ON THE EFFECTS OF SUGGESTED PRICES IN GASOLINE MARKETS

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Abstract. Oil companies announce suggested prices for retailers in the Dutch gasoline market. In the absence of these suggested prices, retailers could also form expectations regarding competitors' price changes by using the publicly available gasoline spot market price. We show that suggested prices contain, compared to the spot market price, additional information that explains retail price changes. We conclude that suggested prices reduce strategic uncertainty in the retail market and give retailers mutually consistent expectations concerning prices of competitors.

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1. Introduction

The boundary between price setting under normal competitive conditions and price coordination is often not clear. This boundary is particularly unclear in case of suggested prices. There is a widespread suspicion that suggested prices distort the normal functioning of markets (see, e.g., Carlton, Gertner, and Rosenfield (1997), Kühn (2001), Motta (2004), and Buccirossi (2008)). An essential element of the competitive process is that firms are uncertain about strategic variables that competitors choose (such as price or output). Under normal competitive conditions, firms have to choose their strategies not knowing the strategies chosen by rival firms. Suggested prices may increase market transparency and hence limit uncertainty about the prices that rivals will choose. They may act as a focal point by creating mutually consistent expectations regarding rivals' prices as the suggested price stands out among all possible prices that firms can choose. Therefore, suggested prices may have a coordinating effect on prices. To our knowledge, the basis for this hypothesis so far is anecdotal evidence and tests in an experimental setting (see, for example, Holt (1995) and Cason (2008)).[1] This paper performs an empirical analysis testing whether suggested prices reduce uncertainty of firms concerning competitors' prices by using data on the Dutch gasoline market.

We define suggested prices as prices that are announced with the recommendation for retailers to follow them. Suggested prices can be chosen by professional organizations or producers higher up in the product chain. Suggested prices can be communicated openly via websites or can remain more hidden, via letters or e-mails sent only to retailers. Depending on

[1] Knittel and Stango (2003) quantify the impact of focal points on price setting via a study on government imposed nonbinding price ceilings in the American credit card market. Foros and Steen (2011) study Norwegian gasoline prices and find weekly price cycles. They argue that the suggested price and retail price are related on the first day of a cycle. Hofstetter and Tovar (2010) study a suggested price for gasoline that the Colombian government announces on a monthly basis. They find that this suggested price has an impact on how retailers adjust their prices after a change in costs. Carlton and Chevalier (2001) compare prices of internet shops to suggested prices. Marshall, Marx, and Raiff (2008) study public price announcements of firms. Albæk, Møllgaard, and Overgaard (1997) relate the degree of price transparency in a market to price setting of firms. Colangelo and Martini (2007), Buehler and Gärtner (2009), Lubensky (2010), and Puppe and Rosenkranz (2011) study suggested prices from a theoretical perspective.

the sector, suggested prices can be changed either infrequently or on a daily basis. Suggested prices are not binding in any legal way and retailers are free to deviate and charge higher or lower retail prices as they wish. As such, they are different from minimum or maximum prices.

There are quite a few cases where different competition authorities have argued that by setting suggested prices, companies or professional organizations have violated competition law. Recently, for example, the Dutch competition authority (NMa) decided that several professional organizations for psychologists and psychiatrists were guilty of violating competition law as they advised their members via their website how much to charge per hour given the costs members typically would encounter.[2] What, according to the organization, was meant as an aid to their members, was judged by the NMa as a way to coordinate pricing decisions of individual entrepreneurs above competitive levels. The NMa argued that suggested prices helped to considerably reduce the uncertainty concerning competitors' price setting behavior. Uncertainty concerning competitors' main strategic decision variable was considered to be a crucial element of a normal competitive process. The decision of the NMa was based, among other things, on EU decisions (e.g., concerning suggested prices in the crane renting sector) taken already as early as 1995.[3]

A similar ruling was made in a private U.S. case on petroleum products.[4] The complaint was that oil companies conspired to raise or stabilize prices by disseminating information concerning wholesale and retail prices, with the purpose of quickly informing competitors so that they could follow suit. The court mentioned in its judgment that it did not see any other business purpose than to facilitate interdependent or collusive interaction.

[2] See NMa decision case 3309/NIP, LVE, NVP, and NVVP 2004. The decision has been successfully challenged by the professional organizations involved. In a decision on 6 October 2008 the court of appeal (CBb) cancelled the decision on the basis that it was not clear that the price was a decisive factor in the decision process of consumers while choosing a psychologist (LJN: BF8820, CBb, AWB 06/667).

[3] See, e.g., XXVth Report on Competition Policy 1995, European Commission, p. 118.

[4] See, e.g., In re Coordinated Pretrial Proceedings in Petroleum Products Antitrust Legislation 906 F.2d 432 1990 and Hay (1999). Borenstein (2004) and Miller (2010) study another related case.

As far as gasoline markets are concerned, suggested prices are quite common in many countries, such as the Netherlands, Norway, Sweden, Austria, and Italy.[5] Typically, large oil companies announce on their websites on a daily basis the prices they advise retailers to set for their gasoline.[6] Retailers are free to deviate from these prices. The gasoline retail market is a good example to study the effects of suggested prices for the following reasons. Gasoline stations change their price several times a week due to daily fluctuations in the gasoline spot market price. Moreover, each station has a substantial number of competitors. Furthermore, as the existence of suggested prices is not a secret, competition authorities apparently think they do not obstruct the competitive process in this particular market (see also OECD (2001)).

Whether suggested prices reduce uncertainty of stations regarding their competitors' price changes depends on the degree of uncertainty that stations would have in case suggested prices would not exist. In that case, stations can use the gasoline spot market price to form expectations about price changes of their competitors. The spot market price is public information and a clear alternative focal point for price changes (because it is the major variable cost for a liter of gasoline). Other focal points do not seem to exist. For example, the wholesale price is not a potential focal point since it is not public information, it differs between stations and oil companies, and not all stations buy gasoline on the same day.

Therefore, the main question this paper addresses is whether suggested prices allow gasoline stations to form more precise expectations about their competitors' price changes than the spot market price would. In other words: do suggested prices provide individual stations with information that helps to predict the size and timing of competitors' price changes that would not be publicly known if suggested prices would not exist? An additional issue we address is the role of multiple suggested prices. In the gasoline market, each large oil company sets its

[5] Recently, oil companies in Italy decided not to publish suggested prices anymore after an investigation of the Italian competition authority (see Autorità Garante della Concorrenza e del Mercato, press release number 5/2007 (I681 - Retail fuel prices) and 92/2007 (Fuel: oil companies' commitments accepted)).

[6] See, e.g., the website of BP for the Netherlands, the website of Statoil for Sweden, and the website of OMV for Austria.

own suggested price. We can thus distinguish between a reduction in strategic uncertainty across stations of all brands and across stations of the same brand.[7]

To analyze these questions, we use panel data techniques on a Dutch data set consisting of daily retail prices of almost all gasoline stations and suggested prices of the five largest oil companies over more than two years. We find that suggested prices contain information that is not present in the spot market price and that explains retail price changes. Both the additional information that is only present in the brand-specific suggested price and the additional information that is common in the suggested prices of all oil companies explain price changes of stations. We conclude that suggested prices reduce the strategic uncertainty concerning rivals' prices, both across all brands and within brands.

We do not exclude the possibility that *individual* stations already know (a part of) the additional information in suggested prices before oil companies make this information public. For example, the additional information in suggested prices that is also present in retail prices may reflect (opportunity) costs of a station (e.g., the wholesale price that it pays to its oil company) or demand factors (e.g., the weather). However, before oil companies have published this information, an individual station does not know that other stations are aware of the same information and that other stations consider it in the same way relevant for their price setting. Moreover, once the information is public, a station also knows that all other stations understand that it is aware of this information. Therefore, even if individual stations already know the additional information contained in suggested prices, then suggested prices still reduce strategic uncertainty regarding rivals' prices by making this information public.

In a different context, a large part of the EU horizontal guidelines are devoted to information exchange between parties (European Commission (2011)). Even though these guidelines

[7] Some oil companies claim to use suggested prices to assist retailers by informing them how they could price their product in view of the frequent changes in the spot market price (see, e.g., the Shell website and Shell (2001)). If suggested prices only reflect changes in the spot market price, then the existence of suggested prices would not reduce uncertainty of stations compared to the situation without suggested prices since the spot market price is already public information. In most other markets (such as the psychologists mentioned before) a clear alternative focal point does not exist.

concern horizontal practices and thus by their very nature differ from the vertical practice of suggested prices, the thrust of the argument is similar. One of the main concerns of the guidelines is that "Information exchange can create mutually consistent expectations regarding the uncertainties present in the market. On that basis companies can then reach a common understanding on the terms of coordination of their competitive behaviour, even without an explicit agreement on coordination." (European Commission (2011, p. 15)).

The rest of the paper is organized as follows. Section 2 describes the relevant aspects of the Dutch gasoline market and the way oil companies set and communicate suggested prices. Section 3 provides details on the data set and gives some descriptive statistics. Section 4 discusses our methodology and Section 5 presents the main results. Section 6 discusses the results. Section 7 concludes.

2. The Dutch gasoline market and suggested prices[8]

There are around 4,300 gasoline stations in the Netherlands with the five largest oil companies (BP, Esso, Shell, Total, and Texaco) having a total market share of around 60% (measured as the total number of stations using the brand of these five oil companies divided by the total number of stations). Shell is the largest oil company with a market share of around 15%. Roughly speaking, there are three types of ownership models: some stations (including almost all the larger stations along highways) are company-owned and company-operated (coco), other stations are company-owned and dealer-operated (codo), and the remaining stations are dealer-owned and dealer-operated (dodo). Coco stations are not free to set their own gasoline prices: these prices are set by the oil company. Dealers of codo stations rent the station from the oil company, but are free to set their own prices. Finally, dodo stations operate most independently from the oil companies and also set their own prices.

[8] Unless mentioned otherwise, the source of the data in this section is BOVAG (2006).

Approximately 60% of the stations are dealer-owned. We do not know exactly how many stations are dealer-operated, but a rough estimate indicates that about 80% are.

Euro95 and Diesel are, with respectively 38% and 54% of all sold liters, the most important gasoline products. There is a close relation between input prices for gasoline and international spot market prices. Although the large oil companies are fully integrated from extracting oil to selling gasoline, the Dutch gasoline sales divisions mainly buy their gasoline at the Amsterdam-Rotterdam-Antwerp (ARA) spot market which supplies large parts of western Europe. A price for this spot market is published once a day. On its website, Shell claims that even if the Dutch sales division buys gasoline from a production division, it uses this spot market price as internal price.

2.1 Suggested prices

For each gasoline type, the larger oil companies quote one national suggested price that they calculate on a daily basis. Oil companies differ in the way they make these suggested prices public. Some publish them on their website, others do not.[9] Nevertheless, all these suggested prices are publicly available since they are published every day on the websites of the ANWB (the Dutch automobile club with almost 4 million members) and United Consumers.[10] In practice, suggested prices act as reference prices. Stations decide whether to give a "discount" compared to this reference price. They advertise this "discount" explicitly (whatever the level of the suggested price may be), for example, via a sign along the road.

Shell has explicitly claimed that it uses the suggested price as a way to make gasoline spot market price changes transparent to its dealers. It also published detailed descriptions on how it calculates the suggested price (see, e.g., Shell (2001) and the Shell website). Shell claims

[9] BP and Total publish suggested prices on their websites. Shell published suggested prices on its website until 15 March 2006. Esso and Texaco do not publish suggested prices.

[10] This latter site also links the prices to other websites like the website of a car magazine and nu.nl, a news website that is the tenth most visited website in the Netherlands.

that every morning it takes the spot market price of the previous day (which is the most recent price available) and that it adds different taxes and margins (for transport, sales costs, etc.) to come up with a price it thinks gasoline stations should charge for their gasoline. If this price differs from the current suggested price, a pricing committee meets to determine whether it changes the suggested price and by how much. If the committee decides to change the suggested price, the oil company communicates the new suggested price (which is valid from the next day onward) via fax and e-mail to all dealers in the evening. Dealers can then update their retail prices the next morning. If oil companies indeed follow this decision process, the delay between changes in the spot market price and prices at stations is exactly two days.

3. Data description and first results

Gasoline retail prices are published daily on the website of Athlon Car Lease. This company leases cars to other firms including a so-called "fuel card". If the driver fills up his car with gasoline, he shows the card to the station and the retailer electronically sends the bill with price and quantity information to the lease company at the same time. As a result, Athlon Car Lease obtains gasoline price notations from 120,000 drivers, who fill up on average twice a week, from all over the Netherlands. Athlon Car Lease puts the data on gasoline prices on its website and we have downloaded the data daily over the period 30 May 2006 - 20 July 2008. The data set includes about 3,600 of the approximately 4,300 gasoline stations in the Netherlands. Stations that the data set does not include seem to be mostly smaller and nonactive stations randomly distributed over the country. Data are available for seven different types of gasoline: Euro95, Diesel, Super, Super Plus, Special Euro95, Special Diesel, and untaxed Diesel. We focus our analysis on Euro95 and Diesel since these are most common. The whole data set contains approximately 6,000 unique price quotations per day.[11] For each combination of station and gasoline type, we have a maximum of one price

[11] Only a couple of observations in the data set are suspicious. There seem to be a few cases where a certain type of gasoline is reported as another kind of gasoline. We deleted these quotations.

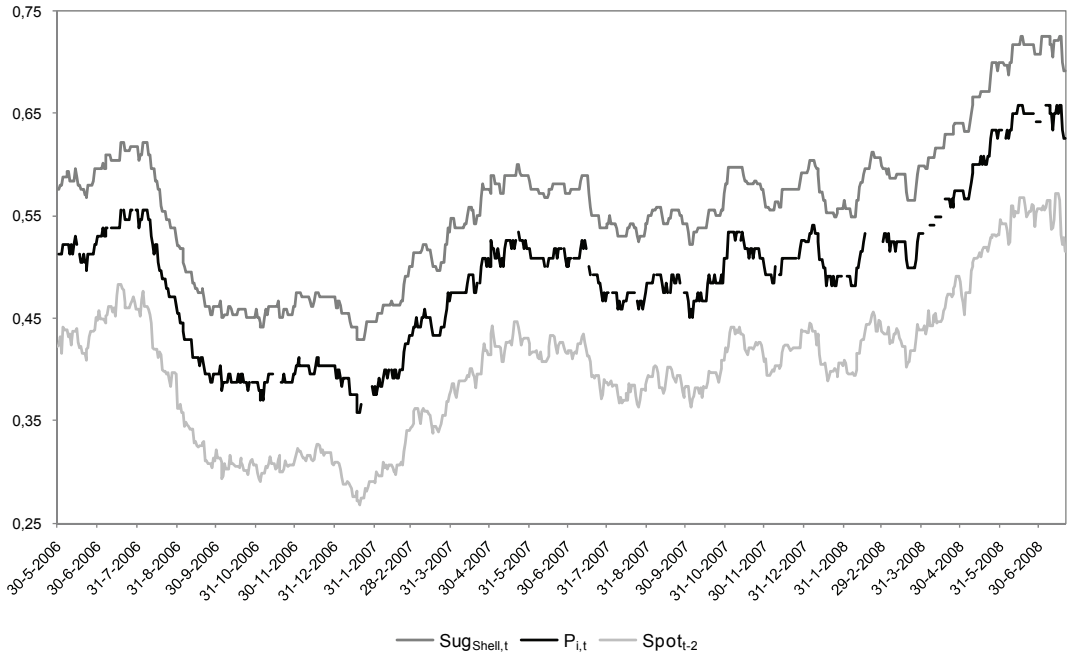
quotation per day. Since less busy stations have a lower probability of being visited by a driver of Athlon Car Lease, the data set contains more quotations of busier stations. This fact does not impact our analysis, however, as there is no indication that the pricing decisions of larger gasoline stations differ significantly from that of smaller ones (after correction for ownership structure). Finally, drivers do not have to pay for the gasoline (because the firm that employs the driver does). So these drivers do not avoid more expensive stations. Casual observation shows that they also do not avoid cheaper stations.

We matched individual stations in the data set to lists of station-specific characteristics, namely owner and brand of a station and whether a station is located along a highway.[12] We do not have data on the operator of a station. However, since we do know the ownership structure, we are able to filter out the stations where an oil company decides on the price.

During the sample period, we downloaded the suggested prices from the website of United Consumers. This website contains daily suggested prices of the five largest oil companies. The spot market price that we use is the daily Platt's Barges FOB Rotterdam High (series: Premium Gasoline 10 PPM for Euro95 and Diesel 10 PPM for Diesel). Shell uses the same notation for calculating the suggested price (Shell (2001)). The websites of the European Central Bank and the Dutch Ministry of Finance provided respectively the dollar-euro exchange rate and data on taxes. We converted all gasoline prices to prices per liter (*excluding taxes*) in euros.

[12] We obtained data on the ownership structure and brand of a station from Catalist (a company collecting data on gasoline stations) and a list with highway stations from the Dutch Ministry of Finance. It may be that stations change their brand or ownership structure during the sample period. As we do not have information on these possible changes (and no indication that they occur regularly), we assume that stations do not change their brand and ownership structure.

Figure 1 Shell suggested price, retail price of a representative Shell station, and spot market price for one liter Euro95



Notes: T=783, price in euros per liter (excluding excise duty and VAT).

3.1 A first look at the data

Figure 1 shows the development over time of the two-day lagged spot market price, the retail price of a representative Shell station, and the Shell suggested price for one liter Euro95 during the sample period. Figure A1 in Appendix A shows the same data for Diesel.

For illustration purposes, we plot some figures with Euro95 prices over the last 100 days of the sample. Figure 2 shows the difference between the retail price and the Shell suggested price for four selected dealer-owned Shell gasoline stations. The figure suggests that the retail price of these four stations equals the suggested price minus a constant on almost every day. Figure 3 shows the difference between the retail price of the same four gasoline stations and the two-day lagged spot market price. Taken together, Figure 2 and 3 show that the difference between the suggested price and retail price is more stable than the difference between the retail price and spot market price. This observation gives some indication that the Shell

suggested price contains information that is not present in the spot market price but that helps to explain the prices of these four gasoline stations.

We are interested in whether suggested prices reduce uncertainty of stations concerning prices of other stations (both of stations with the same brand and of stations with other brands). This would be the case if (i) all suggested prices contain, next to the two-day lagged spot market price, the same information, and (ii) this additional information explains retail prices. In that case, stations can predict prices that other stations will choose by observing the suggested price of their oil company. Figure A2 in Appendix A shows the difference between the suggested price and spot market price for all five oil companies. The figure also contains for each oil company the difference between the average of the suggested prices of the other four oil companies and the spot market price. The figure shows that oil companies often introduce the same additional information in their suggested prices. Over the whole sample, the suggested price of at least four (or *all* five) oil companies differs in exactly the same way from the two-day lagged spot market price on 61% (32%) of the days. So it seems that there is a strong common component in the suggested prices. This observation explains why suggested prices may reduce uncertainty across brands.

Figure 4 shows the difference between the retail price of the four selected Shell stations and the average of the suggested prices of the other four oil companies. This average is a proxy for the information that is common in all suggested prices. Figure 3 and 4 show that the difference between the retail price and the common information in all suggested prices is more stable than the difference between the retail price and the spot market price. The common information in all suggested prices explains the retail prices of the four stations better than the spot market price does. This first look at the data suggests that suggested prices reduce uncertainty concerning prices of other stations regardless of the brand these stations have. In combination with Figure 2, Figure 4 shows that the difference between the retail price and the Shell suggested price is more stable than the difference between the retail price

Figure 2 Retail price - Shell suggested price (Euro95, for four Shell stations)

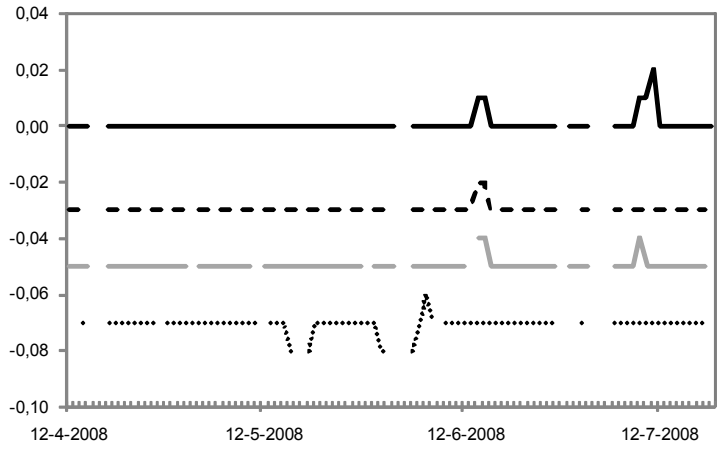


Figure 3 Retail price - spot market price (Euro95, for four Shell stations)

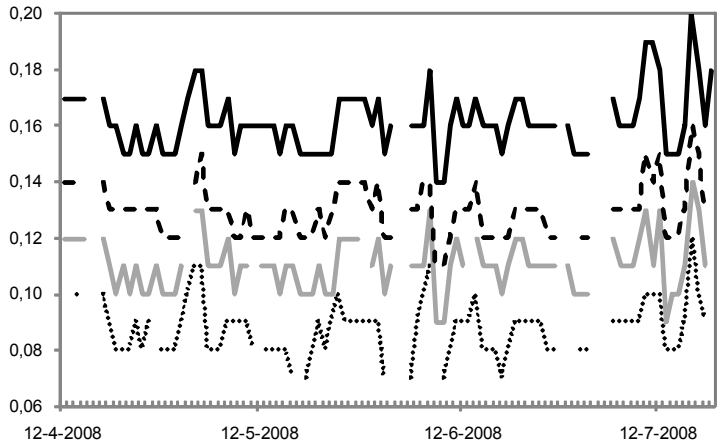
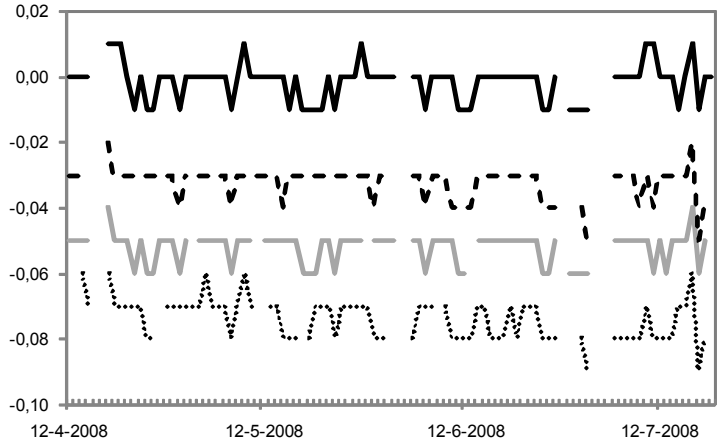


Figure 4 Retail price - average of the suggested prices of the other four oil companies (Euro95, for four Shell stations)



and the common information in all suggested prices. Thus, the Shell suggested price explains the retail prices of the selected Shell stations better, suggesting that the reduction in uncertainty concerning the prices of stations with the same brand is even stronger. We will study these observations in a more structured way in Section 4 and 5. Appendix B provides more descriptive statistics on the similarity of changes in suggested prices and retail prices.

4. Methodology

As explained in the introduction, we investigate whether the existence of suggested prices reduces the uncertainty concerning competitors' prices that stations have when they set their day-to-day prices. Suggested prices reduce uncertainty if they contain, next to the spot market price, information that explains retail prices. If this is the case, stations can make more accurate predictions about competitors' prices by observing the suggested price of their oil company.

We divide the suggested price of an oil company into three parts: (i) the spot market price, (ii) a common component that is present in the suggested prices of all oil companies (next to the spot market price), and (iii) a brand-specific part. We test which parts of suggested prices explain retail price changes.[13]

Whether the existence of suggested prices reduces uncertainty of stations concerning prices of competitors, depends on the part of the suggested price that explains retail price changes. If changes in retail prices only reflect changes in the part of the suggested price that represents the spot market price, then suggested prices do not *further* reduce uncertainty. Stations could use changes in the publicly observable spot market price as effectively to reduce uncertainty. If changes in retail prices reflect changes in the common component of the suggested prices,

[13] We focus on the relation between suggested prices and retail price changes (and not retail price levels). There exists an alternative focal point for changes (the spot market price), but this alternative does not exist for levels. As a result, we cannot formulate a hypothesis on what would happen to retail price level uncertainty in a situation without suggested prices.

then suggested prices reduce uncertainty of stations concerning prices of other stations regardless of their brand (since in this case all retail prices change in the same way as suggested prices, but in a different way than the spot market price). Finally, if changes in retail prices reflect changes in the brand-specific part of the suggested price, then suggested prices reduce uncertainty of stations concerning prices of stations with the same brand (since in this case retail prices of stations with the same brand change in the same way as the suggested price of their oil company).

We model the relation between the retail price and the three different parts of the suggested price via a conditional error correction model:

$$\Delta P_{i,t} = \sum_{k=1}^{q} \alpha_k \Delta P_{i,t-k} + \sum_{k=0}^{r} \beta_k \Delta Spot_{t-2-k} + \sum_{k=0}^{r} \gamma_k \Delta(\overline{Sug}_{-i,t-k} - Spot_{t-2-k})$$

$$+ \sum_{k=0}^{r} \lambda_k \Delta(Sug_{i,t-k} - \overline{Sug}_{-i,t-k}) + \phi_1[P_{i,t-1} - Spot_{t-3}]$$

$$+ \phi_2[P_{i,t-1} - \overline{Sug}_{-i,t-1}] + \phi_3[P_{i,t-1} - Sug_{i,t-1}] + \eta_i + \varepsilon_{i,t} \qquad (1)$$

where $P_{i,t}$ is the retail price of one liter of gasoline at station *i* on day *t*, $Spot_{t-2-k}$ is the gasoline spot market price on day *t*-2-*k*, $\overline{Sug}_{-i,t-k}$ is the average of the suggested prices of all oil companies other than the oil company of the brand of station *i* on day *t*-*k*, and $Sug_{i,t-k}$ is the suggested price of the oil company of station *i* on day *t*-*k*.[14] Finally, η_i is a station-specific effect and $\varepsilon_{i,t}$ is the error term which is allowed to be heteroskedastic (both across stations and time), serially correlated, and cross-sectionally correlated (contemporaneous and lagged).[15] All prices are measured in euros per liter and are excluding excise duty and VAT.

[14] We choose a linear relationship instead of a log specification because the data show that the absolute differences between retail prices, suggested prices, and the spot market price are stable and independent of the level of the spot market price (see Figure 1 and also Borenstein, Cameron, and Gilbert (1997)).

[15] Contemporaneous correlation might, for example, exist because of errors in the suggested price data. If the brand-specific suggested price is important for explaining the retail price of each station and if there is an error in the data for the suggested price of a certain oil company on a certain day, the price of all stations with that brand will deviate from the predicted price in the same manner.

As mentioned before in Section 2, we delay the spot market price with two days, since this is the relevant input price for the suggested price.[16]

First, we motivate why we choose a conditional error correction model. All four price series ($P_{i,t}$, $Spot_{t-2}$, $\overline{Sug}_{-i,t}$, and $Sug_{i,t}$) are integrated of order 1.[17] From Figure 1, it seems that there is one single stochastic trend driving the four price series. In fact, given the strict order in which the prices are set, it seems appropriate to consider the spot market price as the underlying stochastic trend. In other words, there seem to be three stationary cointegrating relations between these four price series. These three linear combinations of price series are not uniquely defined, but can be expressed in many ways. Therefore we choose an expression that is easy to interpret. Our single-equation approach is appropriate due to again the strict order in which the prices are set (on day *t*-2 the spot market price, on day *t*-1 suggested prices, and on day *t* retail prices). Endogeneity issues between retail prices and the other variables are not important, i.e., the explaining variables are really exogenous with respect to retail prices.

Second, we explain how to interpret Equation (1). In Equation (1) the change in the retail price depends on the previous change in the retail price, the current (and previous) change in the different parts of the suggested price, and the error correction terms. We first discuss the direct impact of changes in the different parts of the suggested price on retail price changes. In Equation (1), the second term denotes the part of the suggested price that reflects spot market price changes. The variable $\overline{Sug}_{-i,t-k}$ proxies the information that is common in all suggested prices. So the third term, $(\overline{Sug}_{-i,t-k} - Spot_{t-2-k})$, is a proxy for the information that all oil companies introduce in their suggested price over and above the spot market price (the common component of the suggested prices). If the coefficients γ are positive and significant, retail price changes contain information that is present in the suggested prices of

[16] The suggested price has the highest correlation with the spot market price if we use a two-day lag.

[17] Augmented Dickey-Fuller unit root tests indicate that the two-day lagged spot market price, the suggested prices of the five oil companies, and the averages of the suggested prices are integrated of order 1 (for both Euro95 and Diesel). Augmented Dickey-Fuller Fisher panel unit root tests (Maddala and Wu (1999), Choi (2001)) indicate that both Euro95 and Diesel retail prices are integrated of order 1. Augmented Dickey-Fuller unit root tests on individual price series of gasoline stations indicate that 98% of both Euro95 and Diesel price series are integrated of order 1. We treat all Euro95 and Diesel price series as integrated of order 1.

all oil companies and that is additional to the spot market price. In that case suggested prices reduce uncertainty across stations of all brands. Finally, the fourth term, $(Sug_{i,t-k} - \overline{Sug}_{-i,t-k})$, reflects the brand-specific part of the suggested price and proxies the information that is only present in the suggested price of the oil company of station *i* and not in the suggested prices of other oil companies. If the parameters λ are positive and differ significantly from zero, then suggested prices reduce uncertainty within brands.

The error correction terms are the terms between square brackets and define the long-run or "equilibrium" relationships between the retail price and the other three price series. From an economic perspective, it seems reasonable to assume that the cointegrating relations can be specified as the difference between two price series (see also Footnote 14). In the long run, changes in the underlying stochastic trend of the three price series (which is the spot market price) should be fully reflected in retail prices. Moreover, if we do estimate the long-run impact of $Spot_{t-3}$, $\overline{Sug}_{-i,t-1}$, and $Sug_{i,t-1}$ on $P_{i,t-1}$, we find that their coefficients almost equal 1 (see also Faber (2009)).[18] The parameters ϕ show to what extent retail price changes are influenced by deviations in the equilibrium relation between the retail price and respectively the spot market price, the common information in all suggested prices, and the brand-specific suggested price. Differences between the parameters ϕ show of which of the three long-run relations the deviations have the largest impact on retail price changes.

We estimate Equation (1) two times; once for our subsample of Euro95 prices and once for our subsample of Diesel prices. Our sample only contains stations with the brand of one of the five largest oil companies, since for these stations we have data on brand-specific suggested prices. For both estimations we mainly use the data we have on dodo stations, as these are the stations that are completely free to determine their own prices.[19] We use the Ordinary Least

[18] The panel cointegration test of Kao (1999) reveals homogeneous cointegration between retail prices and the two-day lagged spot market price, the common information in all suggested prices, and brand-specific suggested prices (for both Euro95 and Diesel).

[19] Retail prices are not available for all stations for all days. We can only use an observation of a station's retail price for estimation when the previous q+1 observations of this station are also available.

Squares (OLS) Within estimator.[20] Moreover, we use Driscoll-Kraay standard errors that are robust to heteroskedasticity, serial correlation, and cross-sectional correlation (see Driscoll and Kraay (1998) and also Hoechle (2007)).

5. Results

Table 1 contains the estimation results for Euro95. The first column shows the estimation results of Equation (1) with q=0 and r=0. Our sample contains all dealer-owned gasoline stations that have the brand of one of the five largest oil companies.

The table shows that the coefficient for the immediate impact of the part of the suggested price that reflects the spot market price equals 0.88.[21] So a change in this part of the suggested price is largely reflected in the change of the retail price. However, we also find a strong impact of the part of the suggested price that reflects the information that is, next to the spot market price, common in the suggested prices of all oil companies. The coefficient of this term is, with a value of 0.83, quite substantial and highly significant. This result indicates that the common component of the suggested prices contains information that explains retail prices over and above the fluctuations in the spot market price. The additional information in the brand-specific suggested price, the third part of the suggested price, is also important for explaining the retail price. The value of the coefficient is 0.67. So retail prices also contain information that is only present in the brand-specific suggested price.

[20] Although this estimator is inconsistent for dynamic models if the number of observations over time is fixed (even if the number of groups go to infinity), it is consistent if the number of observations over time also go to infinity. Our data set contains many stations over a relatively long period (783 days), so using the OLS Within estimator should not be a problem.

[21] The coefficients of the different parts of the suggested price differ from the effective coefficients of the variables. For example, the effective coefficient for the direct impact of the spot market price is 0.05 (0.88-0.83). This outcome shows that suggested prices contain most of the information in the spot market price that is also present in retail prices.

Table 1 Estimation results Euro95

	Equation (1), Dependent variable: $\Delta P_{i,t}$	
	q=0, r=0	q=3, r=3
Sample	DO & Brand	DO & Brand
$\Delta P_{i,t-1}$		-0.39 (0.01)
$\Delta P_{i,t-2}$		-0.25 (0.01)
$\Delta P_{i,t-3}$		-0.13 (0.01)
$\Delta Spot_{t-2}$	0.88 (0.01)	0.92 (0.01)
$\Delta Spot_{t-3}$		0.37 (0.02)
$\Delta Spot_{t-4}$		0.25 (0.01)
$\Delta Spot_{t-5}$		0.13 (0.01)
$\Delta(\overline{Sug}_{-i,t} - Spot_{t-2})$	0.83 (0.01)	0.87 (0.02)
$\Delta(\overline{Sug}_{-i,t-1} - Spot_{t-3})$		0.36 (0.02)
$\Delta(\overline{Sug}_{-i,t-2} - Spot_{t-4})$		0.25 (0.02)
$\Delta(\overline{Sug}_{-i,t-3} - Spot_{t-5})$		0.13 (0.02)
$\Delta(Sug_{i,t} - \overline{Sug}_{-i,t})$	0.67 (0.02)	0.69 (0.02)
$\Delta(Sug_{i,t-1} - \overline{Sug}_{-i,t-1})$		0.27 (0.02)
$\Delta(Sug_{i,t-2} - \overline{Sug}_{-i,t-2})$		0.19 (0.02)
$\Delta(Sug_{i,t-3} - \overline{Sug}_{-i,t-3})$		0.10 (0.01)
$(P_{i,t-1} - Spot_{t-3})$	-0.04 (0.01)	-0.04 (0.01)
$(P_{i,t-1} - \overline{Sug}_{-i,t-1})$	-0.04 (0.01)	-0.02 (0.01)
$(P_{i,t-1} - Sug_{i,t-1})$	-0.21 (0.01)	-0.11 (0.01)
Observations	372,450	219,221
Stations	1,176	970

Notes: T=783, Driscoll-Kraay standard errors between brackets (lag length considered in the serial correlation structure determined via Newey-West procedure (6 lags in case of q=0, r=0 and 5 lags in case of q=3, r=3)). Station-specific effects are not reported. DO = dealer-owned stations, Brand = stations with the brand of one of the five largest oil companies. The reported number of stations may not be exactly identical to the number of physical stations (some gasoline stations change their name during the sample period and we do not merge the series of these stations).

All estimated parameters ϕ are negative, which indicates that in all three cases when the retail price deviates from what the equilibrium relation implies, the retail price is corrected in the direction of the equilibrium retail price. However, the estimated values of the parameters ϕ_1 and ϕ_2 are close to 0 (both are -0.04), while the estimated value of ϕ_3 is -0.21. This result shows that retail prices respond mostly to deviations in the long-run relation between the retail price and the brand-specific suggested price. Deviations in the long-run relation between the retail price and the spot market price and between the retail price and the common information in all suggested prices are less important for explaining retail price changes.

The second column of Table 1 depicts the estimation results of Equation (1) with q=3 and r=3. Our estimates are robust to changes in the lag specification. Again, changes in the part of the suggested price that reflects the spot market price are important for explaining changes in retail prices, but so are the parts that represent the common component of the suggested prices and the brand-specific component. Also the estimation results concerning the long-run relations confirm our previous findings. Table A1 in Appendix A shows that estimation results are similar for Diesel.

These results indicate that the part of the suggested price that is, next to the spot market price, common in all suggested prices and the part that is brand-specific are important for explaining retail prices in addition to the part that reflects the spot market price. Retail prices contain all three parts of the suggested price. Therefore, we conclude that the existence of suggested prices reduces uncertainty of stations concerning prices of all other stations. Moreover, suggested prices reduce uncertainty concerning prices of stations with the same brand even more.

5.1 Robustness

We check the robustness of these results by estimating alternative specifications. All alternative specifications underline the important qualitative aspects of the results reported so

far. We report some of these robustness checks here. First, we estimate the equation for all company-owned gasoline stations with the brand of one of the five largest oil companies. These are the gasoline stations which are not (or possibly not completely) free to deviate from the suggested prices as set by the oil companies. The first column of Table 2 contains the estimation results of Equation (1) with q=0 and r=0 for Euro95. The estimated coefficients are similar to those of the group of dealer-owned stations. This result shows (what was to be expected) that also for company-owned gasoline stations the part of the suggested price that is common in all suggested prices and the part that is brand-specific are important for explaining retail prices in addition to the part that reflects the spot market price. Therefore, suggested prices help dealer-owned stations to predict prices of company-owned stations as well.

Second, we estimate the equation for subsamples of our population of dealer-owned gasoline stations with the brand of one the five largest oil companies to take into account possible heterogeneity of stations. To this end, we group gasoline stations based on location (highway or nonhighway) and brand. Table 2 contains for each of these respective cases the estimation results of Equation (1) with q=0 and r=0 for Euro95. The second and third column show estimation results for stations that are located along a highway and stations that are not located along a highway, respectively. In both cases, we confirm the general conclusion that changes in retail prices reflect changes in all three parts of the suggested price. In the lower part of Table 2 we group the gasoline stations by brand. The results show that for some brands the coefficient that measures the impact of the brand-specific part of the suggested price is larger than for other brands.[22]

We also estimate an alternative version of Equation (1) by replacing the average suggested price by the Shell suggested price (as some consider Shell to be the price leader in the Dutch

[22] We perform the same robustness checks as reported in Table 2 for our subsample of Diesel observations. The results are not reported here as their qualitative conclusions are similar to the conclusions of the checks reported in Table 2.

Table 2 Robustness of estimation results Euro95

	Equation (1), Dependent variable: $\Delta P_{i,t}$		
	q=0, r=0		
Sample	CO & Brand	DO & Brand & Highway	DO & Brand & Nonhighway
$\Delta Spot_{t-2}$	0.92 (0.01)	0.90 (0.01)	0.88 (0.01)
$\Delta(\overline{Sug}_{-i,t} - Spot_{t-2})$	0.87 (0.01)	0.85 (0.02)	0.83 (0.01)
$\Delta(Sug_{i,t} - \overline{Sug}_{-i,t})$	0.73 (0.02)	0.60 (0.02)	0.67 (0.02)
$(P_{i,t-1} - Spot_{t-3})$	-0.03 (0.00)	-0.03 (0.01)	-0.04 (0.01)
$(P_{i,t-1} - \overline{Sug}_{-i,t-1})$	-0.04 (0.01)	-0.12 (0.02)	-0.04 (0.01)
$(P_{i,t-1} - Sug_{i,t-1})$	-0.15 (0.01)	-0.25 (0.02)	-0.21 (0.01)
Observations	579,202	17,265	355,185
Stations	1,093	40	1,136

	Equation (1), Dependent variable: $\Delta P_{i,t}$				
	q=0, r=0				
Sample	DO & Brand A	DO & Brand B	DO & Brand C	DO & Brand D	DO & Brand E
$\Delta Spot_{t-2}$	0.91 (0.02)	0.83 (0.02)	0.92 (0.01)	0.85 (0.02)	0.83 (0.01)
$\Delta(\overline{Sug}_{-i,t} - Spot_{t-2})$	0.85 (0.02)	0.75 (0.02)	0.87 (0.02)	0.84 (0.03)	0.81 (0.01)
$\Delta(Sug_{i,t} - \overline{Sug}_{-i,t})$	0.64 (0.04)	0.50 (0.04)	0.85 (0.02)	0.57 (0.05)	0.65 (0.02)
$(P_{i,t-1} - Spot_{t-3})$	-0.06 (0.01)	-0.07 (0.01)	-0.05 (0.01)	0.03 (0.01)	-0.01 (0.01)
$(P_{i,t-1} - \overline{Sug}_{-i,t-1})$	-0.05 (0.02)	-0.12 (0.02)	0.03 (0.01)	-0.11 (0.03)	-0.06 (0.02)
$(P_{i,t-1} - Sug_{i,t-1})$	-0.24 (0.02)	-0.09 (0.02)	-0.26 (0.02)	-0.18 (0.02)	-0.24 (0.02)
Observations	58,286	67,141	128,014	64,096	54,913
Stations	144	190	282	270	290

Notes: T=783, Driscoll-Kraay standard errors between brackets (lag length considered in the serial correlation structure determined via Newey-West procedure (6 lags)). Station-specific effects are not reported. CO = company-owned stations, DO = dealer-owned stations, Brand = stations with the brand of one of the five largest oil companies. The reported number of stations may not be exactly identical to the number of physical stations (some gasoline stations change their name during the sample period and we do not merge the series of these stations).

gasoline market). These estimations show that information in the brand-specific suggested prices that is additional to the Shell suggested price is important for explaining retail prices of stations with the brand of one of the other four oil companies.

6. Further discussion of the results

In the previous section, we have shown that suggested prices contain information that explains (and thus predicts) retail prices over and above the spot market price. We do not exclude that individual stations would know the additional information in suggested prices if oil companies would not publish it. The correlation that we find can exist because stations use suggested prices or because suggested prices are correlated with unobserved factors, like demand factors or (opportunity) costs, that explain the prices that individual stations set.[23] However, in both cases, suggested prices help stations to reduce strategic uncertainty concerning competitors' prices.

If factors that we do not observe impact suggested prices, then suggested prices contain information that (i) is not yet available in the public domain for all retailers (like wholesale prices), or (ii) shows whether and how information in the public domain (like the weather or the day of the week) can be used for price setting. It could be that an individual station would know this additional information even if suggested prices would not exist. However, since suggested prices do exist, the station knows that all other stations know this information as well. And it understands that all other stations know that it is aware of this information. Moreover, stations know that this information is a good indicator for the prices their competitors will choose that day. Therefore, even if unobserved factors cause retail prices and

[23] For example, the additional information in suggested prices might be correlated with wholesale prices and retailers may subsequently pass through these costs in retail prices. Or, for example, suppose that it would rain on day *t*. Retailers look outside the window, know that rain increases demand, and increase their prices. However, on day *t*-1 oil companies read the weather forecast and decided to increase their suggested prices for day *t*. In these two cases, stations do not use suggested prices, but changes in retail prices are correlated with changes in the additional information in suggested prices.

suggested prices are merely correlated with these unobserved factors, then it remains the case that suggested prices reduce strategic uncertainty and create mutually consistent expectations concerning competitors' prices.

7. Conclusion

This paper examines the impact of suggested prices on gasoline retail prices using a large panel data set with almost all gasoline stations in the Netherlands. We show that suggested prices contain information that explains retail price changes in addition to the information contained in the spot market price. Individual stations can better predict competitors' prices on the basis of the suggested price of their oil company. More specifically, a suggested price of an oil company provides a retailer relevant information on prices set by competitors with the same brand and on prices set by competitors with other brands. This result does not exclude the possibility that an *individual* station would know the additional information in suggested prices in case oil companies would not publish it (because the information reflects, for example, the wholesale price that the station pays). Due to the publication of suggested prices, however, all stations understand that every station is aware of the same information and that all stations consider this information in the same way relevant for retail price changes. We therefore conclude that suggested prices reduce uncertainty of stations concerning competitors' price changes and help firms to form mutually consistent expectations concerning their pricing strategies.

Finally, it is important to stress that most stations do not charge the suggested price. In fact, many stations give a "discount" on the suggested price. What we show is that this "discount" is almost constant so that *changes in retail prices* are similar to *changes in suggested prices*. As a consequence, the absolute differences between prices of stations are relatively constant over time. Knowing the change in the suggested price reduces the strategic uncertainty concerning price changes of others.

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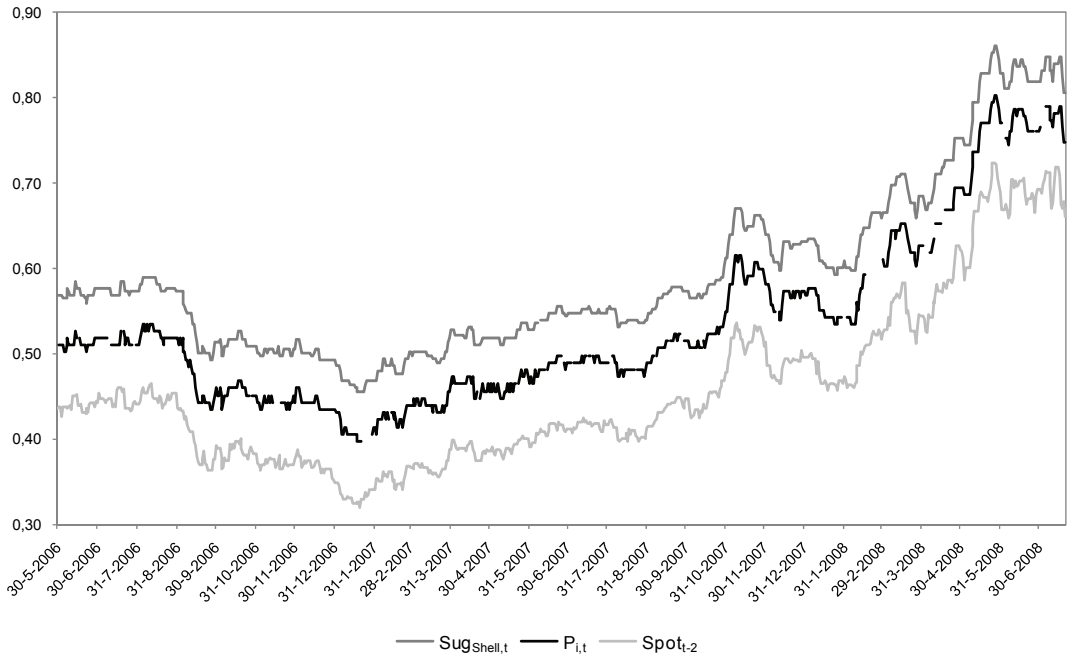
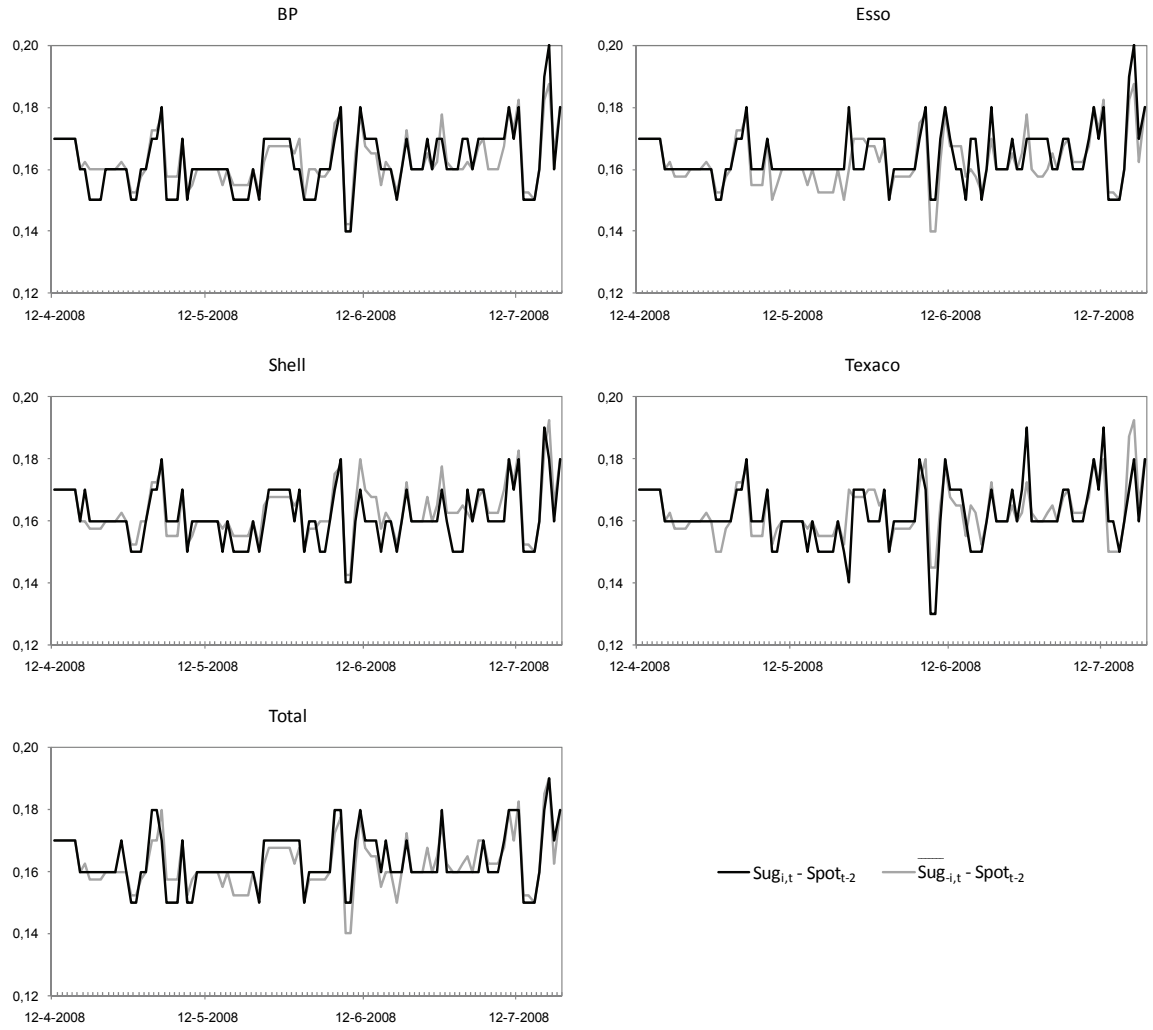
Appendix A Extra figures and tables

Figure A1 Shell suggested price, retail price of a representative Shell station, and spot market price for one liter Diesel



Notes: T=783, price in euros per liter (excluding excise duty and VAT).

Figure A2 Suggested price - spot market price, and Average of the suggested prices of the other four oil companies - spot market price (Euro95, for all five oil companies)



Notes: T=100, difference in euros per liter (excluding excise duty and VAT).

Table A1 Estimation results Diesel

	Equation (1), Dependent variable: $\Delta P_{i,t}$	
	q=0, r=0	q=3, r=3
Sample	DO & Brand	DO & Brand
$\Delta P_{i,t-1}$		-0.37 (0.01)
$\Delta P_{i,t-2}$		-0.22 (0.01)
$\Delta P_{i,t-3}$		-0.11 (0.01)
$\Delta Spot_{t-2}$	0.89 (0.01)	0.93 (0.01)
$\Delta Spot_{t-3}$		0.34 (0.01)
$\Delta Spot_{t-4}$		0.20 (0.01)
$\Delta Spot_{t-5}$		0.11 (0.01)
$\Delta(\overline{Sug}_{-i,t} - Spot_{t-2})$	0.85 (0.01)	0.89 (0.01)
$\Delta(\overline{Sug}_{-i,t-1} - Spot_{t-3})$		0.33 (0.02)
$\Delta(\overline{Sug}_{-i,t-2} - Spot_{t-4})$		0.20 (0.02)
$\Delta(\overline{Sug}_{-i,t-3} - Spot_{t-5})$		0.11 (0.01)
$\Delta(Sug_{i,t} - \overline{Sug}_{-i,t})$	0.63 (0.02)	0.66 (0.02)
$\Delta(Sug_{i,t-1} - \overline{Sug}_{-i,t-1})$		0.24 (0.02)
$\Delta(Sug_{i,t-2} - \overline{Sug}_{-i,t-2})$		0.16 (0.01)
$\Delta(Sug_{i,t-3} - \overline{Sug}_{-i,t-3})$		0.07 (0.01)
$(P_{i,t-1} - Spot_{t-3})$	-0.03 (0.01)	-0.03 (0.01)
$(P_{i,t-1} - \overline{Sug}_{-i,t-1})$	-0.06 (0.01)	-0.02 (0.01)
$(P_{i,t-1} - Sug_{i,t-1})$	-0.20 (0.01)	-0.11 (0.01)
Observations	483,469	310,726
Stations	1,209	1,108

Appendix B Similarity of changes in suggested prices and retail prices

Figure 2 suggests that the retail prices of the four selected gasoline stations and the suggested price change in a similar way on almost every day. To corroborate this observation for our entire data set, we pool all our price data across time and stations.[24] Table B1 shows how often a retail price changes, given that the suggested price of the oil company of the gasoline station changes. It shows that if the suggested price changes, the retail price also changes in 73% of all cases. Moreover, if the suggested price does not change, the retail price also does not change in 77% of all cases. We split the upper left cell of Table B1 for the direction of the suggested price change. If the suggested price increases (decreases), then 97% (96%) of all changing retail prices increase (decrease) as well.

Next, we analyze the size of the differences. The first column of Table B2 shows that in 72% of all observations, the size of the change in the retail price equals the size of the change in the suggested price. If the suggested price changes, 56% of all changes in the retail price are equal to the change in the suggested price. The fourth column of Table B2 shows that if both the suggested price and the retail price change, then in 77% of all cases the change in the retail price equals the change in the suggested price.

Table B1 Frequency of a retail price change conditional on a suggested price change

	if $\Delta Sug_{i,t} \neq 0$	if $\Delta Sug_{i,t} = 0$
$\Delta P_{i,t} \neq 0$	73%	23%
$\Delta P_{i,t} = 0$	27%	77%
	100%	100%

Table B2 Frequency of a similar change in the retail price and suggested price

		if $\Delta Sug_{i,t} \neq 0$	if $\Delta Sug_{i,t} = 0$	if $\Delta Sug_{i,t} \neq 0$ and $\Delta P_{i,t} \neq 0$
$\Delta P_{i,t} = \Delta Sug_{i,t}$	72%	56%	77%	77%
$\Delta P_{i,t} \neq \Delta Sug_{i,t}$	28%	44%	23%	23%
	100%	100%	100%	100%

[24] Calculations in this appendix are based on Euro95 observations of dealer-owned stations with the brand of one of the five largest oil companies. We only report results for Euro95 since results for Diesel are similar.