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The Effects of Gasoline Price Regulations: Experimental Evidence^{*}

Justus Haucap and Hans Christian Müller^{**}

April 2012

Abstract: Economic theory suggests that gasoline retail markets are prone to collusive behavior. Oligopoly market structures prevail, market interactions occur frequently, prices are highly transparent, and demand is rather inelastic. A recent sector inquiry in Germany backed suspicions of tacit collusion and suggested to adopt regulatory pricing rules for gas stations similar to those implemented in Austria, parts of Australia, Luxembourg or parts of Canada. In order to increase consumer welfare these rules either restrict the number of price changes per day or they limit the mark-up for gasoline retail prices. As theoretical predictions about the impact of these measures are mixed and empirical studies rare, we analyze the effects, using an experimental gasoline market in the lab. Our results reveal that two of the suggested rules rather decrease consumer welfare: The Austrian rule which only allows one price increase per day (while price cuts are always possible) and the Luxembourg rule which introduces a maximum markup for retailers. While no rule tends to induce lower retail prices, the Western Australian rule which allows at most one daily price change (no matter whether up or down) does at least not harm consumers.

JEL Codes: L13, L71, L81, L88, K23, C90

Keywords: Gasoline Prices, Fuel Prices, Experimental Gasoline Market, Fuel Price Regulation, Retail Price Regulation, Gas Stations

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1 Introduction

Few prices in the Western world are regularly fueling so much interest and debate as gasoline prices. In many jurisdictions around the world the up and down of fuel prices is a subject of regular discussion in the press and among politicians. In many countries, public uproars have put pressure on Governments to limit gas stations' power to exploit their perceived market power. To name but a few, price regulations have recently been discussed in Canada, Germany and the Netherlands, and new regulations have been introduced in Austria as of 1 January 2011.

Many competition authorities around the world (such as those in Australia¹, Austria², Bulgaria³, Germany⁴, Ireland⁵, Portugal⁶, to name just a few) have also conducted in-depths investigations of the gasoline market, as gasoline market are under notorious suspicion to be cartelized. Motoring organizations around Europe regularly call for investigations into market manipulation⁷, and in June 2011 the US Federal Trade Commission (FTC) said that it would begin another investigation to determine whether rising retail gasoline prices are the result of market manipulation or other anticompetitive behavior⁸, following several studies by the US Energy Information Administration (EIA).

In fact, economic theory suggests that gasoline retail markets are indeed prone to collusive behavior. Oligopoly market structures prevail, market interactions occur frequently, prices are highly transparent, and demand is rather inelastic.

A recent sector inquiry by Germany's competition authority, the Federal Cartel Office, backed suspicions of tacit collusion (see Bundeskartellamt, 2011) and recommended to consider regulatory pricing rules for gas stations similar to those implemented in Austria, parts of Australia, Luxembourg or parts of Canada. With the aim to bring down gas prices these rules either restrict the number of price changes per day or they limit the mark-up for gasoline retail prices.

The in-depth sector inquiry into the German gasoline market, which the Federal Cartel Office published in 2011, accused the five major gas station operators of having established a "competition-free" oligopoly that was characterized by tacit collusion. The sector inquiry revealed that the number of price changes has increased quite dramatically over the last years and that the two largest chains act as price leaders within the oligopoly: The leaders' price changes are typically followed by all other gas stations within three hours, leading to almost perfectly parallel price developments and only small price differences. Furthermore,

¹ See Australian Competition and Consumer Commission (2007).

² See http://www.bwb.gv.at/BWB/English/annual_report_2006.htm

³ See http://ec.europa.eu/competition/ecn/brief/04_2011/bg_si.pdf

⁴ See Bundeskartellamt (2011).

⁵ See National Consumer Agency (2008).

⁶ See <http://www.concorrenca.pt/en/publications/competition.asp>

⁷ See <http://www.guardian.co.uk/money/2012/jan/19/aa-inquiry-cost-diesel>

⁸ See <http://www.cspnet.com/news/fuels/articles/ftc-launches-gasoline-price-investigation>

gas stations tend to uniformly raise gas prices during rush hours. The Federal Cartel Office thus concluded that the market lacks substantial competition and that the Government should consider establishing new pricing rules by law (see Bundeskartellamt, 2011).

While the interpretation of the data by the Federal Cartel Office is, at least, debatable, as for example more frequent price changes among gas station typically tend to be a sign of more rather than less intense competition (see Noel, 2007a), we do not wish to discuss the findings of the sector inquiry and its interpretation by the Federal Cartel Office at length here. The focus of our paper is rather on the proposed remedies, i.e. the different pricing rules suggested by the Federal Cartel Office.

In order to make collusion more difficult, the following pricing rules pricing regulations for gas stations have been proposed:

- The “Austrian rule” (in force in Austria since January 2011) which allows price increases only at 12 noon, while price cuts are always possible.
- The “Western Australian rule” (also known as the Fuel-Watch-Concept) which was established by the Government of Western Australia in 2001. The regime constrains the gas stations to change their prices at most once a day (no matter whether up or down), these price changes must be announced at 2 pm the day before.
- Price ceilings (in force in Luxemburg and different Canadian states) which set a maximum mark-up for gasoline retail prices based on wholesale market prices.

Although all three regulations were established in their particular jurisdictions in order to protect consumers from exploitative price setting behavior by gas stations, a solid theoretical underpinning is missing at least for the Austrian and the Western Australian rule while empirical or experimental support for the rules’ effectiveness is even missing in all three cases.

To help filling this gap, we use a controlled lab experiment to analyze how the three pricing rules affect market outcomes. The setup of our experimental gasoline market is similar to the one studied by Deck and Wilson (2008), albeit with an entirely different focus. As Deck and Wilson (2008) we use a spatially differentiated oligopoly model where robot consumers face certain transport costs. For a fictional product, four players can set prices within varying time intervals, depending on the implemented pricing rule. Both demand and input prices vary in order to closely reflect the realities of most gasoline markets. While demand fluctuations follow the same pattern over every 4-round period (i.e., a full day in our game) and are communicated to all players at the beginning of the experiment, the periodical input price variations are random from the four players’ perspective.

The results of our experiment are as follows: The Austrian rule tends to lead to higher prices and firms’ profits compared to an unregulated market. The increase in both the mark-up and the profit level is statistically and economically significant. Similar results emerge for the Luxembourg scenario, even though we were only able to conduct the experiment for one

particular price ceiling even though one could test, at least in theory, an infinite number of price ceilings. The Western Australian rule did not result in any price or profit level that have been different in terms of statistical significance when compared to an unregulated market.

We conclude that Governments should rather refrain from introducing the Austrian pricing rule, as it may lead to increased prices and thereby reduce consumer welfare. The Luxembourg rule is also unlikely to provide consumer benefits if the price ceiling is not binding, while we cannot explore the dynamic effects of the Luxembourg rule (including entry and exit) if the regulatory price ceiling is binding. Although the Western Australian rule does not lead to significant improvements for consumers, it does not do much harm either. If there is a strong consumer preference for price stability over the day, our experiments suggest that the Western Australian rule may at least be implemented without inducing price increases.

The remainder of our paper now is organized as follows: Section 2 provides an overview over the related literature, while section 3 describes the experimental setting and derives hypotheses. Section 4 presents the results, before section 5 summarizes and concludes.

2 Related Literature

Apart from the many sector inquiries that have already been quoted above there is also a limited academic literature on pricing strategies in retail gasoline markets. A particular expert in this field is Michael Noel whose research has focused on the theory and practice of so-called Edgeworth price cycles. The theory of Edgeworth price cycles was first formalised in a seminal contribution by Maskin and Tirole (1988), who consider two identical firms that produce an homogeneous good and compete by setting prices in an alternating fashion. As Maskin and Tirole (1988) have shown two types of equilibria can emerge. Either prices remain sticky or, alternatively, an asymmetric price cycle emerges, where prices rise fast and then fall slowly.

In an extension of this theory, Noel (2008) has shown that Edgeworth Cycles are a robust equilibrium even if there are cost shocks, as is typical in retail gasoline markets. Maybe even more importantly, Noel (2008) has also shown that the inclusion of a third firm is compatible with the emergence of Edgeworth cycles. However, now situations can emerge where a firm may first increase its price, but then revert to a lower price if the other firms continue to compete at the bottom of the cycle for too long without following.

In Noel (2007a) weekly data on average prices is studied for 19 Canadian cities over 11 years, accounting for variation in concentration ratios across cities and over time. As Noel (2007a) shows Edgeworth cycles are more prevalent where small and price aggressive independent gas stations have a larger presence. In addition, Noel (2007a) finds that the presence of price aggressive firms results in faster and taller cycles. The empirical findings support the argument that the cycles are generated by an Edgeworth Cycles process and that Edgeworth

Cycles are associated with more competitive markets. Further support for these results is provided by a detailed study of the Toronto retail gasoline market in Noel (2007b).

Finally, while Noel (2009) has shown that Edgeworth cycles can be a cause of asymmetric cost pass-through in gasoline retail markets, Lewis and Noel (2011) find that pass-through rates are much faster in Edgeworth Cycles markets than in non-cycling markets. Hence, there is a welfare benefit to consumers in markets where there are Edgeworth Cycles.

There is also very limited experimental work on retail gasoline markets. The main contribution on experimental gasoline markets is the paper by Deck and Wilson (2008) which analyzes the effects of so-called zone pricing rules in wholesale gasoline markets, using a controlled laboratory experiment. Deck and Wilson (2008) investigate how zone pricing affects consumers, retail stations, and refiners in comparison to uniform wholesale pricing to retailers. In a nutshell, they find, firstly, that uniform wholesale pricing rules benefit retailers at the expense of consumers, and, secondly, that the retail prices are not as well related to underlying costs.

The experimental work by Engelmann and Normann (2009) and by Engelmann and Müller (2011) is also related to our Luxembourg rule, as their papers show that price ceilings do not have any effect on prices or on the stability of collusion, as long as the price ceiling is not binding. Hence, their experiments cannot support the idea that price ceilings may serve as focal points that help to facilitate collusion.

Finally, a recent paper by Berninghaus, Hesch and Hildenbrand (2012) provides a very simple experimental analysis of the Austrian rule, using a two player game where the two players can choose between four different prices. They show that the percentage of two-player pairs that play the collusive equilibrium (which yields twice the payoff of the competitive equilibrium) increases from 66 % to 78 % when the Austrian rule is implemented. However, their game lacks many of the features of most retail gasoline markets. First of all, they study only duopoly situations which are known to be much more prone to collusion than games with three or four players (see Huck, Norman and Oechssler, 2004; Isaac and Reynolds, 2002). Secondly, players can only choose between four different prices. Thirdly, there are no cost variations which are a typical feature of retail gasoline markets. And fourthly, there are no demand fluctuations in their market.

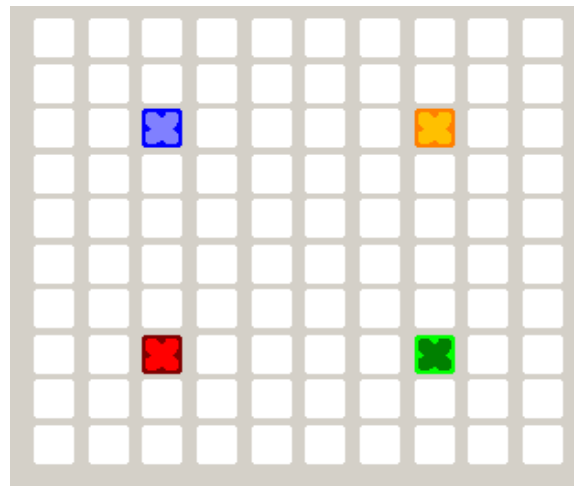
3 Experimental Setting

We have developed an experimental gasoline market which reflects many key features of a real retail gasoline market. Firstly, it models the spatial oligopoly structure of many retail gasoline markets where customers are located at different points so that they face different transport costs. Secondly, we have incorporated different demand levels at different times, as the majority of car owners tend to buy gasoline at rush hours rather than at noon or at night (see, e.g., Bundeskartellamt 2011). Third, interactions are regular and occur

repeatedly. And fourthly, wholesale prices (retail costs) fluctuate over time, as do wholesale gasoline prices in reality.

To implement these features into our experimental gasoline market, we use a modified version of the experimental setting of Deck and Wilson (2008). Our participants were randomly allocated into fixed groups of four, playing the role of a supplier of a fictional good which they sold at a chosen price to robot buyers. In order to prevent framing effects, the fictional good was not specified as gasoline. The shops were located symmetrically over a two dimensional, quadratic 10x10-Hotelling-type city within the square at blocks (3,3), (3,8), (8,3) and (8,8), respectively, as depicted in figure 1.

Figure 1: Quadratic 10x10-Hotelling-city with four shops (gas stations)



Buyers

A number of 10,000 robot buyers was uniformly distributed over our two-dimensional, quadratic 10x10-Hotelling-type city. Each block was inhabited by 100 buyers, so that the entire city had 10,000 buyers in total. Each of the 10,000 robot buyers purchased the fictional good once per day (where a day consist of four rounds, which reflect different times of day). However, buyers purchased the good at different daytimes. 35 percent of the daily demand was known to materialize in the morning and another 35 percent in the afternoon, while 20 percent of the buyers purchased at noon and the remaining 10 percent at night. Thus, 3,500 customers bought in the first and third round of each day, 2,000 in the second round and the remaining 1,000 in the last round, before a new day started. This rule held for the entire city.

The robot buyers automatically purchased at the shop where their total cost of purchase were minimal. The total cost of purchase at shop i consisted of travel cost and the shop i 's retail price. The travel cost was known to be one Taler for every side of every block travelled.

Buyers were assumed to only travel horizontally and vertically, but not transversely. Hence, the maximum distance that a buyer could travel was 14 blocks, for example if the buyers at block (10,10) would purchase at the shop at (3,3). The minimum distance was zero, for example if the buyers at block (3,3) bought at shop (3,3). If two or more shops offered prices such that the same minimum total cost of purchases resulted for a group of buyers at a given block, the buyers located in the respective block were automatically split up equally between these shops. All buyers were known to have a maximum willingness to pay of 40 Talers less their respective transport cost. Hence, buyers at block (10,10), e.g., only purchased at shop (8,8) if the price of that shop was not higher than 36 Talers and the other three shops did not offer prices which led to a smaller total cost of purchase. In general, buyer j only purchases the good if at least for one shop i $p_i + t_{ji} \leq 40$ holds, where t_{ji} is the transport cost buyer j faces when travelling to shop i .

Sellers

Each of the four participants in every market ran one single shop in a fixed-matching setting against the same three rivals throughout the whole experiment, since repeated strategic interactions are a common feature of gasoline markets.

All sellers had to choose their retail price simultaneously. When asked to choose their selling price, sellers were also informed about the current wholesale price and the market results of the previous round (daytime), i.e. the number of buyers at their shop, their profit, their market share and their rivals' selling prices, as rival price monitoring is a key characteristic of gasoline markets (see, e.g., Bundeskartellamt 2011). Sellers were not allowed to charge retail prices below the wholesale price.

The profit seller i made during a round was calculated as the number of buyers at shop i multiplied by the mark-up, which consists of the difference between i 's retail price p_i and the uniform wholesale price where the latter was always the same for all participants.

The uniform wholesale price which all sellers equally had to pay (as long as they made any retail sales) changed once a day (always before the first round of the day). As wholesale prices were always known before retail prices had to be chosen, sellers did not have to speculate or to form beliefs about future wholesale price developments in order to manage any inventories, as inventories were ruled out to avoid artificial effects induced by risk aversion and similar participant characteristics.⁹

The next day's wholesale price was random from the participants' perspective and only known to fluctuate between 15 and 25 Taler. However, following Deck and Wilson (2008), the same price path, with a mean of 20 Taler, was used throughout all sessions in order to keep the results comparable.

⁹ This contrasts with Deck and Wilson (2008) who also have inventories in their game.

Treatments

The experiment comprised two phases and each phase consisted of eight “days” which in turn were split into four “daytimes” (to reflect varying demands at morning, noon, afternoon and night). We used an identical wholesale price path in the first phase (days 1 to 8) and the second phase (days 9 to 16) of the game in order to facilitate an unbiased comparison of the two phases of the game.

In the baseline scenario, the suppliers were allowed to change their retail prices every round, i.e. four times per day. Thus, over an 8-day phase sellers could make 32 retail price choices.

Apart from the baseline scenario (B), in which participants were able to change their price in every single round and which represents the current unregulated situation in many countries, we have tested three different price setting rules:

- The Austrian rule (A), which allows prices to increase only once a day (in the morning), while price cuts are allowed at all four rounds of given day.¹⁰
- The Western-Australian rule (W), which only allows one price change (whether up or down) per day at all. In order to keep the timing of the experiment constant, participants had to click through the four rounds of any day, as in the baseline scenario, and they were only able to change their retail price in the morning.
- The Luxemburg rule (L), which sets a maximum mark-up, by which the retail price may at most exceed the wholesale price. We have set a maximum mark-up of 8 Talers, which is above the two single stage Nash equilibrium mark-ups (which come to 5 and 6 Talers), for two main reasons: Firstly, a relatively high mark-up allows us to test the hypothesis that the maximum mark-up can serve as a focal point which helps to facilitate collusion. To test this hypothesis, a mark-up that exceeds the competitive benchmark is necessary. An secondly, we have chosen a mark-up of 8 Talers, as it is half of the cartel price, if we take the average purchasing price of 20 as a basis.

To analyze the effects of the different pricing rules, we have conducted seven different treatments. In the first treatment, participants were playing the baseline game in both the first phase and the second phase. In the second, third and fourth treatments, the experiment started with one of the three pricing rules which was then repealed after phase 1 (days 1 to 8) for the second phase (days 9 to 16). In treatments 5, 6 and 7, this timing was reversed. The experiment started with the baseline scenario, followed by one of the three pricing rules which were implemented in the second stage.

This approach allows us to compare the results between treatments as well as within treatments. First, we are able to compare the behavior of groups which operate under

¹⁰ This slightly differs from the Austrian regime as established in reality where any price increase must be implemented at 12 noon. We have chosen the first round of a day (morning) instead so that participants did not need to form any expectations about the following morning's wholesale price.

different pricing rules from the beginning by looking at the first-phase results of treatments 2, 3 and 4 and comparing them to the other four treatments which all begin with the baseline game. Since the participants were only informed *that* the rules of the game may or may not change in the second phase of the game, but not *how* they may change, before they actually entered the second phase, we can sum up the first-phase results of treatments 1, 5, 6 and 7 for this purpose. This facilitates a comparison between treatments.

Secondly, we are able to analyze the effects of introducing different pricing rules in the second phase by comparing the second-phase behavior of treatments 1, 5, 6 and 7 which all started with the baseline game in phase 1.

Table 1 summarizes the different treatments and gives the number of groups which played the corresponding treatments.

Table 1: Treatments

| Treatment | Abbr. | First phase | Second phase | # Groups |
|------------------|--------------|--------------------|---------------------|-----------------|
| 1 | B-B | Baseline | Baseline | 10 |
| 2 | A-B | Austria | Baseline | 12 |
| 3 | W-B | Western Australia | Baseline | 9 |
| 4 | L-B | Luxemburg | Baseline | 13 |
| 5 | B-A | Baseline | Austria | 11 |
| 6 | B-W | Baseline | Western Australia | 10 |
| 7 | B-L | Baseline | Luxemburg | 9 |

The experiment took place in the laboratory of the Duesseldorf Institute for Competition Economics (DICE) between November 2011 and January 2012. 296 subjects participated in 15 sessions which all lasted about two hours. 145 participants were females (49 percent), and the mean age was 24 years and one and a half months. Participants received a show-up fee of 4 Euros and the sum of their total profits after 64 periods, converted into Euros at an exchange rate of 10,000 Talers to 1 Euro. The total amount was rounded up to full multiples of 50 Eurocents. Participants thus earned an average total amount of 19.32 Euros (median: 19 Euros).

Hypotheses

Our experimental gasoline market has three theoretical reference points: First of all, there is the cartel case with a price of 36 Talers which maximizes the suppliers' profits. At a price of 36, the market is completely covered, since no buyer has to drive more than four lines to reach the closest shop and 40 Talers is the buyers' maximal willingness to pay. However, if all players charge a price of 36, every single player has an incentive to deviate downwards, as a price of 35 generates a higher profit if the three other firms charge a price of 36.

The second and third reference points are the two symmetric Nash equilibria of the stage game with mark-ups of 5 and 6 Talers, respectively (with the latter being the payoff dominant equilibrium). If one's three rivals charge the respective mark-up, no additional profit can be gained by deviating upwards or downwards. In contrast, if one's three rivals charge a mark-up of less than 5 Talers, it is beneficial to raise the price, while it is profitable to lower one's price if the rivals' uniform mark-up is larger than 6 Talers.

From a purely theoretical perspective, one might expect one of the two symmetric Nash equilibria to emerge, as the game ends with certainty after 64 rounds. However, as is well known from experimental economics other outcomes regularly emerge.

Focusing on the effect of our pricing rules, it is clear that they do not change the symmetric Nash equilibria nor do they change the collusive outcome. With respect to the Western Australian rule where only one price change per day is allowed the effect on the likelihood of a collusive outcome is ambivalent at the outset. On the one hand, deviation becomes more profitable as one's rivals can only react with some delay. On the other hand, any punishment is also more severe, as one-self cannot react to being undercut. Prices also become easier to monitor as they change less frequently. In this context it is also useful to recollect the theoretical result of Noel (2008) that in retail gasoline markets with more than two players situations can emerge where one firm may first increase its price, but then revert to a lower price if the other firms continue to compete at the bottom of the cycle for too long without following. The incentive to "lead the pack" with a price increase may be reduced if one cannot easily revert to a lower price.

This last point would not concern the Austrian rule where one can easily increase the price and then reduce it again once the rivals do not follow. Hence, a price increase that is not followed by the rivals is less costly and, therefore, a price increase less risky under the Austrian pricing rule. Hence, we would expect prices to be higher on average under the Austrian pricing rule than under the Western Australian rule.

In addition, recent empirical studies on gas station cartels (see Andreoli-Versbach, 2011) as well as on other cartels (see von Blanckenburg, Geist and Koholodilin, 2012) have found that, in order to make monitoring easier, price changes occur less often when markets are cartelized than in competitive markets (also see Noel, 2007a). In line with this research, we

expect the Austrian and the Western Australian rule rather to facilitate than to prevent collusion.

Regarding the Luxembourg rule, previous experimental research by Engelmann and Normann (2009) and Engelmann and Müller (2011) has not found any focal point effect. Hence, we would expect the non-binding price ceiling of an 8 Taler mark-up (which exceeds the two symmetric Nash mark-ups of 5 and 6 Talers) not to have any effect.

4 Results

4.1 Competition Dynamics

4.1.1 Representative Group

Figure 2 shows the retail prices chosen by a representative group of the first treatment (B-B). Mean profits and the dispersion of retail prices are most close to the mean values of all groups of treatment 1, so this one was chosen as a representative group. The orange curve, depicting the mean selling prices per daytime, clearly reveals that prices were almost always chosen below the stage game Nash equilibria, a result that holds for a vast majority of groups within our experiment.

Figure 2: Representative Group in Treatment B-B

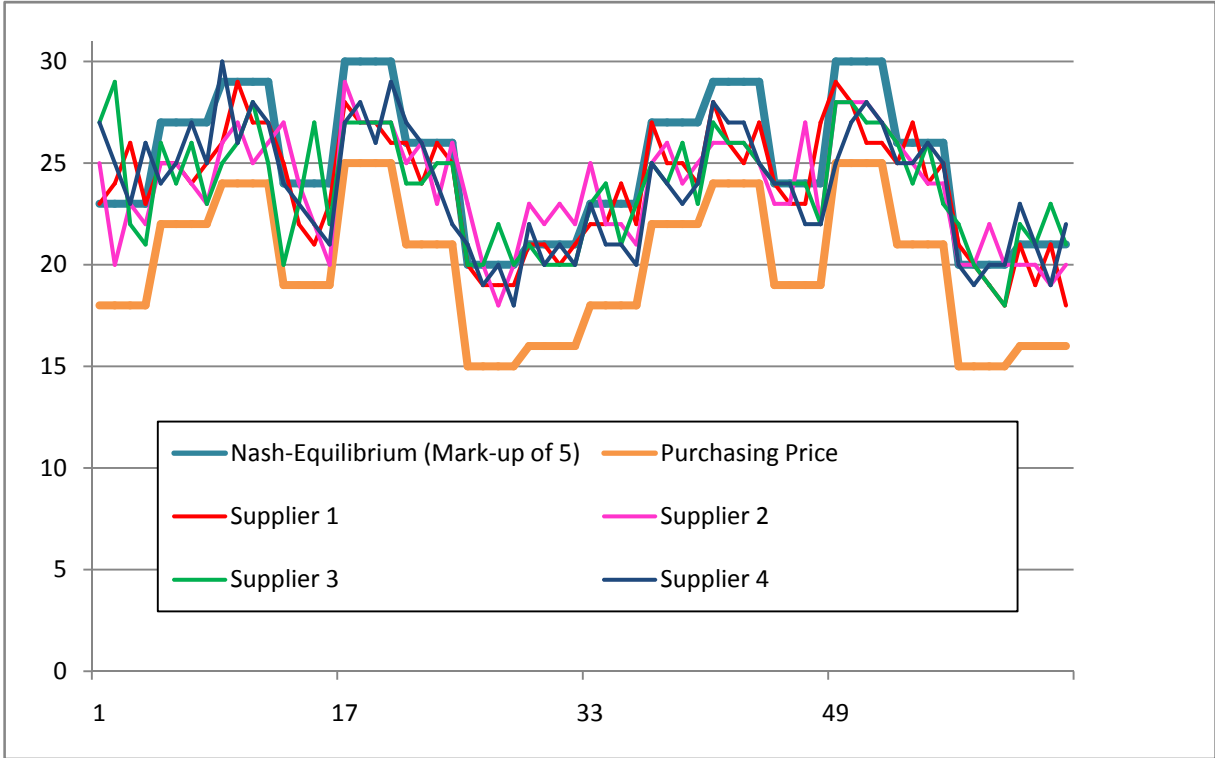
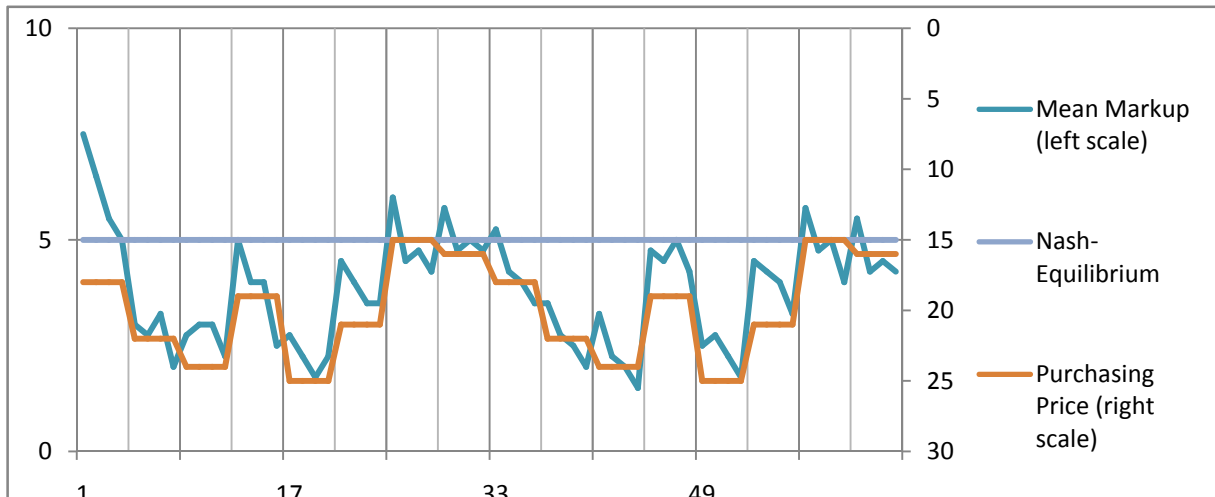


Figure 3 shows the representative group's mean price mark-ups (the difference between retail and wholesale prices). The orange curve depicts the respective absolute wholesale prices on an upside-down scale (right scale). The picture emerges that retail prices developed negatively correlated to the wholesale prices, which is also a common result for other groups. Thus, wholesale price changes were not fully passed through to buyers.

Figure 3: Mark-ups and Wholesale prices

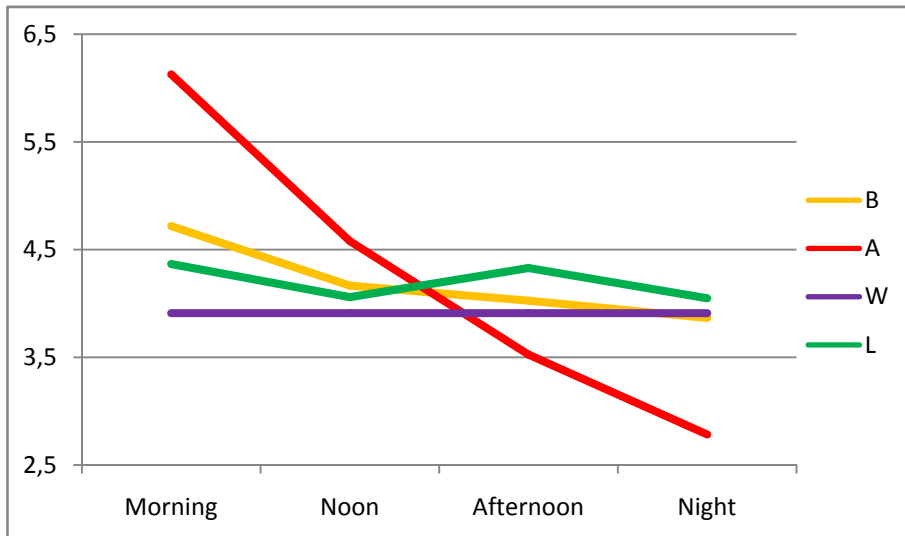


4.1.2 Mark-ups Depending on Time of Day

Figure 4 depicts the mean mark-ups, depending on the implemented pricing rule and the time of day. The red curve, showing the results under the Austrian regime, is by definition downward sloping, since participants were not allowed to increase prices, but had to keep them constant or even cut prices during the day. Nevertheless, the decline is quite large, as the mark-up more than halves from morning to afternoon. The purple curve (Western Australian regime) is by definition flat, since participants were not allowed to change their retail prices during the day.

According to the Bundeskartellamt (2011), it is a common feature of the (German) gasoline market that prices peak during rush-hours, that is in the morning and the afternoon in our setting. Figure 4, therefore, illustrates the experimental results under the Luxemburg rule and the baseline scenario (where price changes are not regulated). As it turns out, the groups under the Luxemburg regime quite accurately followed the path described by the Bundeskartellamt (2011), on average. Mark-ups are high in the morning and in the afternoon and low during low-demand times of day. In the baseline scenario, the picture is less clear. Average mark-ups always drop after the morning, although the difference between noon and afternoon is quite small.

Figure 4: Average Mark-ups under over the day



4.1.3 Focal point

Examining treatments B-L and L-B which both included the Luxembourg rule (either in the first or second round), the maximum mark-up of 8 Taler was hardly ever chosen. In the first phase of the L-B treatment, only 2.5 percent of the mark-ups were equal to 8, while no group ever completely agreed on this maximum mark-up. The picture slightly changes, once the second-phase results of the B-L treatment are taken into account. Here, 18.7 percent of the mark-ups equaled the maximum markup of 8, and there were 29 occasions where entire groups “agreed” on this maximum level. However, this was almost exclusively due to the behavior of one single group which managed to “agree” on the maximum mark-up 20 times in a row. Among all other groups of treatment B-L, only one percent of the chosen markups equaled 8 Taler.

4.2 Consumer Welfare

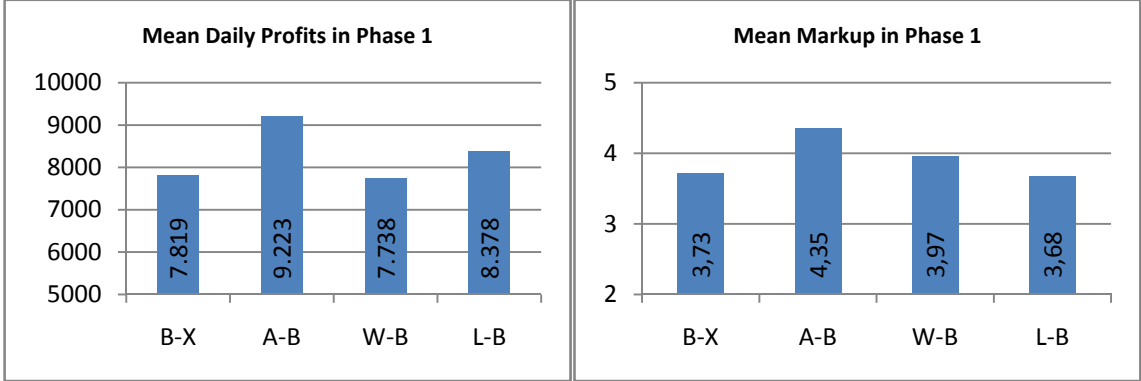
A pricing rule may increase consumer welfare if it results in lower retail prices and, therefore, lower supplier profits. In fact this expectation was the main impetus from a political perspective to implement the rules. This subsection tests the hypotheses that the three price regulation rules meet this requirement. Put differently, the question is whether the rules achieve their political objective.

4.2.1 First Phase Results

We now turn to the comparison between the different treatments and start by comparing the first-phase results. Figure 5a shows the groups’ mean daily profits in phase 1 in

treatments A-B, W-B, L-B and B-X. The latter embraces the treatments B-B, B-A, B-W and B-L, since all these groups started with the baseline scenario game in the first phase. Figure 5b depicts the groups' weighted average daily mark-up. When computing these average daily mark-ups, the mark-ups in the four rounds per days (the daytimes) were weighted by the differing demand levels.

Figure 5a and 5b: Weighted Average Profit and Mark-up in Phase 1



The two figures show that none of the three pricing rules leads to noteworthy improvements for consumers. Suppliers in treatment B-X gained the second smallest average profit (only the groups in Western Australian regime earned slightly less), and they charged the second lowest mark-ups (only the groups in Luxemburg regime charged slightly less).

According to a non-parametric Mann-Whitney test which uses the groups' mean values of phase 1, the groups in treatment A-B made higher profits than those in treatments B-X (weakly significant), while the difference is clearly statistically significant at the five percent level if a two-group mean-comparison T-test is used. Regarding the mean mark-ups, both tests reveal that A-B groups charged higher mark-ups than B-X groups (statistically significant at the five percent level). Comparing the B-X groups to the W-B and L-B groups, respectively, shows no significant differences regarding the groups' mean daily profits or daytime mark-ups.

Figure 6, depicting the groups' mean daily profits (solid lines, left scale) and the weighted average daily mark-ups (spotted lines, right scale), confirms this impression: The red line (Austrian price regime) is almost always above the orange line (B-X), while the others do not seem to differ qualitatively.

Figure 6: Mean Daily Profits and Mark-ups

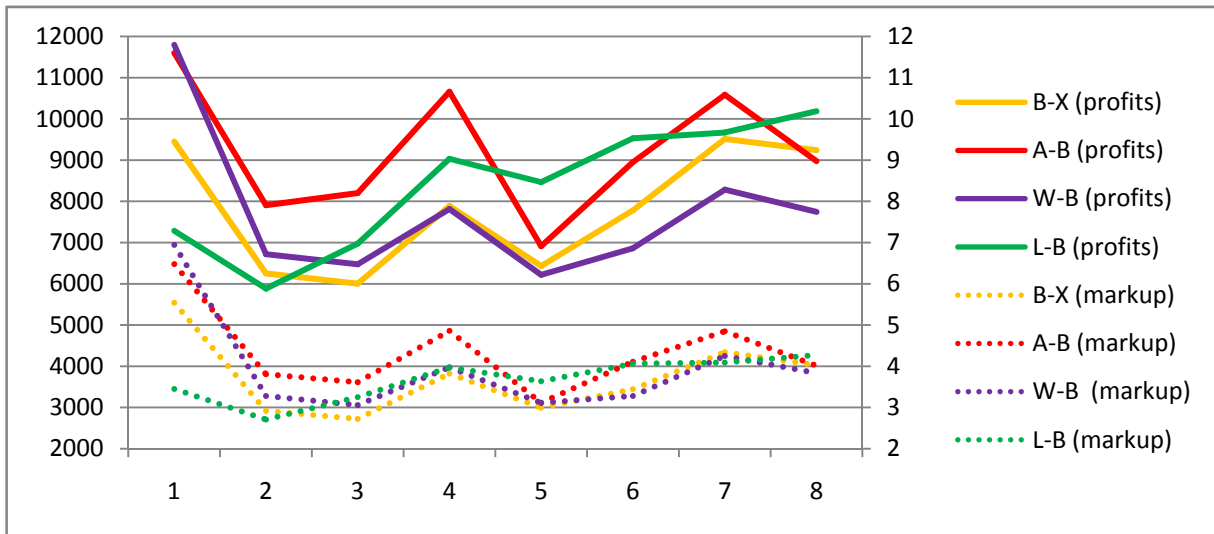


Table 2: Random Effects Panel Model for Phase 1

| Variable | Daily Profits | Daily Averaged Weighted Markups |
|------------------------|-------------------------------|---------------------------------|
| Method | RE | RE |
| Regimes: | | |
| Baseline | (base) | (base) |
| Austrian | 1403.1561** (-0.0414) | 0.6281** (0.0329) |
| W.- Australian | -81.3370 (0.8938) | 0.2394 (0.5008) |
| Luxemburg | 558.2365 (0.4150) | -0.0467 (0.8659) |
| Wholesale Price | - 345.1227*** (<0.0001) | -0.2158*** (<0.0001) |
| Day | -38.8273 (0.6441) | -0.1651*** (0.0000) |
| Constant | 14896.65*** (<0.0001) | 8.7843*** (<0.0001) |
| Observations | 2368 | 2368 |
| Subjects | 296 | 296 |
| Groups | 74 | 74 |
| R2 (overall) | 0.1129 | 0.1263 |
| R2 (within) | 0.1431 | 0.1700 |
| R2 (between) | 0.0567 | 0.0415 |

Our regression analysis further substantiates the impression. Table 2 presents the results of random-effects panel model (with group-clustered standard errors) which we chose to use in order to account for the panel structure of the data. We use the subjects' mean daily profits of the first phase or their weighted average price markup, respectively, as dependent variable.

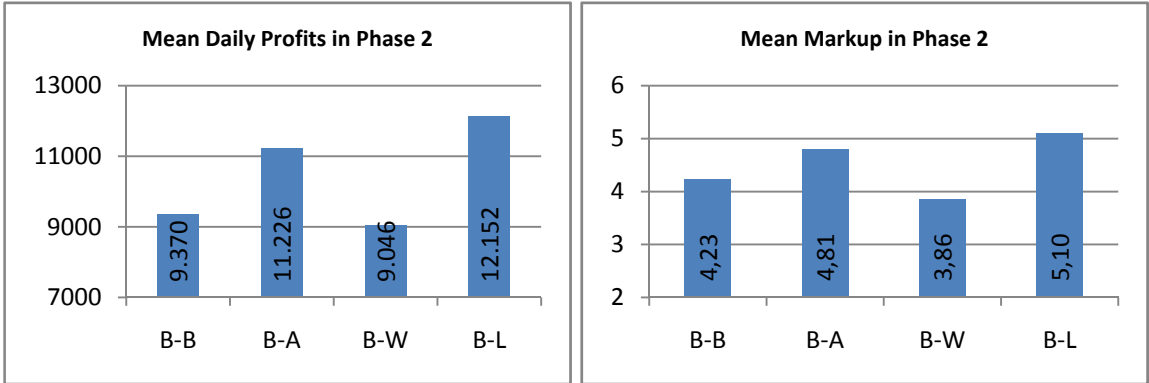
As regressors we include a time trend (since Figure 6 suggests that profits and mark-ups change over time), the corresponding wholesale price (since profits and mark-ups seem to vary inversely proportional to the wholesale price) and dummy variables representing the three pricing regimes.

The regressions reveal that profits and mark-ups are significantly higher in the Austrian regime compared to the baseline scenario: All other things equal, groups in the Austrian regime gain an additional 1,403 Talers per day (i.e., plus 17.9 %) and charge additional 0.63 Talers (i.e., plus 16.9 %). The coefficients further show that, compared to the baseline scenario, profits are higher under the Luxemburg regime, but prices are lower, while the opposite appears to hold for the Western Australian regime. Note, however, that here all coefficients are insignificant. As expected, the wholesale price has a negative influence on profits (highly significant). There is also a negative effect of time on mark-ups.

4.2.2 Second Phase Results

We now compare the second phase results of those treatments which started with the baseline scenario in order to check the robustness of our results. Figure 7a shows the mean daily profits per treatment, while figure 7b depicts the mean mark-ups. A picture emerges that groups under the B-W regime made the smallest profit and charged the smallest mark-ups, followed by the B-B treatment groups. Both the B-A and the B-L treatment groups earn and charge considerably more compared to the two other treatments. Profits and mark-ups were highest in the Luxemburg regime.

Figure 7a and 7b: Weighted Average Profit and Mark-up in Phase 2



Using a non-parametric Mann-Whitney test as well as a two-group mean-comparison T-test reveals that the mean values did not differ between the groups significantly in the first phase. This was expectable, since these groups all started with the baseline game and were not previously told which price-setting regime would later follow in phase 2. Hence, we are largely confident that observed differences are caused by the different pricing rules and not by particular characteristics of the groups.

Comparing the second phase results of the different treatments (group averages), using a non-parametric Mann-Whitney test, reveals that profits were higher in the B-A treatment compared to the B-B treatment (weakly significant), a result which is confirmed by a two-group mean-comparison T-test. According to both tests, mark-ups did not differ significantly. A T-test further finds profits (five percent level) and mark-ups (ten percent level) to be significantly higher in the B-L treatment compared to the B-B treatment, while the Mann-Whitney test reveals no significant differences. Furthermore, both tests reveal no significant differences between the B-B and the B-W treatment.

Figure 8: Mean Daily Profits

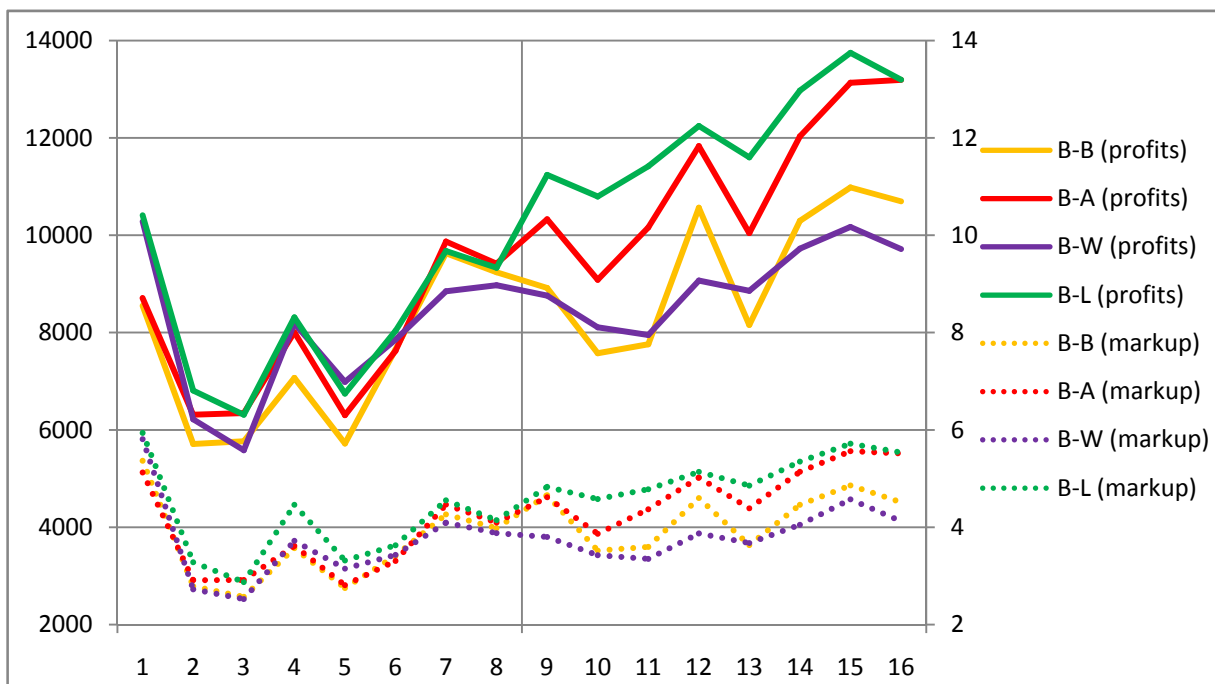


Figure 8, again showing mean daily profits (solid lines, left scale) and the weighted average mark-ups (spotted lines, right scale), further reveals how the treatment-results diverged after the beginning of phase 2. While they were fairly similar in phase 1 (during which the groups of all four treatments played the baseline game), the red (B-A) and the green (B-L) are always located at higher levels throughout phase 2.

Random effects panel regressions with data of the second phase, whose results are presented in table 3, support the previous impression: Compared to the baseline scenario, higher daily profits can be reported for the Luxembourg regime (2782 Talers higher or 29.7 %, all other things equal) and the Austrian (1856 Talers or 19.8 %) regimes (both weakly significant). Also, mark-ups differ systematically. In contrast, the Western Australian regime does not appear to make a difference (no statistical significance).

Table 3: Random Effects Panel Model for Phase 2

| Variable | Daily Profits | Daily Averaged Weighted Markups |
|-------------------------|-------------------------------|--|
| Method | RE | RE |
| Regimes | | |
| Baseline | (base) | (base) |
| Austrian | 1856.2074* (0.0945) | 0.5788 (0.1718) |
| W.- Australian | -324.2212 (0.7409) | -0.3725 (0.3422) |
| Luxemb. | 2781.8435* (0.0519) | 0.8673 (0.1116) |
| Purchasing Price | - 166.3161*** (<0.0001) | - -0.0856*** (<0.0001) |
| Day | 297.5162 (<0.0001) | 0.0846 (0.0160) |
| Constant | 8977.3734 (<0.0001) | 4.8856 (<0.0001) |
| Observations | 1280 | 1280 |
| Subjects | 160 | 160 |
| Groups | 40 | 40 |
| R2 (overall) | 0.2608 | 0.1362 |
| R2 (within) | 0.1916 | 0.1256 |
| R2 (between) | 0.1619 | 0.1188 |

5 Conclusion

Having compared the results of the first and the second phase, the following picture emerges: While it can be reported that the Austrian regime (in both phases) and the Luxemburg rule (only in the second phase) tend to increase mark-ups (and profit levels) compared to the baseline scenario, no significant differences have been found between the Western Australian regime and the unregulated baseline scenario.

Policy makers thus should, therefore, be rather skeptical about the merits of the Austrian or Luxemburg pricing rule. The Western Australian regime does not appear to lead to lower average prices and profit level either, but, at least, it does not appear to harm consumers.

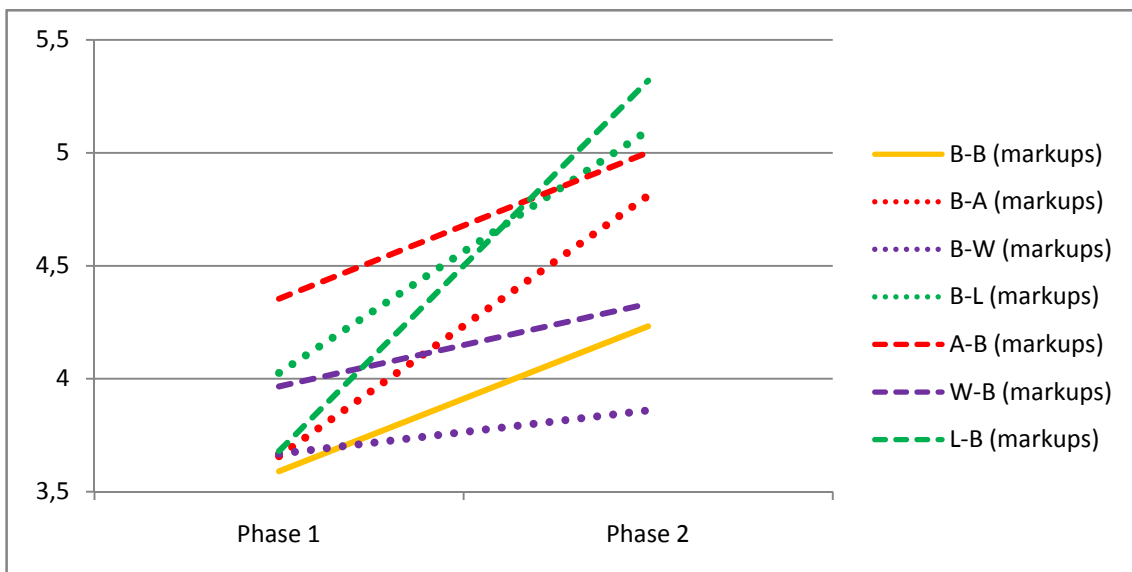
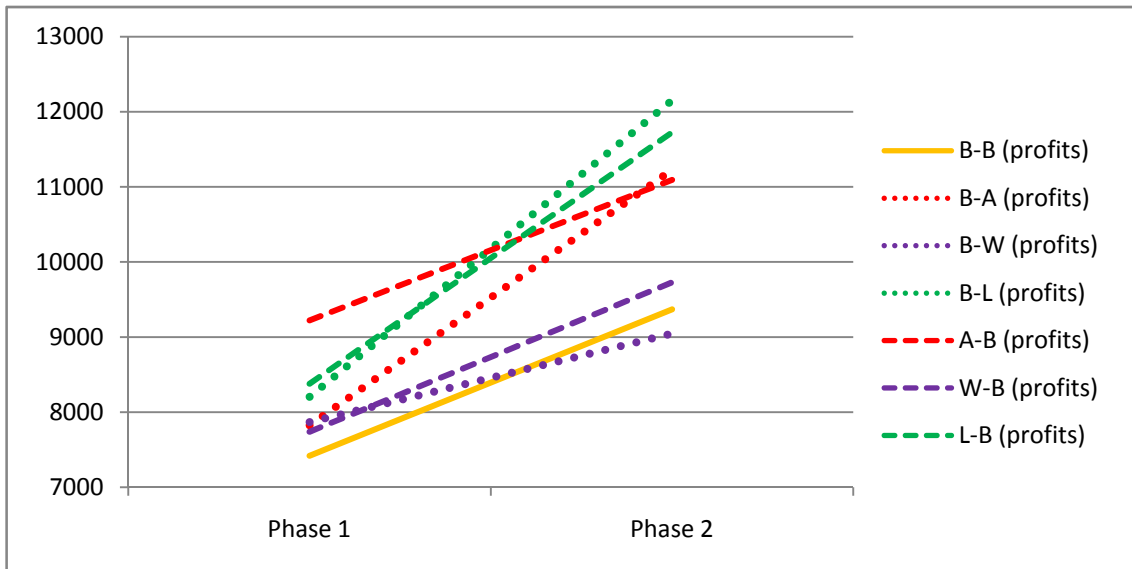
Regarding the focal point theory, our experimental results are somewhat surprising. Although summary results in subsection 4.1.3 suggested that the maximum mark-up in the Luxemburg regime does not serve as a focal point, since the maximum mark-up was hardly ever chosen, it turned out that profits were (at least weakly significantly) higher compared to the baseline scenario in the second phase. Thus, one might conclude that although a maximum mark-up does not make suppliers to choose exactly this maximum mark-up, it may still induce suppliers not to undercut the focal point by too much, thereby leading to higher profits than in the non-regulated market.

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Appendix

Figure A1: Average Profits and Mark-ups



Instructions (B-A Treatment)

Welcome to this experiment! Thank you for your participation!

This is an experiment about decision making. During the experiment, please do not talk to the other participants in the room. If you have any questions, please raise your hand, then we will come to your place.

After the experiment you will be rewarded according to your performance in the experiment. You will receive the respective payment in cash.

Structure of the experiment:

The experiment consists of two phases. The instructions you are currently reading only pertain in the first phase. After the end of the first phase, we will stop the experiment and distribute the instructions for the second phase. After the end of the second phase, we will kindly ask you to fill in a questionnaire. Afterwards, we will pay you the amount of money that you won.

The first phase consists of eight game-"days", which in turn consist of four "daytimes" (morning, noon, afternoon and night). Altogether, you have to make 32 decisions in the first phase.

Your task:

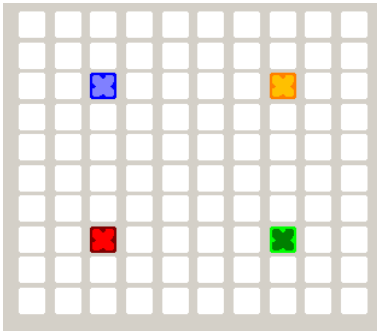
Your role in this experiment is that of a seller. You buy a fictional product at purchase price and sell it at your chosen sale price on to the buyer. Within your group, there are three other sellers. The game currency in this experiment is called Talers.

Any buyer who buys from you earns you a profit which is equal to the difference between the sale and purchase price. You may choose any sale price that is less than the purchase price.

The purchase price you have to pay does not differ from the price that has to be paid by the other sellers in your group. However, the purchase price will change on every game-day. On top of the screen, the currently valid purchase price will be displayed.

The three other sellers in your group were chosen randomly selected and are also located somewhere in this room, but you do not know them. In both phases of the experiment you are playing against the same three other sellers.

The buyers:



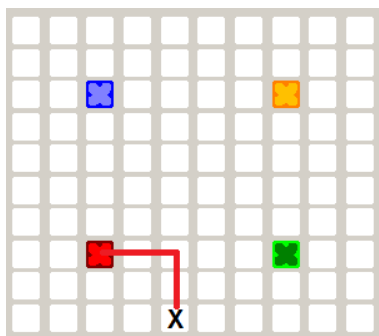
The buyers will be played by the computer. They live on a quadratic field, which consists of 100 points (see left). 100 buyers live on every point, so there are a total of 10,000 buyers. The colored dots mark the shops where the sellers sell their products. At the top of the screen, you can see which shop belongs to you (ie, what color is your shop). The color and the location of your shop does not change during the entire experiment.

At every game-day, each buyer wants buy exactly time and one good. However, not all buyers go shopping at the same time of day: In the mornings and in the afternoons, the number of buyers is greater than at noons or in the nights.

The exact distribution is as follows: 35 percent of buyers go shopping in the morning, 20 percent at noon, 35 percent in the afternoon and 10 percent at night. Thus, the number of buyers is 3500 in the mornings and in the afternoon, 2000 at noons and 1000 at night.

Each buyer buys only if total buying costs are no greater than the amount of money that it is available per day. This amount is called "maximum willingness to pay" and equals 40 Talers. The total buying costs consists of the selling price and the individual transportation costs. These transportation costs are the higher the further a buyer has to travel to a shop. Each step from one point to the next one will cost the buyer one Taler of transportation costs. A buyer can only travel horizontally or vertically, but not diagonally.

Example: A buyer on the point marked with "X" wants to buy at the red store. She has to run four fields to get there. The transportation cost in this case is four Talers.



A buyer will always automatically go to the shop, which holds the best offer for him ready. That means he will choose the shop where the sum of selling price and individual transportation costs is the smallest.

Once a buyer would have to pay more than 40 Talers even at the shop with the best offer, she will not go shopping at all. When the buyers living at one point would have to pay the same total buying costs at two or more shops, the buyers will

split up equally between the respective shops.

Procedure of Phase 1:

You and the other three sellers of your group always have to choose a selling price simultaneously. Therefore, the input screen pops up where you please type in your chosen selling price. Afterwards, please confirm with a click on "OK". By the time all sellers have chosen a price, the computer calculates how the buyers are distributed to the four shops.

Afterwards, you will see the results screen. Here, the prices of all four sellers are listed, further the number of buyers who bought at your shop and how much profit you have made. Your profit at a particular daytime is calculated on as follows:

$$\text{Profit} = (\text{selling price} - \text{purchase price}) \times \text{number of buyers}$$

In addition, your total profits are listed. On the right side of the results screen, you also see a figure that depicts how the buyers are distributed to the individual stores. The graph therefore represents the respective market shares. A point on the field always represents exactly one percent market share. The color of a field indicates, to which shop the buyers went who are living on this particular point. A gray point means that the buyers have split up between two or more shops, since their total buying costs were exactly identical. A white point means that buyers did not go shopping at all, since their total buying costs were higher than the maximum willingness to pay of 40 Talers.

After the results screen is displayed, the next daytime begins and you must select a selling price again.

End of the experiment:

After the end of the second phase, we ask you to fill in the receipt we passed out to you as described on the screen. Afterwards, we kindly ask you to answer the questions of the questionnaire. Following this, we will pay out your total profit in cash. The total profit is converted into Euros at an exchange rate of

$$10,000 \text{ Talers} = 1 \text{ euro}$$

The euro amount is rounded up to the next higher 50-cent amount. In addition to your total profits, you will receive a show-up fee of four Euros for participating in the experiment.

If you still have questions, please hold your arm out of the cabin!

Instructions of phase 2:

The second phase of the game is constructed identically to the first, with one exception:

You can only increase your selling price in the mornings. Afterwards, you are only allowed to keep your selling price constant or reduce it.

You may therefore continue to freely choose a sale price on each morning. But on the following three daytimes of a day (noon, afternoon and night), you must not choose a selling price which is greater than that the selling price of previous daytime.

If you still try to choose a forbidden selling price, a message appears telling you that this is not possible. However, you can then choose a correct price.

The second phase again lasts eight game-days, which in turn consist of four daytimes each. Thus, you have to choose a selling price 32 times again.

If you still have questions, please hold your arm out of the cabin!

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