benefits for overall consumer surplus. Following the increase, firms have no interest in charging low prices or making any significant price decreases, as this would restrict their price flexibility for the second period (morning hours).

If consumer demand, i.e. purchase time, is looked at as an endogenous factor, meaning that consumers can make a purchase whenever they want, the policy might even reduce the consumer surplus. Obradovits (2014) suggests that due to the policy's restriction on

price increases, firms set their prices relatively higher at noon and in the afternoon, so that they can maintain their aggregate expected profits constant and decrease their prices later. This behavior leads to price distortions. Obradovits comes to the conclusion that if one takes into account consumers' purchase period, the Austrian policy makes the less flexible consumers, who purchase after the one-time price increase, significantly worse off than they would be without the policy. Consumers who cannot delay their purchase due to high waiting costs or inflexible purchase behavior and inelastic demand "pay" the price of the regulatory policy. Furthermore, the longer consumers delay their purchase for the second period due to lower waiting costs, the higher firms set the price levels so that their expected profits are maintained. This leads to an even greater loss in welfare. This negative externality suggests that the policy may even harm consumers. The study concludes that the policy possibly has a negative effect on aggregate consumer surplus.

Obradovits' theoretical conclusions regarding doubts about regulatory effectiveness are also supported by other papers that examine, for example, the effects of regulatory price ceilings, taking into account the consumer search framework, where there is an externality caused by the policy. Fershtman and Fishman (1994) find that price ceilings force firms to set their fuel prices at a lower level, which in turn creates an indirect negative effect on consumer surplus. This is because consumers gain less by searching for an alternative option, which paradoxically results in a higher price level on average. Similarly, the Austrian-type policy is likely to lead to a lower level of price dispersion, in other words, the benefits for searching consumers gained by switching are reduced. This is presumed to lower the number of searching consumers, leading to a higher overall level of prices (Obradovits 2014).

2.2 Lack of Edgeworth Price Cycles

The theory of Edgeworth price cycles states that in a market with homogeneous goods and similar firms, such as the retail gasoline market, prices can be set in two different ways. They can stick to each other's fluctuations, or, they can change in an asymmetric way due to competition. The latter is known by the name of Edgeworth Cycles,

characterised by sharp price increases and slow step-by-step decreases (Maskin and Tirole 1988). Noel (2007) proposes that Edgeworth Cycles appear at markets with a mixture of oligopolistic players and a high number of small independent players, causing prices to be decreased sequentially. However, if the number of small players is low, prices tend to be more rigid, as oligopolists have a relatively strong market power. Noel (2008) found supporting evidence for the existence of Edgeworth Cycles in the retail gasoline market, especially in regions with high competition. Edgeworth Cycles occur more frequently and in larger proportions in gasoline markets consisting of a higher number of independent gasoline stations competing with major stations. Especially in Canada and some parts of the U.S., Edgeworth Cycles prevail in the market, which proves that retail gasoline markets have competitive characteristics as a result of the high number of competitive independent firms. The price movements of these have an intense cycle of price undercutting, eventually reaching price levels matching marginal costs.

Consumer surplus is greater when Edgeworth Cycles are present, as prices are adjusted to the oil market much quicker than without this intense competition (Lewis et al. 2011). In the German retail gasoline market, the Bundeskartellamt (2009) found evidence of Edgeworth Cycles. They identified Aral and Shell as price leaders, whose price increases tend to start off the new price cycle.

Evidence shows that consumers often lack information regarding price cycles and potential monetary gains Noel (2012). Pennerstorfer et al. (2014) analyzed Austrian *diesel* prices to examine the connection between the degree of price information by consumers and measures of price dispersion in the retail gasoline market. They found that better-informed drivers can actually lower prices.

Since the Austrian-type policy lets firms decrease their prices at any time, it is still possible for Edgeworth cycles to happen in the pricing pattern. However, due to the restriction on price increases, firms can only follow each other's price decreases. As all fuel stations have to implement their price increase at noon, small independent firms cannot follow a price leader like in the case in Germany. At the same time, observed

price movements differ in Austria from the “regulation-free” Germany. In Austria, the strongest determinant for the level of prices is the time of day. Thus, price “stickiness” prevails in the market. With no significant differences in pricing among firms, this suggests a lower level of competition than in a market with Edgeworth Cycles. The price “stickiness” phenomenon is also characteristic of the collisional behavior among firms (Blinder et al., 1998).

2.3 Competition Increase

Handler (2012) conducted an economic analysis of regulating price changes in the gasoline market, initiated by the Austrian government, BMWFJ, to assess the economic efficiency of the Austrian regulatory policy introduced in 2009. The researcher concludes that price transparency is an essential element for competition within the market for enabling both competitors and consumers to assess prices and make decisions. In case of the existence of any information asymmetries, like in the case of the gasoline market, government intervention in the form of a policy is an efficient tool to solve information imbalances.

2.4 Lower Price Levels?

Another relevant empirical study regarding the fuel price regulation in the Austrian retail gasoline market (Dewenter and Heimeshoff, 2012) aimed to identify in a panel data setting the treatment effect of the policy. The authors found that overall fuel price levels in Austria had actually decreased since the policy’s implementation, establishing a significant negative effect on fuel prices. The study used weekly data of average prices in Austria between 2005 and 2012 with a total of 7,224 observations. They differentiated the effect of the regulatory policy from other effects, such as taxes or Rotterdam prices, with the help of the difference-in-differences method, using a control group of 24 European countries. Their results indicate that even though there was an overall increase in fuel prices over the years, the policy implementation exerted a significantly negative effect on fuel price levels. Thus, price levels increased as a result of other factors, such as taxes or the crude oil market. The Austrian regulatory policy

did actually lower firms' markups. Along with this result, the holidays were also found to have a significantly negative effect on average price levels. Dewenter and Heimeshoff (2012) argue that the policy made it more difficult for firms to engage in collusive behavior, so they adopted more competitive pricing. However, it is important to point out the limitations of their study: the data used only covered the weekly average fuel prices, and their results may be biased depending on the price collection method, especially the point of time.

Contrary to Dewenter and Heimeshoff's (2012) results of the policy's negative effect on price levels, a study conducted by Berninghaus et al. (2012) finds that the regulatory policy in Austria could possibly lead to higher price levels compared to the price levels prior to implementation, and suggests that collusive behavior becomes stronger due to easier coordination. The authors analyzed the impact of regulatory policy with the help of combining game theory with experimental research using a two-player game with the choice of four different price levels. In a computer experiment they demonstrated that in in regulated markets, prices are set at a higher level due to easier coordination. Berninghaus et al. (2012) conclude that, based on their results from the experiment and game theory, the "Austrian-type" regulatory policy enables collusive behavior among firms more than the opposite. The policy lets price levels to be set higher, even though prices become less volatile compared to a policy-free market. These factors lead to a significant decrease in social welfare. However, their study has some limitations: only two-player (duopoly) set-ups are examined, who can coordinate more easily with each other than settings with more participants Also, players can choose only from four price alternatives leading to easier collusion.

The results of another experimental study conducted by Haucap and Müller (2012) also indicate higher levels of fuel prices in relation to the "Austrian-type" regulatory policy. They found that price levels in a regulated market, including mark-ups and margins, are set significantly higher compared to an unregulated market. The setting of the experiment was similar to the gasoline retail market in the real world: oligopoly structure with varying waiting costs and demand for customers, and with varying wholesale prices for firms. For firms in a regulated market, a relatively larger price

increase becomes "easier", as it cannot be followed by competitors in the market due to the policy's restriction on price increase (only once a day at noon). This enables better player coordination and leads to higher price levels. There are several other studies on the observed phenomenon of collusive behavior in oligopoly markets supporting the results of Haucap and Müller (2012) and Berninghaus et al. (2012).[3]

Dewenter et al. (2012) looks at past publications of empirical and experimental research to examine if potential policy measures could increase competition in the retail gasoline market. They also study the effect such policies may have on consumer welfare and make recommendations. With regard to the Austrian-type policy, the authors find outweighing evidence in experimental literature for tacit collusion among the firms, as margins and profits are found to be significantly higher in the regulated market as compared to an unregulated environment. This may result in a significant reduction in social welfare.

2.5 Austria versus Regulation-free Germany

Due to the similarities between the Austrian and German fuel demand, it makes sense to compare the two markets in regard of the policy's impact on consumer welfare. Boehnke (2014) uses hourly price data from over 16,000 gas stations, representing over 90% of the market, to examine the degree of competition and the effect of the Austrian regulatory policy on firms' price setting and consumer welfare in the German and Austrian retail gasoline markets in the period from the year 2012. Analyzing prices, price levels and fluctuations with a special focus on neighboring rivalling stations, the author finds that gas stations use price discrimination across different consumer groups. Evidence from the collected data indicates that German gas stations' price levels are higher in the morning, discriminating inflexible and price-inelastic consumers. In contrast, prices are significantly lower in the evenings, when consumers have more flexibility to "switch" stations. This is not the case in Austria due to the government's restrictive policy on price increases. The policy's effect on firms' price-setting

[3] For example: Andreoli Versbach (2011) and Noel (2007)

strategies results in less fluctuations but higher average price levels every day of the week for both types of fuels compared to the regulation-free German market. It appears that Austrian firms aim to compensate for the policy restriction in the morning, when they cannot raise prices and demand is high, by maintaining high average price levels throughout the day to benefit from the morning traffic (see Boehnke's comparison in the figure below):

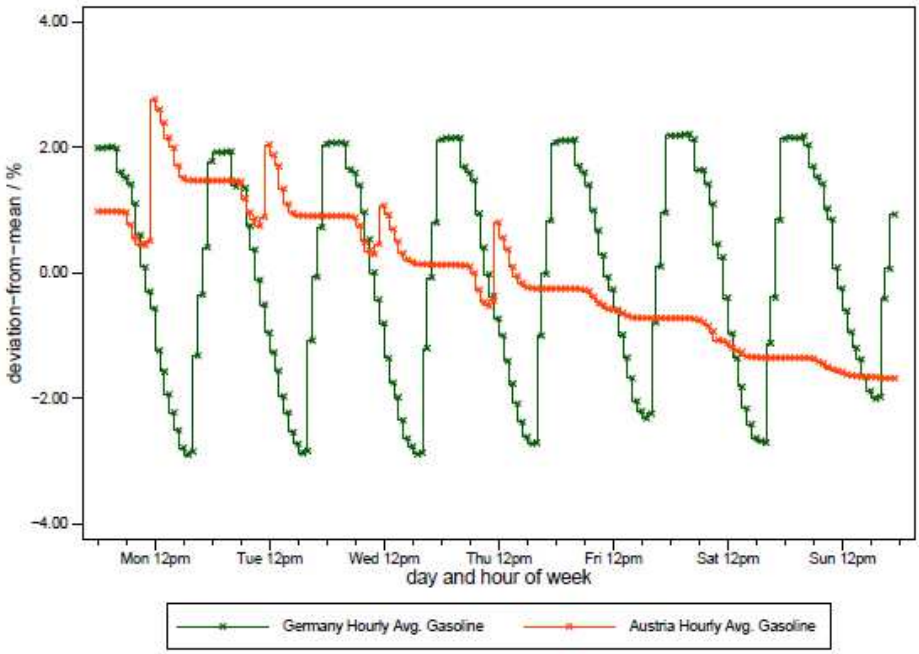


Figure: *Average gasoline price during a week in 2014 in Austria and Germany: (% deviation from mean, cross-sectional average) (Source: Boehnke, 2014)*

In addition, Boehnke (2014) observes that both in Germany and Austria, gas stations within the local market undercut each other's prices. It is mainly independent small stations that start with the undercutting to offer the lowest prices, while stations of multinational companies match these prices. However, he finds that Austrian stations have a lower number of price reductions than German stations.

2.6 Market Transparency

In their most recent research, Dewenter and Heimeshoff (2017) analyse the effect of positive or negative impact on fuel prices due to increased market transparency in Germany as a result of the German market transparency unit (MTU) in the retail gasoline market. This policy requires gasoline stations to notify the Bundeskartellamt's of any price changes. The goal is to provide up-to-date information to consumers on prices and it acts as a control mechanism on the market competition. The researchers' concern is that competing fuel companies use the available price data to monitor each other's prices. This results in negative effects on consumers' welfare as firms base their pricing decisions on their competitors' price movements. Comparing 27 European countries, Dewenter and Heimeshoff (2017) find evidence that average fuel prices have increased by about 1.5 Eurocents per liter due to transparency MTU regulation's introduction. They explain the increase on the firms' ability to more effectively compare competitor prices and make better pricing decisions in an oligopoly market. These results are relevant, as the Austrian gasoline price regulation also covers market transparency pricing requirements, which provides more information to gas stations, eventually harming consumers.

2.7 Overall Conclusion from Past Research

Overall, experimental and empirical literature provides both support for the benefits of implementing such regulatory policy, as well as evidence for negative externalities and harmful consequences for consumers. The main argument against the policy is that due to the restriction, firms have an incentive to make the maximum possible price increase at noon together, thus coordination is easily enabled, especially among vertically integrated oil companies. Considering the fluctuating demand throughout the day, a price increase at noon occurs after the morning rush hour and before afternoon home-goers. Firms aim to compensate for the policy restriction in the morning, when they cannot raise prices and demand is high, by maintaining high average price levels throughout the day to benefit from the morning traffic. Thus, regulatory effects are

heavily dependent on the small independent stations, who can initiate price drops throughout the day, leading to lower price levels, hence lower margins. However, Boehnke (2014) finds that Austrian stations have a lower number of price reductions than German stations.

These contradictory past research results call for further empirical analysis to determine intraday price developments and their potential effects on consumers.

3. Austrian Retail Gasoline Markets

3.1 Market Characteristics

In 2015 there were over 4.5 million personal vehicles in Austria, and an Austrian driver covered a daily average distance of 34 kilometers (VCÖ, 2016). Diesel cars with over 2.7 million dominated the market compared to 2 million *gasoline*-fueled cars (Statistik Austria, 2017). In addition, *diesel* demand was higher due to the frequency of trucks, transporting goods between Eastern and Western Europe. In previous years the difference between the ratios of *gasoline* (28%) and *diesel* (72 %) consumption in Austria was even larger (Koch, 2011).

3.1.1 Competition Set-up

The Austrian retail gasoline market used to be relatively dense with a high number of gasoline stations. However, the number of stations has decreased over time, from over 3,000 stations in 2000 to around 2,700 stations by the end of 2009. This reduction in numbers was mainly due to technical improvements of car engines, leading to less gasoline consumption and hence lower demand.

The Austrian market can be divided into two groups of gas stations (WBK, 2008). One group contains the "major-branded" and vertically integrated multinational companies: BP, Eni, JET, OMV und Shell. In 2015, Austria had about 2,600 stations, each serving about 3,267 citizens on average (WKO, 2015). With an EU average of 4,502 citizens per station, this is in the mid-field of countries in terms of retail market density. The market consisted of 1,357 major-branded gas stations (319 Eni, 284 BP, 257 Shell, 207 OMV, 149 JET und 141 Avanti (OMV)). In the other group are 1,284 gas stations of small players (Genol, Turmöl, Avia, A1 or IQ). There is a positive trend of creating additional services at gas stations of premium locations, while many smaller gas stations are getting converted into automatic ones (WKO, 2015). Altogether, 745 gas stations of the overall market were open 24 hours. Despite product homogeneity of *gasoline* and *diesel*, there are significant price differences among the various brands. This is due to the heterogeneity of gas stations in terms of additional services, brand recognition, and degree of competition based on their location (Haucap et al., 2016).

Both franchisees of multinational oil companies and small independent stations watch the prices of their competitor stations. Every gas station observes about 3-4 competitor stations in their surrounding areas and report any price changes. Gasoline station partners report their rivals' prices 5 to 7 times a day to their headquarters (Obradovits, 2014). This results in regional markets to have a price leader, whose price decreases are followed by surrounding rival gas stations. With price coordination creating a monopoly, collusion enables the greatest aggregate profit level to be achieved. As it harms customers, cooperation in the form of cartels is forbidden and subject to the strict control of competition authorities. However, tacit collusion is difficult to eliminate, as it is not based on contractual agreements. Tacit collusion is created by the repeated interactions among gas stations resulting in "trust", that is price signaling leading to a cooperated price setting of high prices and high margins (Steckenbauer et al., 2010).

3.1.2 Consumer Behavior

On the consumer side, the price elasticity of demand for fuels is low in the short term, as consumers are reluctant to change their habits and reduce their mobility. Accordingly, it is highly unlikely that they will change their fuel consumption as a response to higher prices. This is also backed by the "Market-Institution" consumer survey (2010). According to the survey, consumers have changed only partially their behavior due to the policy: 85% have reported not to have changed their behavior, with only 13% buying fuel at a later point of the day on purpose (BMDW, 2010). Fuel purchase times are still spread quite evenly throughout the day: 30% fill up in the morning or before midday, 39% around midday or in the afternoon, and 27% in the evening or during the night. 28% of the respondents reported to notice any price effects of the policy, with 71% having noticed no changes to the fuel prices.

The survey found that drivers are indeed aware of price differences between neighboring stations, however, their purchase decisions have to outweigh strong consumer loyalty and switching costs. This behavior results in 71% of the drivers to visit the same gas station out of loyalty, with only 29% switching frequently between stations. Only 59% of car drivers make price comparisons on a regular basis, while 16% rarely and 25% never do so. At the same time, 78% of the car drivers claim to be ready to drive up to 5 kilometers in search of a cheaper option, with 16% willing to drive up to 10 kilometers.

3.1.3 Factors Influencing the Market Power

In her examination of the various market factors accounting for local market power in the Austrian retail gasoline market, Koch (2011) finds that the greater the distance between the gas station and its competitor station, the larger the local market power of the station. Hence, the higher the station density is in the market, the lower the local market power. Motorway stations have lower demand elasticity, so they have a larger

market power than road stations. In addition, by leading to differentiation within the market, product innovations can lead to higher market power. In the first year, tax increases are passed through to consumers in lower proportions than the actual increase. Overall, whilst the Austrian retail gasoline market appears to be competitive, there are significant regional differences between degree of competition within the market, depending on the number of, and distance to, the rival stations, as well as the offer in terms of product innovations.

3.1.4 The German versus the Austrian Retail Gasoline Market

According to the sector inquiry of the German Federal Cartel Office, (Bundeskartellamt 2011), based on price data from 2007 until 2010, there is some empirical support for the existence of an oligopolistic market structure in Germany (Bundeskartellamt, 2011).
The market, with an oligopolistic structure, is dominated by the large vertically integrated oil companies, while the cheapest offers are provided by small independent gas stations. Station partners are obliged to monitor their rivals' prices and pass the information on to the upstream department of oil companies. Similarly to Austria, German gas stations make on average about five price changes a day. There are stations, however, that do not change their prices for several days in contrast to some others making over 10 changes a day (Haucap et al., 2016).

Average fuel price levels in Germany are at their highest on Friday and Saturday mornings, and during the week, on Thursday mornings. Mondays offer the lowest level of prices, followed by Sundays. There is a price asymmetry regarding price settings among competitors. Gas stations tend to follow the price increases of oligopolistic price leaders', but there is no symmetry in terms of price decreases. This suggests a coordinated parallel behavior among major oil suppliers regarding their price settings, which is possibly harmful for consumers. However, due to the lack of evidence on a collusive agreement, firms' collusive behavior still falls within the boundaries of the competition law. Thus, independent price setting strategies by firms to follow their competitors' prices for profit maximization are allowed. Similarly, in Austria the

weekday is found to have a significant influence on the price setting behavior at the fuel station (Koch 2011). If Monday is chosen as a benchmark, it is found, that average daily fuel prices in Austria are higher by each successive day of the week, from Tuesday until Thursday. However, they tend to decrease again from Friday until Monday. This price movement trend was also identified by an investigation carried out by the Bundeswettbewerbsbehörde (Sharma and Kaltenbrunner, 2008).

In response to the Bundeskartellamt's sector inquiry (2011), in 2013 Germany also implemented an online price platform for more transparency. Gas stations are obliged to make public all price changes toward the Bundeskartellamt, which publishes these data in the internet platform.

3.1.5 Role of Stations' Characteristics

Haucap et al. (2016) provide an empirical analysis on the differences in price levels in the retail gasoline market based on a year's price data from all German gas stations. They find that the different retail price levels and the number of price changes can be explained by station characteristics and input costs, ex-refinery prices. Key station characteristics include brand recognition (premium brands), additional service amenities (shop offerings, car wash) and station location (highway vs. road) are found to have significant positive impact on price levels and volatility. However, a more competitive environment with several brands in the surrounding area has a negative effect on price levels. Pass-through rate of wholesale (Brent) prices is found to be about 90 %. This result suggests a competitive environment in the German retail gasoline market.

3.2 Price Characteristics

3.2.1 Composition of Retail Price

Gross retail fuel prices in Austria are determined primarily by exogenous factors and consist of three parts (Benigini and Prinz, 2005): (1) fuel tax and VAT (55 % of the total price, fixed in Austria); (2) the Rotterdam market's crude oil price in Dollars and its exchange rate into Euros, profit margin by the refinery, transport and storage costs (36 %); (3) competitive market factors such as the franchiser provisions, marketing and operation costs, and general expenses, firm profits and interest rates (9 %).

Overall in the long term, the level of fuel prices is determined by the international crude oil prices, given by the Rotterdam market, and the national taxes. Several empirical studies have found a positive correlation between the crude oil prices of Rotterdam market and the weekly price movements of the net fuel prices in Austria.

3.2.2 Price Asymmetries

According to the Austrian automobile clubs and the media, crude oil price drops, in contrast to rises, are not passed through to the Austrian retail market, signaling the presence of a price asymmetry. Some empirical findings also support the claim that such price adjustment asymmetries are present in the retail gasoline market, suggesting lack of competition (Bettendorf et al., 2003). Investigating the price asymmetry between crude oil price increase (Brent) and decrease in the retail gasoline market, the Austrian Bundeswettbewerbsbehörde (2008) identified for both *Diesel* and *Super* short-term price asymmetries. Whereas price increases in the wholesale market are passed through to consumers within one day, price reductions take on average three days to reach consumers. At the same time, longer term, that is monthly average price transmissions between crude oil and retail prices show no observable price asymmetry between the two markets (Jaenicke et al., 2010). Koch (2011) found no significant evidence to such

asymmetries in price transmissions either. In specific to the Austrian regulatory policy, a research was conducted how the regulatory policy impacted any price asymmetries present by comparing pre-regulation and post-regulation period (Fasoula et al., 2018). Especially, if price asymmetries grew post-policy-period due to potential retail fuel price distortions. In pre-regulation sample, the researchers find no statistical evidence of positive price asymmetries in the diesel market. However, in post-regulation sample, they find evidence for a faster pass-through of wholesale price decreases than increases. This is possibly a sign that the policy might have increased market competition, hence increased consumer welfare.

3.2.3 Pricing and Margins

Austrian gas stations have had the lowest level of margins in Europe over the last few years (WKO, 2017). This also raises the alarm at discussions of additional tax rises, as this would mean even lower margins for the future, threatening the profitability and eventual closure of several gas stations. According to the recent report by the consultant firm Wood Mackenzie, gas station margins in 16 European countries indicate that for the year 2016, Austria is at the one before the last position for *Super*, and at the 4th lowest position for *Diesel*. Association of the Austrian Petroleum Industry (FVMI) sees the margins in Austria as critically low. In 2015 there was a drop in average gross margin for *Super* from 10.32 Eurocents/liter to 9.48 Eurocents/liter in the second half of 2015. In 2015 the only country with lower margins is the United Kingdom, where the UK retail gasoline market is characterized mainly by "budget" gas stations making margins of 7.82 Eurocents/liter. Gross margins are still subject to additional costs, such as transport costs, investment costs, operational costs, inventory costs and provisions. In contrast to Austria, countries such as Norway (*Super:* 25.19 Eurocents/liter; Diesel: 22.62 Eurocents/liter) and Switzerland (*Super:* 22.63 Eurocents/liter margin; Diesel: 24.10 Eurocents/liter margin) have over double the margins of that of Austria (FuelsEurope, 2015).

The main reason for the low margin level in Austria is the high level of competition among gas stations, which is also due to high station density.[4] Due to the intense price competition in Austria, oil companies are forced to operate at minimum margin level or, in the short term, even below the break-even point. This also contributes to the steadily decreasing number of gas stations, as companies cannot lower fuel prices any further. They have to rely on additional services, such as a car-wash, a shop and restaurant services so that they can survive the heavy competition in the gasoline market. The other "survival" strategy for oil companies is to convert their gas stations into automatic ones as a way to minimize their operational costs.

For the years, previous to the policy introduction Austria was, again, in the lower bottom of profit margins for both *Super* and *Diesel*, compared to 15 European countries. The following graphs demonstrate Austria's ranking in terms of profit margins for *Super* and *Diesel* in the year 2003 to 2010 (OTS, 2015):

Table 1: European gross retail margins 2003 - 2010

European gross retail margins for Eurosuper

in cents per litre	2003	2004	2005	2006	2007	2008	2009	2010
Austria	9.92	10.01	9.16	8.31	9.80	8.26	8.09	9.26
Belgium	12.55	13.80	13.75	13.67	14.55	15.30	12.65	12.36
Denmark	12.96	8.95	10.25	10.48	11.37	12.18	12.42	10.23
Finland	10.03	8.76	7.50	8.84	8.69	13.00	10.03	11.61
France	8.90	8.60	8.52	7.30	11.67	15.00	10.08	9.12
Germany	7.65	7.47	6.06	6.45	7.18	7.08	8.82	10.05
Ireland	11.18	9.41	8.22	8.66	9.42	11.60	10.65	11.14
Italy	14.50	14.09	13.70	13.66	13.89	17.01	13.95	14.28
Luxembourg	12.52	12.53	12.75	12.92	15.08	13.97	11.48	12.11
Netherlands	13.52	12.51	12.11	11.78	12.82	12.96	12.70	13.73
Norway	16.44	15.41	15.46	14.00	14.72	16.15	15.91	16.47
Portugal	10.67	10.13	10.06	11.94	11.69	14.28	13.06	13.58
Spain	10.79	10.56	10.23	9.95	10.18	12.81	12.65	12.31
Sweden	10.66	9.89	8.50	6.37	5.67	5.88	5.37	6.54
Switzerland	10.49	12.27	12.2	13.56	12.57	16.08	13.55	15.29
United Kingdom	7.69	7.84	7.81	7.85	8.64	10.57	5.57	7.49

European gross retail margins for diesel fuel

in cents per litre	2003	2004	2005	2006	2007	2008	2009	2010
Austria	8.32	8.89	8.38	7.56	8.34	7.79	7.70	8.84
Belgium	12.52	12.66	13.62	13.52	14.57	15.18	12.43	11.88
Denmark	10.35	7.33	8.07	9.77	10.00	10.59	11.34	8.84
Finland	10.26	8.48	9.55	10.95	9.91	14.63	11.93	10.82
France	10.18	9.31	9.81	8.04	11.52	13.53	9.89	7.33
Germany	7.42	7.29	6.66	6.45	7.99	8.16	9.16	9.59
Ireland	12.40	10.15	11.17	11.37	10.79	12.36	13.06	12.17
Italy	12.67	12.96	13.87	14.68	14.17	15.57	13.83	13.37
Luxembourg	9.87	9.43	10.31	11.28	12.42	11.94	10.60	10.62
Netherlands	11.66	10.96	10.98	11.06	11.44	11.82	11.73	11.96
Norway	22.15	18.60	19.90	16.40	16.04	17.22	16.66	18.29
Portugal	9.94	9.44	9.63	11.35	11.33	13.93	14.38	15.03
Spain	9.97	9.04	9.92	10.49	10.17	12.03	13.28	12.81
Sweden	13.12	10.27	10.02	10.19	7.63	7.75	8.97	9.97
Switzerland	10.69	11.55	12.71	13.93	10.97	13.93	15.09	16.42
United Kingdom	8.18	7.17	7.72	8.59	8.27	9.01	6.98	5.69

Source: Wood Mackenzie

Source: Wood Mackenzie. (2015).
Retrieved from: scs-unp.cz/wp-content/uploads/2015/08/marging_eu.pdf

Based on the Wood Mackenzie margin statistics shown above, there is no clear indication of any impact of the regulatory policy framework on average fuel margins. As the initial form of today's policy was first applied in 2009, when gas stations were allowed to increase prices once a day (its time depending on the type of the gas station), and public price signaling had to be adopted by all stations. *Super's* average margin in Austria in 2008 (pre-policy) was 8.26 Eurocents/liter vs. 9.26 Eurocents/liter in 2010 (post-policy) (increase). *Diesel's* average margin in Austria in 2008 was 7.79 Eurocents/liter vs. 8.84 (again, increase). This statistics could be the first indication, that on average, price levels were not reduced due to state intervention, but due to drops in wholesale prices or other non-regulatory factors. As margins do not seem to have been

reduced, but they even showed an improvement, we can assume that fuel stations have adopted their price setting strategies to the restrictions and have made sure to maintain margin levels. However, these gross margins are needed to be deducted by taxes and costs, so in the end, Austrian fuel stations earn only a few Eurocents per liter, making fuel-selling not a lucrative business. Nevertheless, it is important to note that profit margins in the wholesale market are not considered in these margin statistics. Vertically integrated oil companies earn the largest share of their profits in the wholesale market.

Overall, it seems to be difficult to make any assumptions on margin level developments alone.

4. Empirical Analysis and Results

4.1 Data and Method

In the following sections, the results of the empirical analysis on retail and wholesale price levels will be presented, both for the pre-policy period of 2008 and the post-policy period of 2015. Furthermore, results for the various factors that may impact these price levels, such as wholesale oil prices and time of day, interday versus intraday price cycles, as well as measures of margin developments will be described.

4.1.1 Sample Characteristics

The sample of this study consists of gasoline stations of a major vertically integrated oil company in Austria. Only non-highway stations are included in this study, as gas stations located along the „Autobahn“ (highway) follow a different pricing strategy due to their unique competitive environment. Situated along highways, such gas stations generally follow a high-price strategy due to the lack of competition and consumer

alternatives. In a sector inquiry conducted by Germany's Federal Cartel Office, highway stations are even registered as constituting a separate market.

In 2008 Austria had a total of 2,802 gas stations. Over the years, the market share of major gas stations had dropped from 71% in 2000 to 61.2% in 2009, and to approximately 50% in 2015 (WKO, 2015). The sample used for 2008 in this study comprises 294 non-highway "premium" stations, and 146 self-service "discount" non-highway stations. In 2015, the number of gas stations in Austria dropped to 2,641, reducing the corresponding sample size to 172 non-highway "premium" stations and 141 self-service "discount" stations.

4.1.2 Data Description

This empirical analysis uses high-frequency intraday price data of two fuel types, *Super* and *Diesel*, collected from the gas stations of the sample, made available by a vertically integrated and major-branded oil company, using a centralized price setting system-software. Hourly average prices are used, weighted by all the prices charged within an hour and weighted by their demand. For descriptive statistics, the prices are expressed in euros per liter and in gross terms, including all taxes and duties. Thanks to the use of weighted average prices rather than absolute average prices, these data sets are considered to be of higher intraday frequency and more accuracy than those used in previous comparative studies. As benchmark price for crude oil Rotterdam prices are used in US Dollars per barrel. Rotterdam prices are converted to Euro per liter using the relevant USD/EUR exchange rate.

4.1.3 Time Periods of the Analysis

Prices are collected from two periods of time: (1) a five-month period in 2008 (01.01.2008– 31.05.2008.), prior to the introduction of the policy (pre-regulation), and (2) the entire twelve-month period in 2015 (01.01.2015– 31.12.2015), following the

introduction of the policy (post-regulation). The data for the second half of 2008 (June to December) were excluded due to an oil price shock occurring as a result of the economic weakness of the United States in the second half of 2008. In the summer of 2008 there was a sharp increase in the oil price. In June 2008 the WTI oil price reached a record $158 a barrel, possibly due to speculative demands. Later that year, in the wake of the financial crisis, as the global economy stalled, prices dropped to near $50. Overall, the second half of 2008 saw extreme volatility in the oil price. For this reason, in this analysis, the second half of 2008 is not included.

4.1.4 Statistical Method

The methodology used to model the relationship between fuel prices and the day of the week or the oil price is linear regression and multiple linear regression (where multiple explanatory variables are used). The explanatory variables are used to predict the dependent variable – fuel prices. Any variation in the dependent variables that cannot be explained by the independent variables is captured in the error term of the multiple regression.

The R-squared measure of the regression, which is a percentage between 0% and 100%, tells us what percentage of the variation in the dependent variable (fuel prices) can be explain by the independent variables. The higher the R-squared the more variation can be explained by our model and the less variation is captured in the error term.

The regression equations also make use of dummy variables, which take on values of 0 or 1. The effect of Mondays on the fuel price, for example, is modeled as a dummy variable, whereby the dummy variable takes on the value of 1 if the date is a Monday and 0 otherwise. As a result the regression coefficient for this dummy variable will tell us what effect does it have on the dependent variable if it is a Monday.

The statistical significance of the results is determined using t-statistics, as the regression coefficients follow a t-distribution. The t-statistic can be obtained by dividing

the regression coefficient by its standard error. If the t-statistic t is within the 95% interval around zero (-1.96 < t < 1.96), then our coefficient is not statistically significantly different from zero at the 5% level of confidence. This means that we do not have strong evidence that the independent variable associated with this coefficient is important in explaining changes in the dependent variable.

However, if the t-statistic is outside the (-1.96, 1.96) range, it means that our regression coefficient is significant at the 5% confidence level and the corresponding independent variable seems to be important in explaining variations in the independent variable.

4.2 Descriptive Analysis

4.2.1 Relationship: Retail and Wholesale

In this section, the time series of average daily retail and wholesale prices across the observed stations are presented for the periods of 2008 (pre-regulation) and 2015 (post-regulation). The daily average price data is plotted against the variable measuring the previous day's Rotterdam spot price for oil for both types of fuel (*see Tab1e 2 for Diesel and Table 3 for Super*). Both figures indicate the trends in average gasoline prices for the respective years. In 2015 prices decreased over the year, however, 2008 shows an upward trend in both wholesale and retail prices.

Table 2: DIESEL - daily average prices

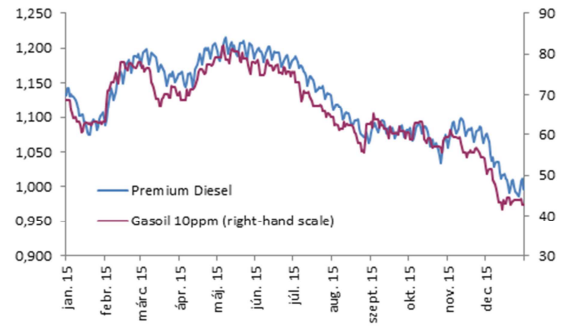
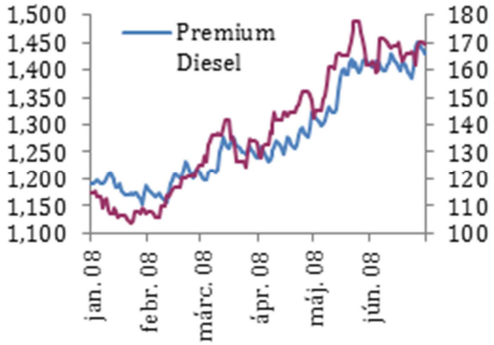
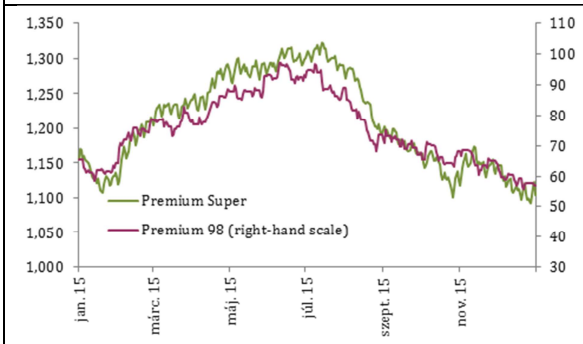
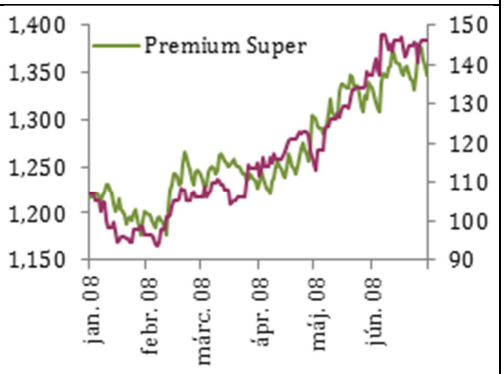
Diesel 2015	*Diesel 2008*
	

Table 3: SUPER - daily average prices

Super 2015	*Super 2008*
	

It is visible that wholesale oil prices and retail fuel prices move closely together. To demonstrate how fuel retail price levels are influenced by changes in the wholesale price of gasoline (Rotterdam), regression analysis is used. As *Table 4 for Diesel and Table 5 for Super for years 2015 versus 2008* show, the two data series move very closely together and are highly correlated (R-square around 90%). (Price levels are used for both time series, but results are similar when changes in price levels are used.) Interestingly, in 2015 there is a slightly stronger correlation observed than in 2008, although the difference is not necessarily statistically significant. This observation could

be in line with the study conducted by Fasoula et al. (2018). The researchers find evidence for a faster pass-through of wholesale price decreases than increases in the post-policy period due to increased competition.

Table 4: DIESEL - daily average prices

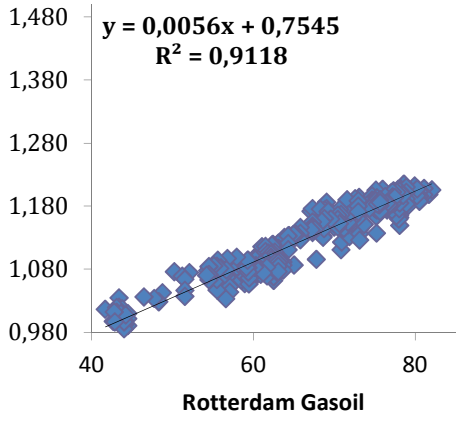
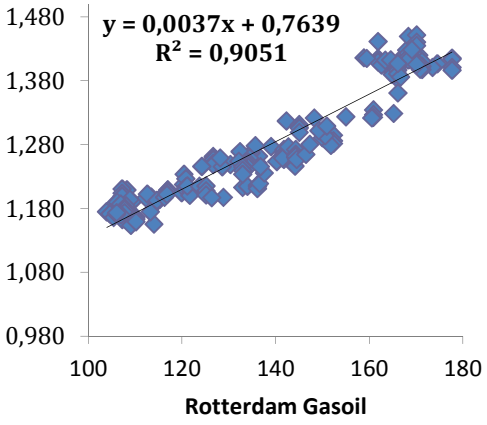
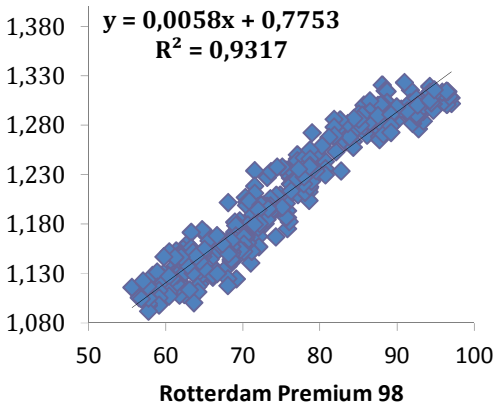
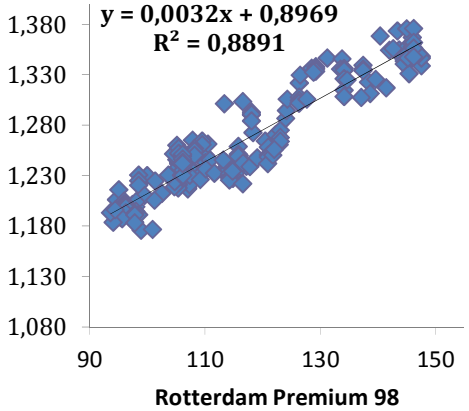
Diesel 2015	*Diesel 2008*
	

Table 5: SUPER - daily average prices

Super 2015	*Super 2008*
	

All regression equations in *Table 4 and Table 5* show an R-squared of close to 90% or above. This means that 90% or more of the variation in daily average fuel prices are explained by the daily fluctuations in oil prices. Only the remaining 10% of the variation can be potentially explained by other factors or random variation. These numbers underline how fundamentally important oil prices are in determining retail gasoline prices (once tax rates have been set).

4.2.2 Price Levels: Retail and Wholesale

In 2008 (*see Table 6*), on the basis of 24-hour averages, daily retail prices were highest for the *premium Diesel*, with an average of 1.278 €/liter, and for *discount Diesel* with 1.267 €/liter, followed by *premium Super* and *discount Super*. Average price levels for *premium Diesel* and *premium Super* fluctuated between 1.153 €/liter and 1.176 €/liter (daily minimum prices) and 1.451 €/liter and EUR 1.367 €/liter (daily maximum prices) respectively across the period of observation. The self-service automated stations, as expected, have lower average price levels of approx. 0.009 €/liter than their premium counterparts.

In 2015, daily retail prices were highest for *premium Super* with an average of 1.210 €/liter, and discount *Super* with 1.175 €/liter, followed by *premium* and *discount Diesel (*see *Table 6).* Average price levels for the two *premium Diesel* and *premium Super* fluctuated between 0.986 and 1.092 €/liter (daily minimum prices) and 1.215 and 1.323 €/liter (daily maximum prices) respectively across the period of observation. The self-service automated stations, again, have lower average price levels of approx. 0.036 €/liter than their premium counterparts.

Here three trends can be observed. During the period between 2008 and 2015, overall mean daily retail price levels seem to have slightly decreased. In 2015, *Super* is more expensive than *Diesel*. In addition, there is a larger price gap between premium and discount brands.

Table 6 shows the summary statistics of the price levels by fuel types across the observed stations, included in the data set for the two relevant periods:

Table 6: Summary Statistics: Retail

2008 (to June)

	Discount Diesel	Discount Super	Premium Diesel	Premium Super
Mean	1,267	1,257	1,278	1,265
Median	1,248	1,240	1,257	1,250
Standard Deviation	0,091	0,056	0,089	0,054
Min	1,139	1,161	1,153	1,176
Max	1,442	1,369	1,451	1,376

2015

	Discount Diesel	Discount Super	Premium Diesel	Premium Super
Mean	1,087	1,175	1,125	1,210
Median	1,090	1,167	1,127	1,205
Standard Deviation	0,058	0,068	0,057	0,067
Min	0,949	1,062	0,986	1,092
Max	1,180	1,287	1,215	1,323

In the following table, *Table 7* displays the daily wholesale (Rotterdam) prices for the two observation periods. To the wholesale costs are added the tax, transport and sales costs and the station's retail margin, determining the final retail price level. Wholesale prices had clearly decreased over the years between 2008 and 2015. Due to the sharp fall in crude oil prices by 47% in 2015, prices of refined products also decreased by 13,7%. The average price of a barrel of Brent crude oil was $48 in January 2015, dropping to a low of $37 in late 2015, last observed during the financial and economic crisis in 2008 (WKO Mineralöl-Bericht, 2015). These events had an impact on fuel price levels for both 2008 and 2015.

Table 7: Summary Statistics: Wholesale

2008 (to June)		
	Premium 98	**Gasoil**
Mean	104,3	125,1
Median	109,5	129,6
Standard Deviation	30,8	32,5
Min	93,6	103,9
Max	151,2	177,8

2015		
	Premium 98	**Gasoil**
Mean	75,5	65,9
Median	74,3	65,1
Standard Deviation	11,4	9,7
Min	55,6	41,7
Max	97,0	82,1

4.3 Temporal Pricing Patterns

This part of the empirical analysis presents the typical pricing patterns of the Austrian gasoline stations in the two observation periods of 2008 and 2015, as shown by the available price data. Both interday and intraday patterns are analyzed in order to highlight the differences between the pre- and post-policy price cycles.

4.3.1 Interday (within-week) Pricing Patterns

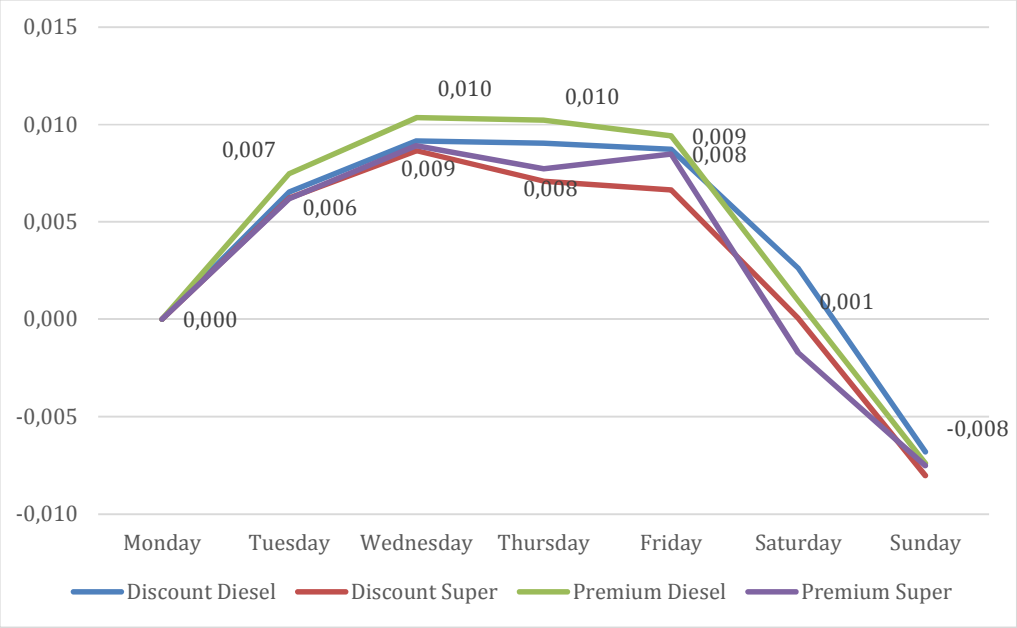
In accordance with previous studies (Sharma et al., 2008; Koch 2011) the results below show that price levels vary according to the day of the week.

In 2015, if Monday is chosen as a benchmark for the interday (weekly) pricing patterns, relative average prices rise by each successive day, from Tuesday until Wednesday. After Wednesday, there is some price stagnation until Friday (see *Figure 1*).

Putting this trend into number perspectives for 2015, as shown on Figure 1: On Tuesday, the average price for *premium Diesel* is 0.007 €/liter higher than the price on Monday. On Wednesday and Thursday fuel is 0.010 €/liter more expensive than on

Monday. However, it is -0.008 €/liter cheaper on Sunday, which is -0.018 €/liter cheaper than on the most expensive day of the week (Wednesday/Thursday).

Figure 1: Prices Relative to Monday in 2015



In 2008, prices rise with each successive day of the week from Monday until Friday (see *Figure 2*). For both periods, there appears to be a sharp price fall from Friday to Monday, reaching the lower price levels over the weekend, with the lowest prices observed on Sunday. In 2008, this trend for *Premium Diesel* is sharper for the respective days: Friday is 0.023 €/liter more expensive than Monday (see *Figure 2*):

Figure 2: Prices Relative to Monday in 2008

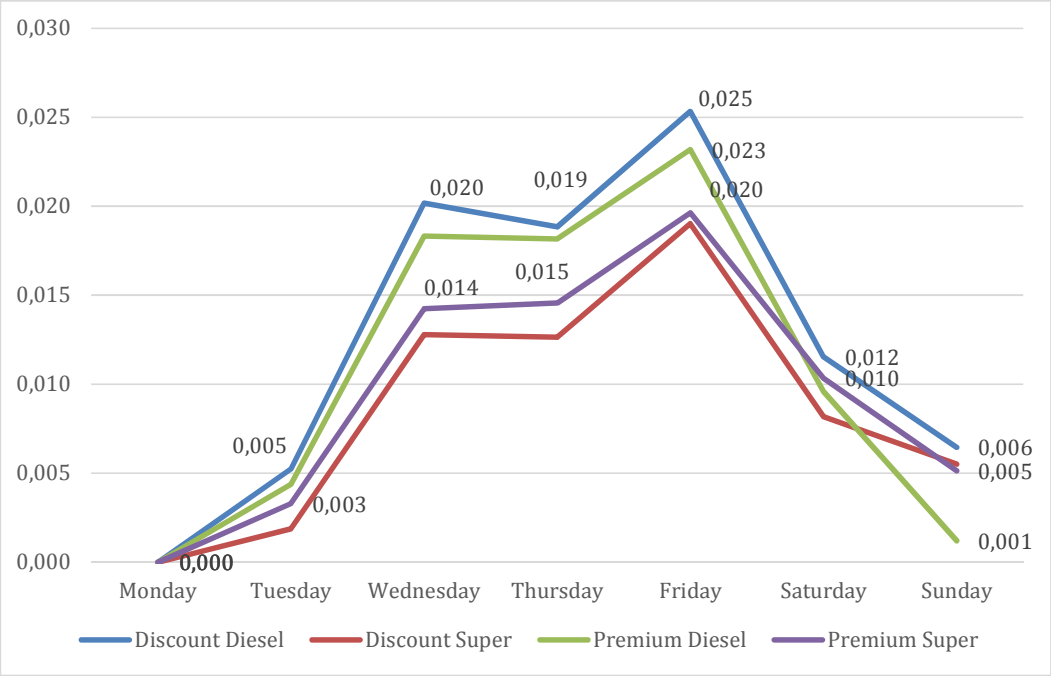
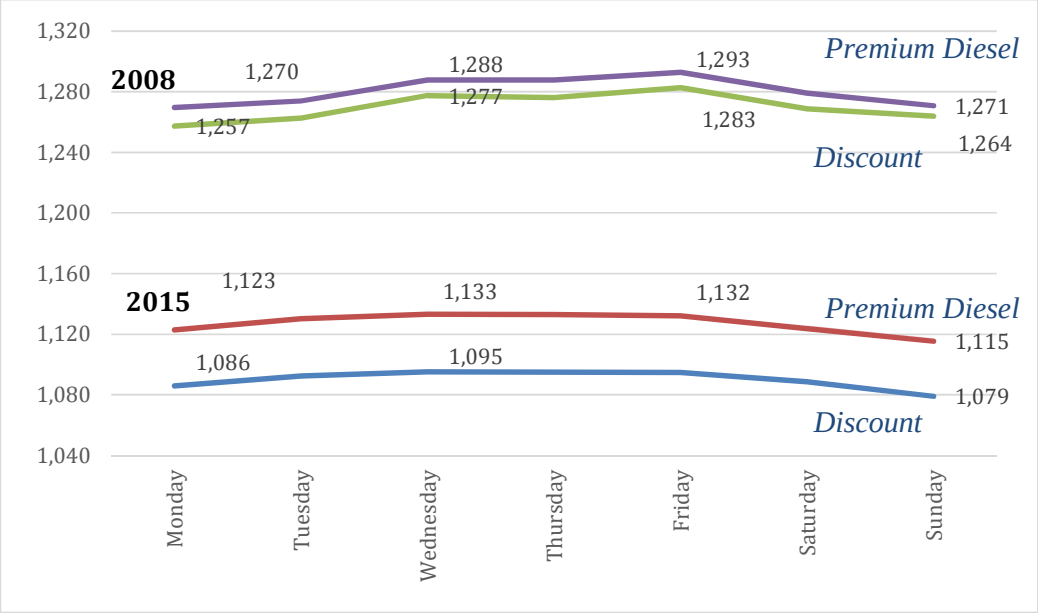


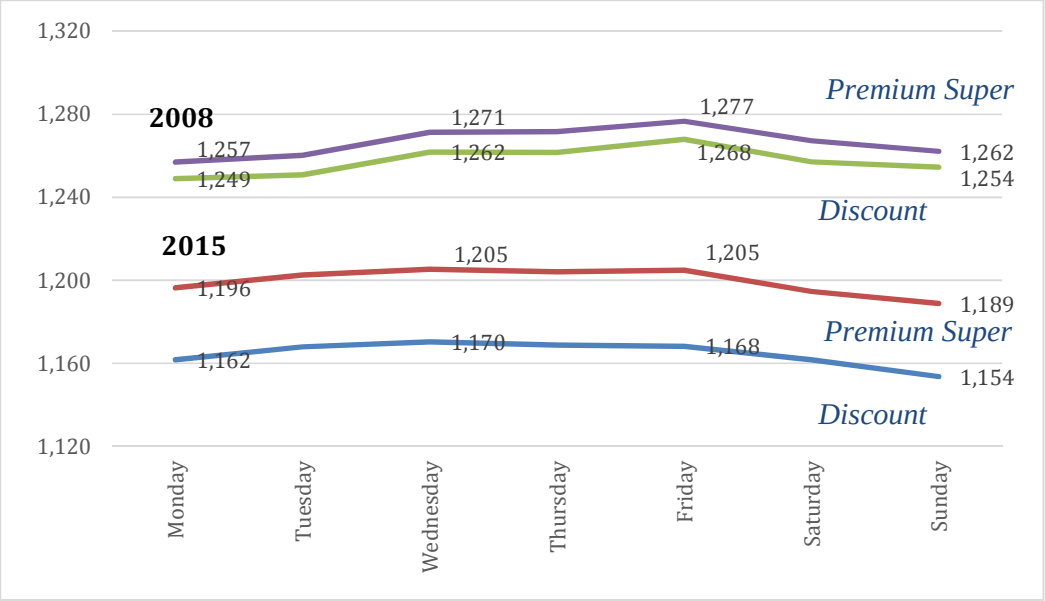
Figure 3 and Figure 4 display the average absolute price level movements across the week in Austria, excluding school and national holidays, for both fuel types. Here, weekday price levels exhibit the same trend as shown in the benchmark *Figure 1 and Figure 2*. In 2008, Friday is the day with the highest average price level of 1.293 €/liter for *Diesel* and 1.277 €/liter for *Super*. Monday is the least expensive day with 1.270 €/liter for *Diesel* and 1.257 €/liter for *Super*. In 2015, Wednesday is the most expensive day with 1.133 €/liter for *Diesel* and 1.205 €/liter for *Super*. Sunday is the cheapest day with 1.115 €/liter for *Diesel* and €/liter 1.189 €/liter for *Super*.

Figure 3: DIESEL - average price in 2008 vs. 2015



(excl. school and national holidays)

Figure 4: SUPER - average price in 2008 vs. 2015



(excl. school and national holidays)

Interestingly, in the pre-policy period of 2008, Austrian school and national holidays seem to have had an opposite effect on price levels when compared with 2015 (see *Figure 5 and Figure 6.* In 2008, on school and national holidays**,** fuel prices were highest on Saturday and Sunday with 1.291 €/liter for *Diesel* (0.179 €/liter higher than in 2015) and 1.275 €/liter for *Super* (0.044 €/liter higher than in 2015). This could be explained by the lack of policy restriction: in 2008, fuel stations were able to increase prices whenever they wished to do so. As most families prefer to come and go to their holiday destinations at the weekends, stations appear to increase their prices in response to the higher weekend demand, making thereby higher profits:

Figure 5: DIESEL - school and national holidays in 2008 vs. 2015

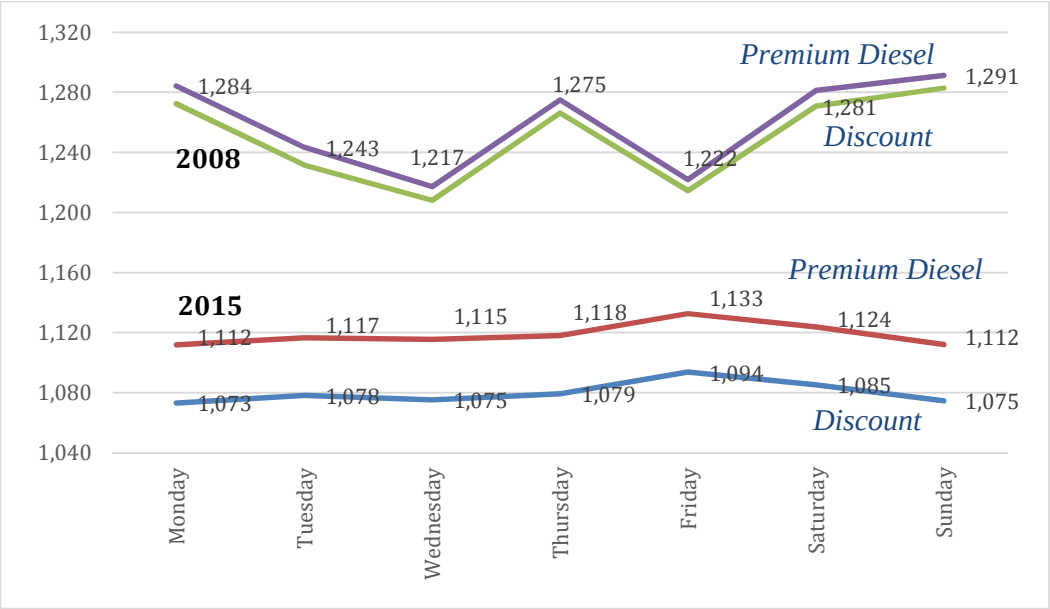
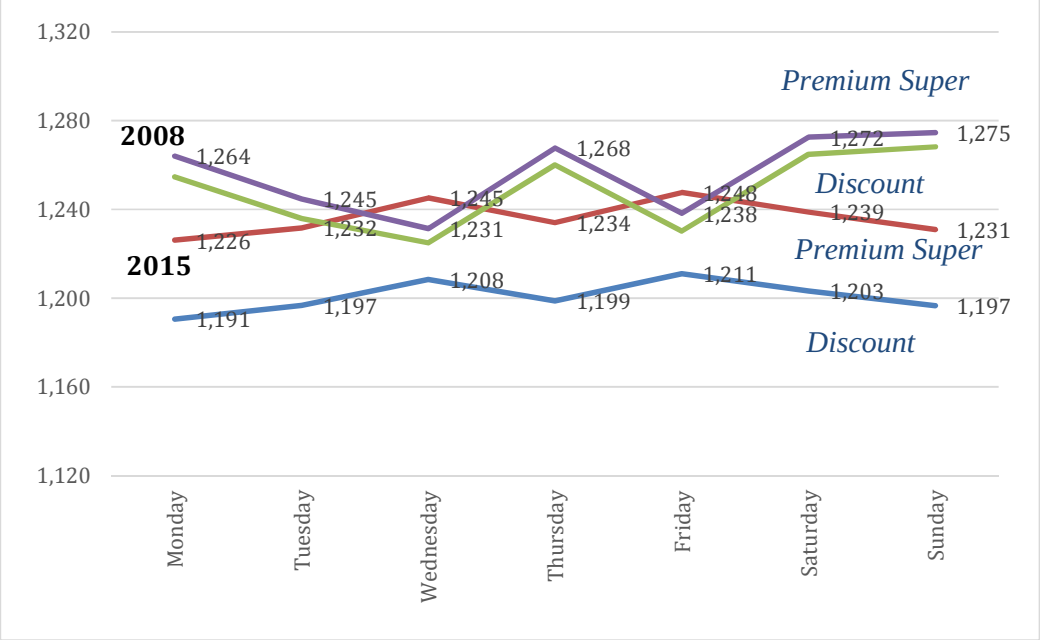


Figure 6: SUPER - school and national holidays in 2008 vs. 2015

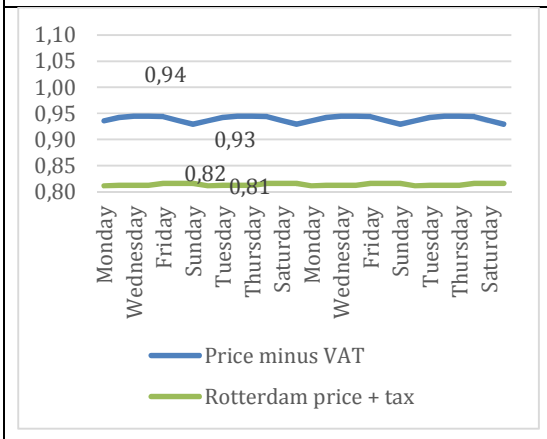


4.3.2 Weekday Effect

The *Tables 8 and 9* illustrate the average daily net price movements (taxes deducted) over four weeks in 2015 and 2008, spotted against the average cost patterns (Rotterdam-wholesale price + gasoline tax) to fully reflect the price dynamics and changes in a time series. They show the same price patterns as seen in the absolute price curves for 2015 and 2008. Whereas in 2015 both Wednesdays and Fridays are high-price days creating a flatter curve than in 2008, in 2008 prices rise gradually, reaching their peaks on Fridays, before falling to their lowest levels over the weekend:

Table 8: DIESEL - interday (weekly) pricing patterns

Premium Diesel 2015



Premium Diesel 2008

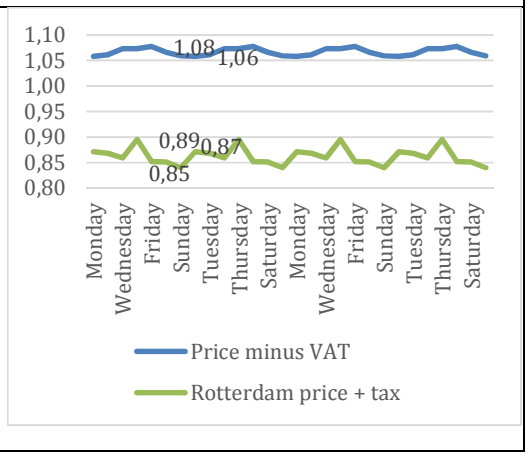
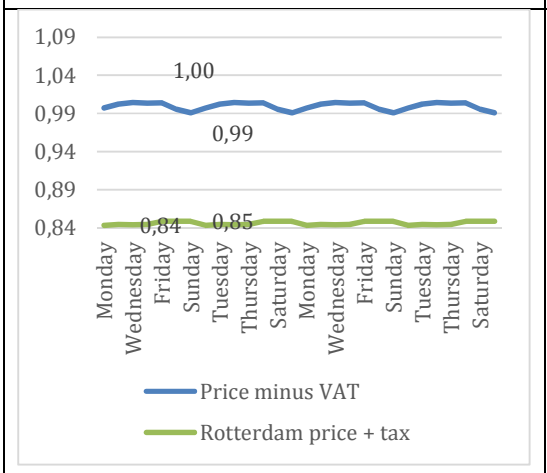
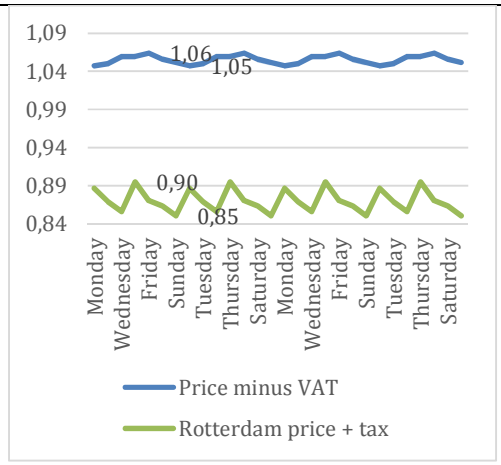


Table 9: SUPER - interday (weekly) pricing patterns

Premium Super 2015



Premium Super 2008



To show the day-of-week effect on prices more formally, in the following section we present the results of a regression analysis run with dummy variables for the different days of the week. The results indicate that some of these effects are indeed statistically significant *(see Table 10).*

In *Table 10*, the summary statistics on some of the key variables of the regression analysis are presented. The aim is to give an overview of the observed trends in interday (weekly) pricing patterns. Statistical results are broadly in accordance with those shown in *Table 8 and Table 9.*

Table 10 results show: with respect to the price of *Diesel* in 2015, only the „Sunday effect“ is statistically significant at the 5% confidence level. Prices were significantly lower on Sundays than on the other days of the week. A possible explanation is that traffic volume and thus demand at gasoline stations is lower on Sundays.

With respect to the *Super* fuel, prices in 2015 are significantly lower on three days of the week: Saturday, Sunday and Monday. The results are similar as shown in *Table 9,* to the extent that prices tend to be lower over the weekend as well as on Mondays.

For the year 2008, no statistically significant day-of-the-week effects on the price can be established in respect of *Diesel*. This is in contrast with 2015, where the „Sunday effect” is statistically significant. Regarding *Super,* there is a statistically significant „Monday effect“, which is in line with the findings for 2015, but the weekend effect is practically non-existent.

With respect to *Super* in 2015, the regression had an R-squared of 95%, which was a slight improvement compared the R-square of 93% for the regression, which only included the wholesale oil price as explanatory variable. In the case of *Super*, the 2015 wholesale oil prices and the day-of-week effect together explain almost all (95%) of the variation in observed retail fuel prices.

Table 10: Regression Analysis: Weekday Effect

2015 Regression Diesel

	Cofficient	Standard error	t-statstic	
Sunday effect	-0,0153	0,0037	-4,16	**
Saturday effect	-0,0053	0,0037	-1,43	
Friday effect	0,0048	0,0037	1,31	
Thursday effect	0,0031	0,0037	0,84	
Wednesday effect	0,0035	0,0036	0,98	
Tuesday effect	0,0000	0,0000		
Monday effect	-0,0057	0,0037	-1,54	
Rotterdam Premium 98	0,0056	0,0001	58,23	**
Constant	0,7596	0,0069	110,35	**
R-squared		93,2%		

*** Coefficient is significant at the 95% confidence level (t-statstic is higher than 1.96 or less than -1.96).*

2015 Regression Super

	Cofficient	Standard error	t-statstic	
Sunday effect	-0,0171	0,0035	-4,92	**
Saturday effect	-0,0108	0,0035	-3,09	**
Friday effect	0,0000	0,0000		
Thursday effect	-0,0022	0,0035	-0,64	
Wednesday effect	-0,0016	0,0034	-0,48	
Tuesday effect	-0,0045	0,0035	-1,28	
Monday effect	-0,0089	0,0035	-2,56	**
Rotterdam Premium 98	0,0056	0,0001	68,85	**
Constant	0,7883	0,0065	120,62	**
R-squared		95,0%		

*** Coefficient is significant at the 95% confidence level (t-statstic is higher than 1.96 or less than -1.96).*

2008 Regression Diesel

	Cofficient	Standard error	t-statstic	
Sunday effect	-0,0044	0,0088	-0,51	
Saturday effect	0,0000	0,0000		
Friday effect	0,0046	0,0086	0,53	
Thursday effect	0,0122	0,0088	1,39	
Wednesday effect	0,0091	0,0086	1,07	
Tuesday effect	-0,0024	0,0087	-0,28	
Monday effect	-0,0074	0,0087	-0,85	
Rotterdam Premium 98	0,0037	0,0001	37,79	**
Constant	0,7581	0,0151	50,06	**
R-squared		91,0%		

*** Coefficient is significant at the 95% confidence level (t-statstic is higher than 1.96 or less than -1.96).*

2008 Regression Super

	Cofficient	Standard error	t-statstic	
Sunday effect	-0,0034	0,0055	-0,62	
Saturday effect	0,0000	0,0000		
Friday effect	0,0055	0,0053	1,02	
Thursday effect	0,0059	0,0055	1,08	
Wednesday effect	0,0039	0,0053	0,73	
Tuesday effect	-0,0072	0,0055	-1,31	
Monday effect	-0,0108	0,0055	-1,98	**
Rotterdam Premium 98	0,0032	0,0001	36,65	**
Constant	0,8945	0,0109	82,09	**
R-squared		90,6%		

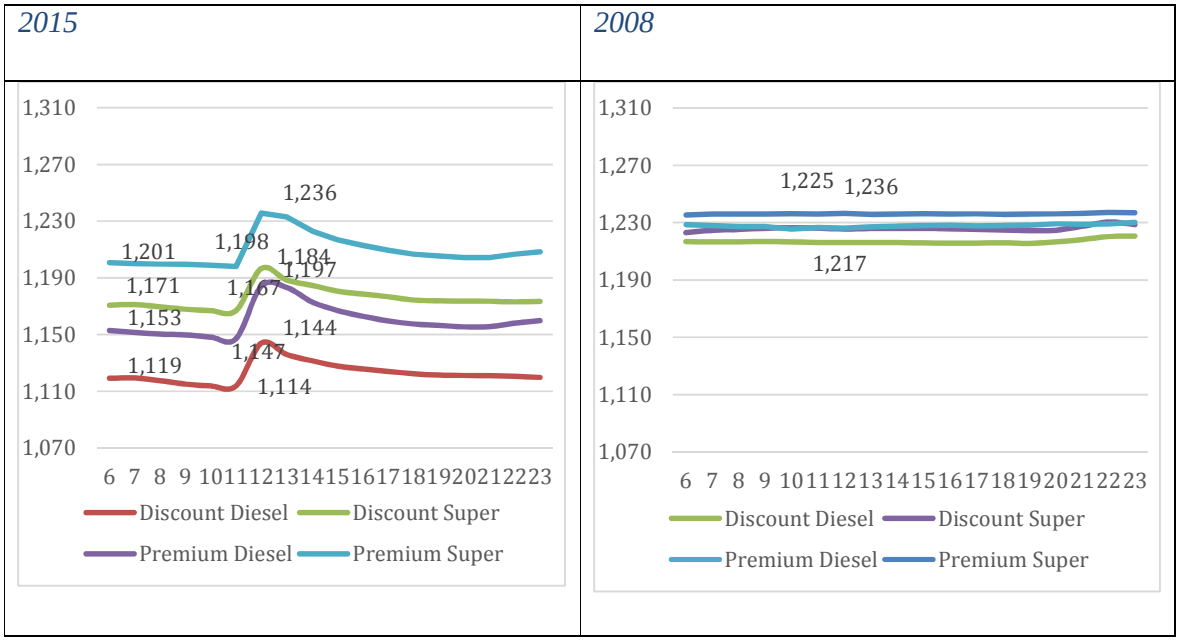
*** Coefficient is significant at the 95% confidence level (t-statstic is higher than 1.96 or less than -1.96).*

4.3.3 Intraday (within-day) Pricing Patterns

In this part of the empirical analysis, the intraday price cycles will be investigated to uncover the typical price changes and pricing strategies throughout a 24-hour time period. As average nighttime prices are higher due to the distorting effect of some of the stations closing at night (showing an increase in average price levels), nighttime prices are removed in order to ensure a "true" picture of price cycle patterns.

Table 11, Table 12, and Table 13 show the average daily intraday pricing patterns for the different fuel types in 2015 versus 2008. The figures show average prices over all stations and all normal days, excluding school and national holidays.

Table 11: Hourly Average Prices by Fuel Types



(excl. school and national holidays)

In 2015, the prices for both *Diesel* and *Super* seem to follow a similar pricing pattern throughout the day *(see Table 11).* A typical intraday price cycle pattern shows a stepwise decrease from 6 a.m., reaching its lowest shortly before 12 p.m. followed by a

significant single price increase at 12 p.m. The price jump appears to be significantly large and offsets intraday downward movements.

Table 11 shows, in 2015, *Premium Super* lies on average around 0.052 €/liter higher than *Diesel*, whereas their respective cheaper (self-service) brands lie parallel 0.040 €/liter below them.

Due to the policy restriction, the price cycle patterns display one single and large price increase at noon (of a magnitude of 0.038 €/liter from 11 a.m. to 12 p.m.), followed by some minor price restorations over the afternoon hours. Average morning prices are slightly lower than in the afternoon as stations cut their prices stepwise after the 12 p.m. increase, only to repeat the increase again the following day. The daily price patterns suggest that firms have adapted their pricing strategy to the policy, as fluctuating demand cannot be matched by changing prices. Stations cannot raise prices for inelastic morning (typically business) consumers, so firms are forced to increase their prices in the second half of the day.

In contrast, in 2008 *(see Table 11),* price patterns display a flat curve from 6 a.m. until midnight. On average, prices seem to be without any significant jumps or drops over the 24-hour cycle. This does not mean that prices are not increased/decreased by the firms throughout the day, but they seem to be changed independently of the hour of the day offsetting any trends on average. In 2008, prices do not follow a visible intraday pattern, but they are adjusted on an individual basis.

The analysis of the 24-hour price cycle for each weekday by fuel type gives more insight into the presence of intraday price cycles, especially to the magnitudes of the midday's price jumps *(see Table 12 and Table 13).* In addition, it highlights the fact that in 2015 the lowest prices can be observed over the weekends. Weekends seem to have a unique price pattern compared to weekdays. Prices do not follow the 12 pm price increase, but display a relatively flat curve. It is possible that as price changes are administered by the centralized system of the oil company in charge, and weekends are

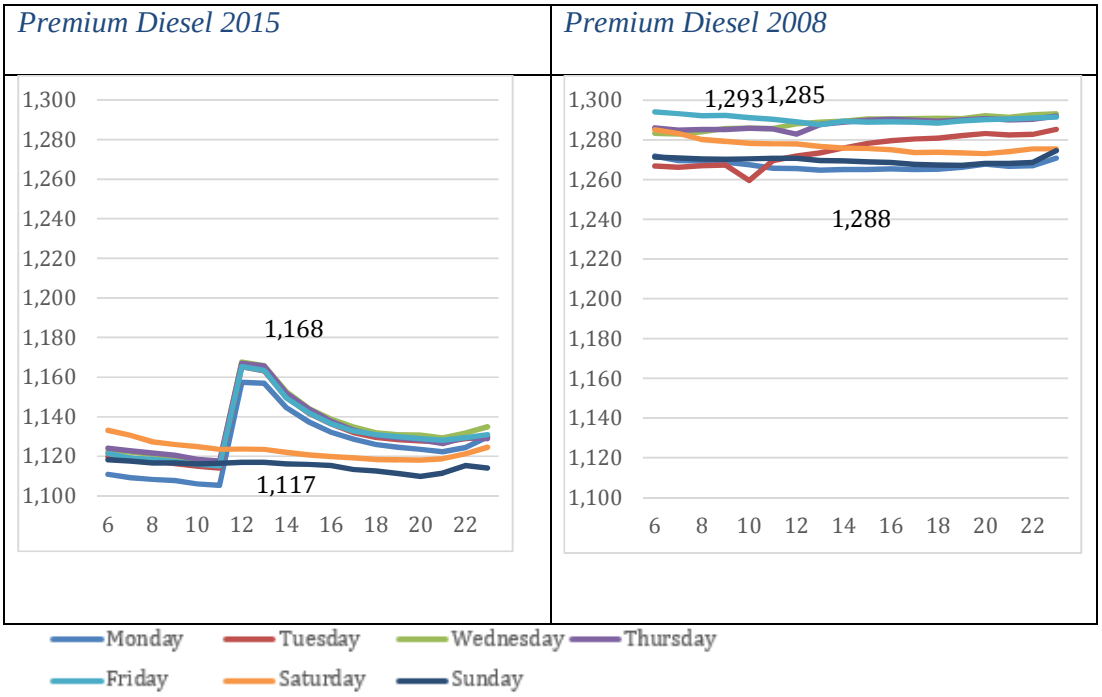
"non-work" days, during weekends prices are not under the control of the company headquarters. Another possible explanation is that competition is more intense during work days. Again, for 2015, the highest price days are Wednesday and Thursday, and the lowest price day is Sunday.

Looking at one of the weekdays with the highest prices in 2015, Wednesday, we can see that there is a 0.051 €/liter price difference between 11 am and 12 pm. for *Diesel* (see *Table 12).* This difference is almost identical for *Super* at 0.052 €/liter (*Table 13).*

For 2008, a price pattern analysis by each weekday gives little information on any trends, showing a more volatile pricing pattern depending on the day of the week and hour. Let us examine Wednesdays again. In 2008, price differences between 11 am and 12 pm. for *Diesel is* only 0.003 €/liter, and for *Super* the price difference is non-existent *(see Table 12 and Table 13).* In 2008, if Friday is analyzed on the basis of the observed 2008 weekly price patterns, where prices appear be higher on Fridays than on other weekdays, prices are highest during the morning hours (rush-hour) for *premium Diesel* (1.293 €/liter), but they fall shortly after 12 m. by 0.005 €/liter to 1.288 €/liter. So here actually the opposite price trend can be observed than in 2015, probably due to demand factors *(see Table 12).*

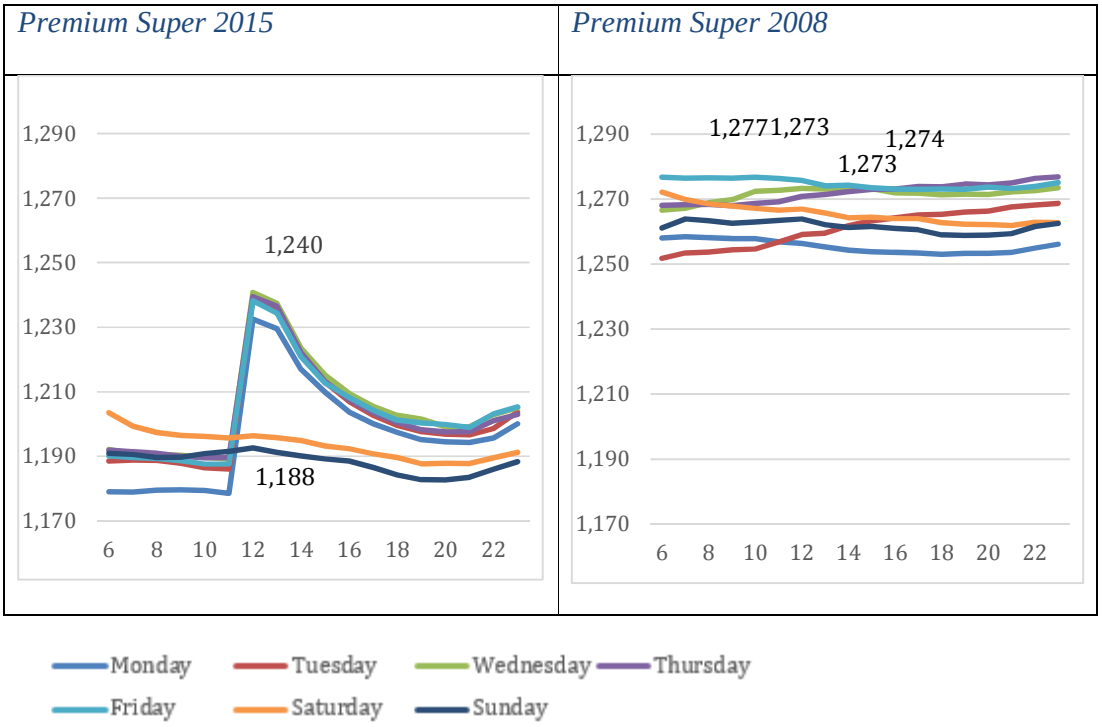
Also for *premium Super,* in 2008, Friday displays a gradually decreasing pricing pattern starting from the morning hours (highest prices) decreasing throughout the day *(see Table 13).*

Table 12: DIESEL - hourly average prices by Weekdays



(excl. school and national holidays)

Table 13: SUPER - hourly average prices by Weekdays



(excl. school and national holidays)

The above differences in daily price patterns between pre-policy (2008) and post-policy (2015) periods suggest that the Austrian regulatory policy intervention had an impact on fuel stations' pricing strategy: stations are forced to adjust their pricing depending on the hour of the day rather than other factors, increase their pricing at midday and keep them relatively high throughout the afternoon/evening hours. Prices are lowered shortly before and after 12 pm. The lowest price levels seem to be reached at 11 am. Pre-policy (2008), prices display on aggregate average a constant level, meaning, stations adjusted their pricing independently of the hour of the day, but they matched the relatively constant demand of the Austrian market spread evenly throughout the day.

Overall, in 2015 financial savings from setting purchasing time shortly before noon may reach about 5 Eurocents/liter on average. With one fill-up at the gas station (=50 liters), this amounts to about 2.5 €. The same magnitude of financial savings can be achieved by choosing the purchase day to be on the weekend. On an annual basis, a typical

Austrian driver of a *Diesel* vehicle could possibly save on average a minimum of 36 €. [5] [6]

4.4 Margin Analysis

An important question is whether the policy introduction and the change in price levels have affected the gross margin for the fuel stations.

4.4.1 Calculation

In the first step, gross prices are converted into net prices to calculate profits for *Diesel* and *Super*. To do so, VAT and taxes are deducted from gross prices. In Austria VAT is 20% and taxes are fixed sums, raised over the years. For the year 2008, taxes were 44.2 Eurocent/Liter for *Super* and 34.7 Eurocent/Liter for *Diesel*. In 2011, they were raised by 6 Eurocents and 5 Eurocents respectively, resulting in 48.2 Eurocent/Liter for *Super* and 39.7 Eurocent/Liter for *Diesel.*

In the second step, wholesale (Rotterdam) prices were taken into account, as most of the oil companies procure their products at the Rotterdam market. It is important to point out that the margins calculated this way are not the exact margins made by the respective company. The absolute net prices could be lower or higher, depending on the procurement costs. However, the resulting net prices give a good overview on the development of margins over the years, before and after the introduction of regulatory policy.

The following margins are calculated as the difference between the net prices and the wholesale prices for *Diesel* and *Super.*

[5] Conversion: 0.63 Tonnes (metric ton) into Liters for substance with density: 885 kg/m^3 = 712 liters

[6] WKO. (02.01.2017). *Dieselverbrauch 2016 gestiegen.* Retrieved from: https://www.wko.at/branchen/industrie/mineraloelindustrie/Dieselverbrauch-2016-gestiegen.html

4.4.2 Margin Levels

The average margin post-policy (2015) is 0.177 €/liter for *Diesel*, and 0.110 €/liter for *Super* at non-highway stations. Pre-policy (2008), the average margin is lower, 0.168 €/liter for *Diesel*, and higher 0.147 €/liter for *Super (see Table 14).*

Table 14: Average Margins in 2015 vs. 2008

Average Margins	Discount Diesel	Discount Super	Premium Diesel	Premium Super
2015	0,146	0,081	0,177	0,110
2008	0,159	0,140	0,168	0,147

The results suggest that after policy introduction, the average gross margin went down by -25 % for *Super*, and it went up by 5% for *Diesel*.

Figure 7 and Figure 8 show the development of the estimated retail profit margins for *Diesel* and *Super* for the year 2015 and 2008. They show strong fluctuations**.**

Figure 7: Margins Developments in 2015

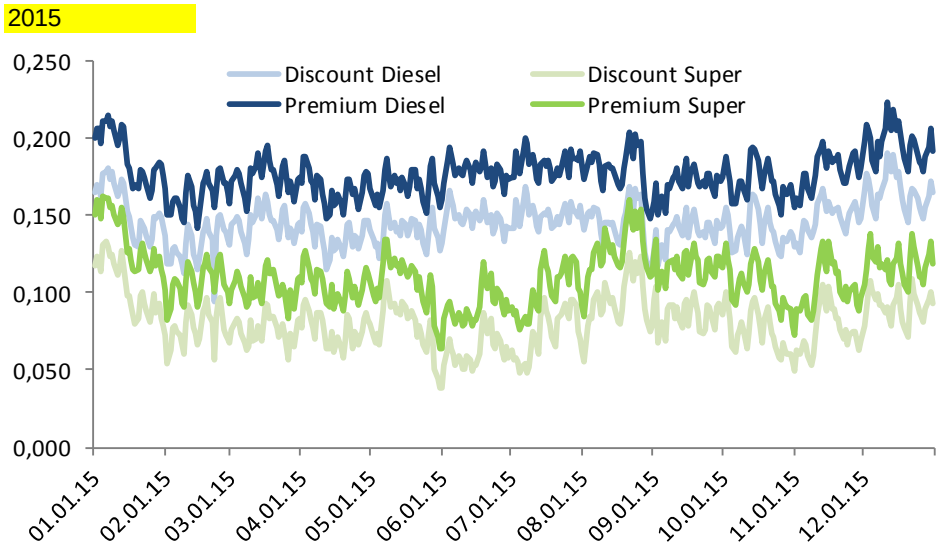
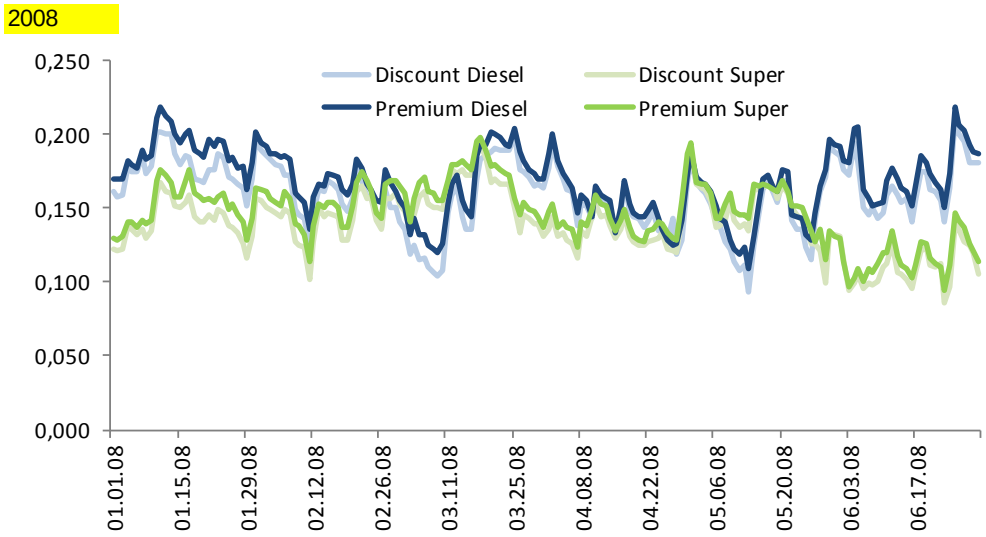


Figure 8: Margins Developments in 2008

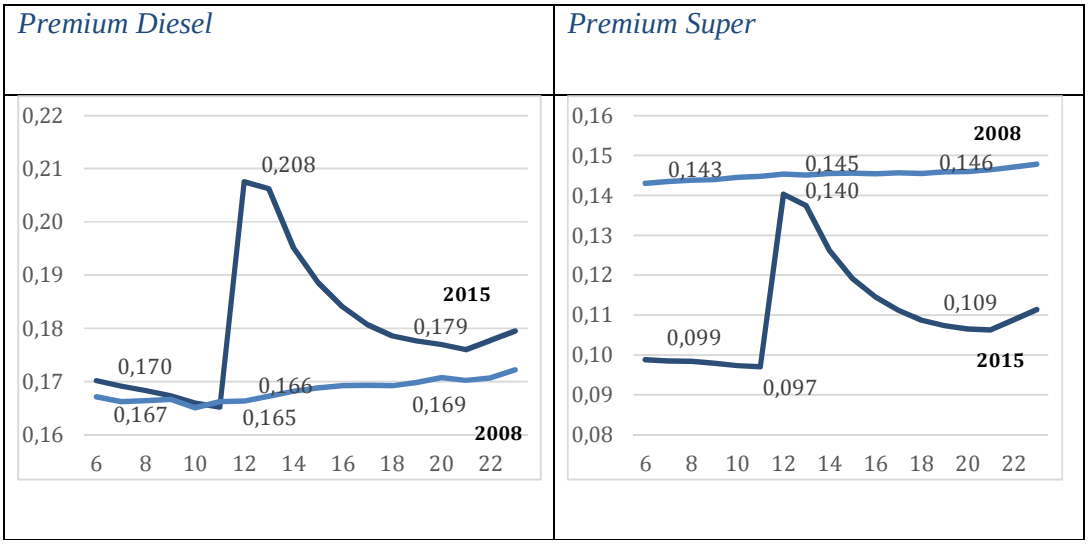


4.4.3 Intraday Margins

Figures 9 illustrates the mean mark-ups (margins) depending on hour of day. In 2015, the average margins are always lower in the morning, followed by a sharp increase at noon, from which point the decline is relatively large. The margin difference between the morning hours and noon appear to be quite significant. Overall, margins are highest at noon and in the afternoon and lowest in the morning. Overall, the margin curve is downward sloping with one sharp upward jump, at the time when gasoline stations are allowed to increase their prices.

In 2008, the picture is less clear *(see Figures 9*). The margin curve is only slightly upward sloping, but mainly flat. Even though participants are allowed to raise their prices during the day whenever they wish to, the price changes and average mark-ups made by the company seem to be distributed evenly in the a 24-hour cycle, and this could possibly due to a relatively even aggregate demand.

Figure 9: Hourly Margins in 2015 vs. 2008



(excl. school and national holidays)

Nevertheless, statistically, Austria still has one of the lowest fuel prices in Europe, a 50 liter fill-up costing 5.5 € less for *Diesel* (51 €) and 9.5 € less for *Super* (55.5 €) than its respective European averages (European Commission, 2016).

However, considering that in 2015, 78% of the total fuel demand was for *Diesel* (0.63 tons of Diesel/Austrian driver), Austria experienced the second largest *Diesel* demand in Europe after Luxemburg (VCÖ, 2016). The observed overall increase in mark-up for *Diesel* (by 5%) after the policy's introduction raises the question whether the policy resulted in any financial benefits for the consumer. There is no evidence found of any significant decrease in average mark-up by the gas stations.

5. Impact of Results on Consumers

The findings suggest that oil companies, and gasoline stations, are prevented by the policy to follow their price discrimination strategy, which could be observed in the German retail gasoline market (Bundeskartellamt, 2014). In Germany, prices are set according to the degree of consumer price inelasticity, i.e. prices are significantly higher for morning (work commuters) consumers and are significantly higher for evening (leisure) consumer types (Boehnke, 2014). In Austria, price levels depend strongly on the hour of the day dictated by the policy's restriction. Is is assumed that Austrian stations wish to keep similar expected margins to the pre-policy period to avoid financial losses. Intraday price patterns might demonstrate more transparency to consumers due to the policy restriction, the sharp price increase at noon followed by higher average price levels across the afternoon and evening hours might harm uninformed and inflexible consumers. It appears, that expected margins are merely re-redistributed, so less flexible or unknowing consumers purchasing at noon or in the afternoon-evening hours might „pay" the price for the policy. This may offset any positive effects in aggregate social welfare. In addition, the more consumers delay their purchase time to the morning hours (where prices are expected to be the lowest), the less the competition intensity is at noon and afternoon-evening hours, and the higher the prices are set by firms at noon to keep expected aggregate margins unchanged, ultimately leading to higher average prices for all consumers.

The ÖAMTC (Austrian Automobile, Motorcycle and Touring Club), an independent association with 1.2 million members, calls for a policy change regarding the time for the price increase during the day. They demand a 9 a.m. increase instead of the current 12 p.m. restriction. Consumers would be potentially better off with an earlier increase to benefit later from decreases during the price cycle ("ÖAMTC will erlaubte Änderungen," 2016). However, based on the results, one can argue that if all consumers try to gain from the presence of price differences throughout that 24-hour price cycle by filling up their tanks at certain hours of the day, the stations would re-optimize their intraday price setting strategies, just as they did following 2009.

6. Conclusion

Price data collected from two periods of time were compared: one set coming from the pre-policy observation period of January to mid-2008 and the other set of data came from the post-policy observation period of January to December 2015. The Austrian regulatory policy may increase consumer welfare if it results in lower price levels, lessened price volatility and higher transparency for consumers. While this paper has not analyzed price volatility, it is assumed that the price restriction successfully reduces volatility by allowing only one single price increase at noon. This paper sought support for the hypothesis that the regulation, adopted in 2011, led to price distortions, hence harming inflexible or uninformed consumers. This hypothesis was tested first of all by examining the changes in intraday price patterns.

Our results show that average price levels for both *Diesel* and *Super* decreased after the adoption of the policy. In 2015, *premium Diesel* prices and *premium Super* prices were 0.153 €/liter and 0.055 €/liter lower respectively than in 2008. Furthermore, their discount counterparties were 0.18 €/liter and 0.082 €/liter lower respectively. However, the majority, if not all, of these decreases in price levels could be due to drops in wholesale fuel prices. In 2015, there is a slightly stronger correlation observed between retail and wholesale prices than in 2008. In both years, R-squared is 90% or above, meaning that most of the variation in daily average fuel prices is explained by the daily fluctuations in wholesale oil prices. However, wholesale oil price is only one element in the cost breakdown of retail fuels, therefore retail and wholesale prices do not rise and fall with each other proportionally.

In respect of the price of *Diesel* in 2015, the „Sunday effect“ is found to be statistically significant, in other words, prices were statistically significantly lower on Sundays than on any other days of the week. A possible explanation is that traffic volume and thus demand at petrol stations is lower on Sundays. In the case of *Super* in 2015, prices are statistically significantly lower on three days of the week: Saturday, Sunday and Monday. In 2015 in respect of *Super*, the wholesale oil prices and the day-of-the-week

effect together explain almost all of the variation (95%) in the observed retail fuel prices.

For the year 2008, in respect of *Diesel*, there is no evidence for any statistically significant day-of-week effects on prices. As regards the price of *Super*, there is a statistically significant „Monday effect“, which is in line with the findings for 2015. The weekend effect is, however, virtually non-existent.

The results for the 2015 intraday pricing patterns show that prices gradually decrease until a single sharp increase occurs. This phenomenon occurs as a result of the policy. Siekmann (2017) points out the presence of intraday price cycles in the retail gasoline market may offer benefits to consumers with individual intraday purchase timing strategies. Due to increased market transparency and intraday price cycles, those consumers who can adjust their purchase time can increase their welfare by making conscious decisions on their purchase time.

In the Austrian case, the empirical findings offer an insight into the optimal purchase timing regarding weekday and time of day. Results show that informed consumers, who purchase on weekends when the lowest prices are observed, may save on average 5 Eurocents/liter filling up on a Sunday instead of a Wednesday noon. If consumers are flexible and make a conscious decision when to fill up their tanks, they can make financial savings. It should be noted that waiting costs or switching costs should be minimal.

The margin analysis shows how the gross margins of the fuel stations are only slightly affected by the policy. In 2008, average margin for *Diesel* is 17 Eurocent/Liter and 15 Eurocent/Liter for *Super*. The average margin for *Diesel* for 2015 is 18 Eurocents/Liter and 11 Eurocents/Liter for *Super* at non-highway stations. The observed overall increase in mark-up for *Diesel* is about +5% after the policy’s introduction. In 2015 78% of the total fuel demand was *Diesel* (0.63 tons of Diesel/Austrian driver), the result raises question whether the policy indeed resulted in any financial benefits for

consumers, as there is no evidence of any significant decrease in average mark-up by the gas stations (WKO, 2017).

Overall, the results support the hypothesis that the regulation, adopted in 2011, leads to intertemporal price distortions, hence harming inflexible or uninformed consumers. Intraday price patterns display a distorted pricing strategy by fuel stations: there is a significant price increase at noon and relatively higher price levels throughout the afternoon and evening hours. It is assumed that this occurs in an attempt to counteract any margin losses and create room for competition-induced price drops later in the day.

Consequently, the higher number of consumers delay their purchase time to the morning hours (where prices are expected to be the lowest), the less the competition intensity is at noon and the afternoon-evening hours, as well as the higher the firms set their prices at noon in order to keep expected aggregate margins unchanged. Ultimately this will lead to higher average prices throughout the day for all consumers. Due to this paradox, the Austrian policy may even have a negative effect on consumer surplus despite less price volatility.

7. Critical Remarks / Limitations

This study only covers a limited number of stations belonging to one vertically integrated oil company and its premium/discount brands. Future empirical research could include other brands as well to get a more comprehensive picture on margin and price levels.

Being volume-weighted averages on a nationwide level, prices offer no information on price differences between locations or any station-level price spreads as a result of certain station characteristics (e.g. brand name, opening times, stations with shop or car wash etc.). By analyzing the influence of the crude oil price on fuel prices and the degree of competition in the retail market, Kihm et al. (2016) find that the brand has a significant effect on fuel prices. The stations of major-brand companies adjust their

prices according to increases in Brent crude prices, while non-major stations pass on the increases relatively weakly.

The analysis could also comprise other dimensions, including consumer's willingness to compare and search for alternatives.

Some of the statistical comparisons between 2008 and 2015 are made more difficult by the fact that the economic environment in general and wholesale oil price behavior in particular were very different during the two periods. Despite the usual noon jump in oil prices, for example, the standard deviation in fuel prices in 2015 was lower than in 2008. However, this was due to wholesale oil prices being lower in 2015. Due to the significant difference in the level of oil prices, simple standard deviation is not comparable between the two periods.

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