DOCUMENT DE TREBALL

XREAP2009-5

(NO)COMPETITION IN THE SPANISH RETAILING GASOLINE MARKET: A VARIANCE FILTER APPROACH

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XARXA DE REFERÈNCIA EN ECONOMIA APLICADA

(NO)COMPETITION IN THE SPANISH RETAILING GASOLINE MARKET: A VARIANCE FILTER APPROACH[1]

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Abstract

Various methodologies in economic literature have been used to analyse the international hydrocarbon retail sector. Nevertheless at a Spanish level these studies are much more recent and most conclude that generally there is no effective competition present in this market, regardless of the approach used. In this paper, in order to analyse the price levels in the Spanish petrol market, our starting hypothesis is that in uncompetitive markets the prices are higher and the standard deviation is lower. We use weekly retail petrol price data from the ten biggest Spanish cities, and apply Markov chains to fill the missing values for petrol 95 and diesel, and we also employ a variance filter. We conclude that this market demonstrates reduced price dispersion, regardless of brand or city.

Keywords: Competition, Petrol, Variance filter analysis, Gibbs sampling, Markov chain Monte Carlo.

J.E.L. Classification: L13, L59, L71

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[1] We would like to express how grateful we are to Dr. Augusto Voltes for his help in simulating the data using WinBugs, and also to Agustín Alonso and Beatriz Ojeda for their database work. Juan Luis Jiménez would also like to express his gratitude for the support provided by Programa Innova Canarias 2020, by the Fundación Universitaria de Las Palmas (2009), and by UNELCO-ENDESA who acted as a sponsor.

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1. Introduction

In the last two decades the Spanish petrol market has undergone an immense restructuring process, the main objective of which has been to introduce competition into the sector. The main petrol sector regulation (Law 34/1992) established the sector as being a service of general interest, provided by free agents and under the terms of competition. Nonetheless, as the paper by Perdiguero and Borrell (2008) states in its title, it is difficult to achieve competition in the sector; and in practice, there still seem to be various factors that impede this original objective.

As Bello and Cavero (2008) indicate and Correljé (1990) previously analysed, the Spanish petrol market has passed from being natural monopoly to being totally liberated in less than twenty years. It is the importance of this market to economic development and the extent of the restructuring process that has attracted the attention of researchers. Contín et al. (1999) analysed the evolution of petrol prices during and after the intense restructuring process, and indicated that its behaviour did not reflect perfect competition. Contín et al. (2001) also point out that the private and unregulated oil pipeline monopoly may be a key obstacle to the effective development of competition within the market. Continuing with price analysis, Contín et al. (2008 and 2009) show how the diesel and unleaded petrol prices symmetrically incorporate the international wholesale price changes.[4]

Despite intense analysis there is little evidence as to whether, either tacit of explicit, collusion exists in the Spanish petrol market. Save for Perdiguero (2006) and Perdiguero and Jiménez (2009), who have respectively analysed the existence of collusive equilibria in Spain and in the Canary Islands, there is no robust empirical evidence on price behaviour in this market. This surely indicates the restricted number of methodologies available in the international literature to detect the existence of cartels or collusive agreements.

One of the most recent methodologies proposed, and which has still to be applied to the Spanish market is variance filtering. Abrantes et al. (2006) conclude that the companies involved in collusive agreements keep their average prices higher and also have reduced variance; that is to say there is a greater price rigidity compared to those markets where this type of anticompetitive agreement doesn't exist. The use is of this evidence to empirically

4 Bello and Cavero (2007 and 2008) show empirical evidence of the relationship between prices and the vertical relationship of the commercializers. The result indicates that vertical integration produces prices that are lower than the market equilibrium.

compare and contrast the existence of such collusive agreements is rare, to date only Abrantes et al. (2006) and Bolotova et al. (2008) have empirically applied this evidence.[5] Our aim is to apply this new empirical technique to the Spanish petrol market, so as to confirm the existence of collusive agreements; moreover we want to complement and back up the results of the aforementioned papers.

This article will contribute to the gathering of empirical evidence on how this technique works when evaluating collusive agreements; for example, its role in the Spanish petrol market, where such accords do indeed appear to exist. It is worth pointing out that this is the first time this technique has been applied to a European market. Secondly, we use a database that enables us to access weekly information on all the service stations operating in the ten biggest Spanish cities, in terms of population; and we can observe the different behaviour among the relevant geographical markets. Thirdly and finally, we provide evidence on how petrol prices function in Spain. The results will complement those previously obtained by other authors, and will help us to evaluate the restructuring process of the Spanish petrol market.

Our main results indicate symmetrical behaviour by the different companies and for different regions, but there are exceptions. Despite this price behaviour it still may fit in with either a price equilibrium or with collusion. Some empirical evidence suggests that the latter is a far more plausible explanation for the market that we have analysed.

The study is organized in the following way. After this introduction in Section 2 we develop the variance filter methodology in greater detail. In Section 3 we describe the database we use, and in Section 4 we assign the missing values and include them with the empirical results. In the final part, Section 5, we present the main conclusions of the study.

2. Filter variance as an empirical approach.

As we pointed in the previous section, variance filter methodology grew from the idea that the price dynamics of a market where companies collude are different to those of a competitive industry, when measured in terms of averages and price variance. Both the economic theory and the available empirical evidence on cartel behaviour and collusion

[5] This author has used this idea in other different markets, as the fresh potatoes market (Muthusamy et al, 2008). They find that price volatility is lower during the period when a cooperative in this market was operating than when it does not. Nevertheless, the mean price level is higher but it is not statistically significant.

agreements suggest that the average prices will be higher in an uncompetitive market; moreover, a significant reduction in the dispersion, or standard deviation, of the prices would also be expected.

With respect to the theoretical literature, there is a wide variety of models that show a positive relationship between collusion and price rigidity. It is worth pointing out that the article by Athey et al. (2004) states that the information costs associated with revealing costs cause greater price rigidity. In the model by Harrington and Chen (2006), in order to minimize the possibility of being detected, the companies don't fully incorporate the cost variations, and this brings about reduced price flexibility. There are equally numerous theoretical models on collusive behaviour in the sphere of auction analysis (Feinstein et al., 1985 o LaCasse, 1995). They also indicate that there is lower price dispersion under the terms of collusive behaviour, and Feinstein et al. (1985) provide empirical evidence to this effect.

As for the empirical evidence, Genesove and Mullin (2001) show how the collusive accord in the sugar refining industry caused higher prices and greater inflexibility in periods of competition. Brannon (2003) analysed the introduction of laws to prevent sales at a loss in the petrol market. This culminated in collusive agreements in the US state of Wisconsin, and resulted in higher prices and less dispersion. Finally, Abrantes et al. (2006) analysed the conspiracy among companies to raise the price of fish sales to the U.S. Department of Defense from 1984 to 1989. The cartel ceased to operate at the end of 1988. The authors used this point in time to demonstrate that the competitive average price was 16% lower and the variance 263% higher than when the price agreement was working.[6]

Despite the existence of so many theoretical arguments as empirical evidence of collusive markets showing higher prices and lower variations, it is still rare that a variance filter has been applied to detect such behaviour. We have only found two articles, by Abrantes et al. (2006) and Bolotova et al. (2008), which analyse price behaviour using a variance filter.

Abrantes et al. (2006) use a variance filter to attempt to find out which service stations in the US state of Kentucky have higher than average prices and low variance, in order to detect possible indicators of collusion in the retail petrol market. However, since all the points of sale showed similar behaviour there were no conclusive results. Bolotova et al. (2008) analysed the price evolutions in the citric acid and lysine market, where collusive

[6] For a review of cartel behaviour and its effect on prices see Connor (2005).

accords had been discovered. In both cases the prices were higher during the periods of collusion. However, in the case of lysine the price variance decreased during the period of collusion, whereas in the case of citric acid it increased.

This methodology has not been applied to the petrol market in Spain, and this study attempts to cover this lack in the application of the methodology. It uses an average and variance filter to try to detect the "suspicious" price dynamics that might indicate uncompetitive behaviour in the local petrol 95 and diesel markets, by using weekly retail price data.

3. Data

The data comes from the website of the Spanish Government's Ministry of Industry, Trade and Tourism (from now on, the Ministry), which is updated every Wednesday. We obtained the published price, expressed in euros per litre, for all the service stations operating in the ten largest Spanish cities measured in terms of population for 2007. According to the Spanish National Statistics Institute (Instituto Nacional de Estadística INE) they are, in order of size: Madrid, Barcelona, Valencia, Sevilla, Zaragoza, Málaga, Murcia, Las Palmas de Gran Canaria, Palma de Mallorca and Bilbao.

The database covers 27 weeks from April to December 2008, and consists of 544 service stations selling petrol 95 and 548 selling diesel, though not all of these stations provided all the data for the sample period. However, if we exclude those stations with a significant number of missing values, we could encounter problems with the sample's bias. For petrol 95 of the 13,121 values some 11.9% were unavailable, and for diesel 14.0% of the 12,974 results were not available. Nonetheless, as we explained in the previous section this potential bias has been minimized by using a Markov chain Monte Carlo to assign the missing values.

However, before assigning the results we analyse whether the stations with less information could bring about a self selection sampling problem. Possibly the companies providing less or generally poorer quality data are those behaving "less competitively". In this case, the potential problem is apparently less important, because the stations with missing values are as representative as any of the other companies. For diesel, the companies with over 50% of their values missing have the following distribution within the total population: Repsol 28.2%, Cepsa 13.0%, Campsa 13.0%, Shell 15.2% and Galp 4.3%.

The database includes the net price, in order to permit the comparison of cities. While within the mainland Spain the taxes to be taken into account are the special taxes, the regional taxes known as the "céntimo sanitario", and VAT; however, in the Canary Islands there is only the special tax and the AIEM tax (Arbitrio sobre la Importación y Entrega de Mercancías), which is a tariff to specifically protect the internal industry.

Next, we briefly summarize the data, both for the brands and for the cities, by using the price average and standard deviation. Table 1 shows the average prices for the six biggest fuel brands in the analysis, in terms of service station numbers. "Others" refers to the sum of the other independent fuel companies, or companies that have a lower numbers of stations. Both the average prices and the standard deviation for petrol 95 are similar for all brands, whether they are Campsa or the Others which have lower prices for both products.

Table 1: Descriptive Statistics (by Brand)

	Petrol 95			Diesel		
Brand	P_A	Nº P.S.	S.D.$_A$	P_A	Nº P.S.	S.D.$_A$
Repsol	0.572	147	0.102	0.704	149	0.114
Cepsa	0.578	103	0.102	0.704	105	0.114
Campsa	0.567	78	0.102	0.701	79	0.115
British Petroleum (BP)	0.584	44	0.099	0.709	44	0.112
Galp	0.571	23	0.103	0.702	22	0.114
Shell	0.586	35	0.099	0.709	36	0.112
Others	0.569	114	0.101	0.699	113	0.114
Total	0.574	544	0.101	0.704	548	0.114

Source: Own elaboration.
Note: P_A is the average price. Nº P.S. is the number of petrol stations. S.D.$_A$ is the average standard deviation.

Table 2 reflects the same descriptive statistics but makes a distinction between the cities. You will notice that for all the products the highest prices are in the city of Las Palmas de Gran Canaria, which may be due to higher transportation and commercialisation costs. With respect to the other cities, petrol 95 is higher priced in Palma de Mallorca, Sevilla and Valencia; the figures range from 0.566 in Murcia to 0.625 in Las Palmas de Gran Canaria. As for diesel, the variations range between 0.698 in Zaragoza and 0.726 cents per litre in Las Palmas de Gran Canaria.

Table 2: Descriptive Statistics (by City)						
	Petrol 95			Diesel		
City	P_A	Nº P.S.	$S.D._A$	P_A	Nº P.S.	$S.D._A$
Madrid	0.570	163	0.103	0.701	164	0.115
Barcelona	0.569	77	0.102	0.702	77	0.116
Valencia	0.571	43	0.102	0.701	43	0.115
Sevilla	0.571	49	0.101	0.704	53	0.114
Zaragoza	0.569	41	0.102	0.698	43	0.115
Málaga	0.569	43	0.101	0.700	45	0.115
Murcia	0.566	29	0.103	0.699	29	0.115
Las Palmas de Gran Canaria	0.625	48	0.092	0.726	45	0.104
Palma Majorca	0.572	42	0.101	0.705	42	0.114
Bilbao	0.569	9	0.102	0.704	7	0.115
Total	0.575	544	0.101	0.704	548	0.114

Source: Own elaboration.
Note: P_A is the average price. Nº P.S. is the number of petrol stations. $S.D._A$ is the average standard deviation.

4. Empirical strategy and results

The first step is to "fill in" the missing data with predicted or simulated values. For this, we follow the paper by Abrantes-Metz et al (2006), which discusses the possible options; i.e. mean substitution, simple hot deck, regression methods and imputation methods. Arguments are also presented for choosing the imputation methods, specifically Gibbs sampling combined with data augmentation method, which is a type of Markov chain Monte Carlo.

In general, multiple imputations are drawn from a Bayesian predictive distribution:

$$p\left(z^m,\theta \mid z^o\right)=\int p\left(z^m \mid z^o,\theta\right)p\left(\theta \mid z^o\right)d\theta$$

Where z^o is the data vector, z^m is the missing observations and θ is the model parameters. The Gibbs sampling tries to estimate the numerical approximation of $E\left[g(\theta)\mid z^o\right]$, where $g(\theta)$ is a function of interest, as the mean or standard deviation of prices for some subset of petrol stations.

In our case, we denote z^{ot} as the observed values and z^{mt} as missing values. The distribution of the unknown parameters θ and z^{mt}, conditional on the known z^{o} being the next predictive distribution:

$$p\left(z^{m},\theta \mid z^{o}\right)=p\left(z^{m},z^{0},\theta\right)\big/ p\left(z^{0}\right)\alpha\, p\left(z^{m},z^{0},\theta\right)=p\left(z,\theta\right)=p\left(\theta\right)p\left(z\mid\theta\right)$$

Specifically, the interpolation for the missing values uses next first-order autoregressive model:

$$z_{it}-\mu_{it}=\rho_{i}\left(z_{it-1}-\mu_{i}\right)+\varepsilon_{it}$$

Where z_{it} is the difference between price station *i* on day *t* minus average daily price. Assuming $\varepsilon_{it}^{iid} : N\left(0,\sigma_{i}^{2}\right)$, the model permits a station to have prices that tend to be higher or lower than average by using μ_{i}.

We would like to state that for all the aforementioned service stations we have presented the total population not a sample. We have calculated the average price and the standard deviation for each station for the twenty-seven weeks of the study. The analysis that we have carried out is for the two types of fuels that have the greatest demand.

It should be borne in mind that, after reviewing the whole market for the ten most important cities in Spain, the aim of this paper is to identify those service stations with higher average prices than the mean for all service stations and low standard deviations. Nevertheless, there is no established predetermined value, either in the theory or in the empirical evidence. In order to establish a benchmark the initial threshold, in accordance with Abrantes-Metz et al, was all the service stations with standard deviation at least 50% lower than the combined average for the population that have a higher price average.

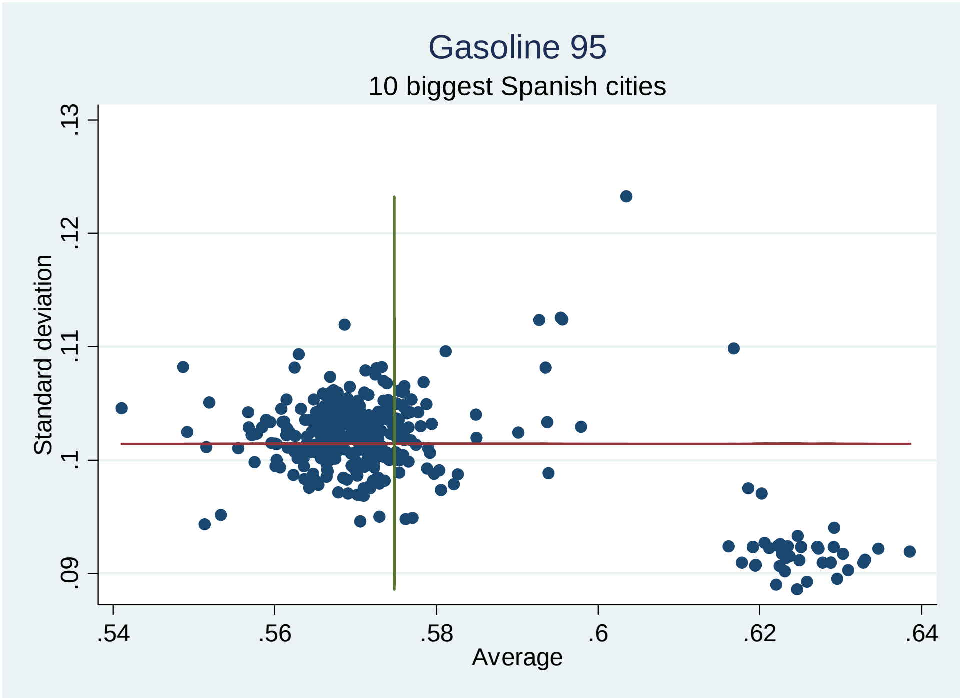
We analyse two products with characteristics that differ principally in terms of demand. The starting point for our hypothesis is that there is a greater probability of collusive behaviour in the product that best fulfils the factors described by Ivaldi et al (2003). Even though we don't include diesel for professional purposes in the analysis, the empirical evidence indicates that there greater absolute price elasticity of demand for diesel than petrol. This could indicate a lesser probability of levels of collusion with respect to petrol 95, whose use is exclusively domestic, and is more inelastic than diesel (Dahl and Sterner, 1991).

The results for petrol 95 are shown in Graphs 1 and 2, as well as in Annex I. In this case the average price of petrol was 0.575 euros per litre, with a standard deviation of 0.101 euros. Figure 1 includes the 544 petrol stations analysed, and at first sight it can be seen that the majority of them conform with a cloud of points around the average values; the exceptions are the service stations in Las Palmas de Gran Canaria, which have higher averages and whose deviations are somewhat lower that the mean.

In fact, the stations that could be considered "suspicious" are those located in the II Quadrant, at the bottom right of the graph; those with a higher than average price and low standard deviation. With this approach there are 68 stations situated in this quadrant, which are comparatively distributed within each city. 70.6% are stations in Las Palmas de Gran Canaria, 10.3% are in Madrid, 7.4% in Sevilla, 4.4% in Barcelona, 2.9% in Valencia and 1.5% in Málaga, Murcia and Zaragoza. None of the petrol stations breach the 50% lower than standard deviation threshold, and as such we can't prove the existence of collusion.

However, we must bear in mind that among the cities there may be cost differences, such as transport, labour and land prices, which influence the previous results. Thus, petrol transport costs may be higher in the archipelagos, and this could explain that higher percentage of service stations from Las Palmas in the II Quadrant. To avoid this problem, the previous analysis has been carried out city by city, to allow for the different competitive dynamics that have developed.

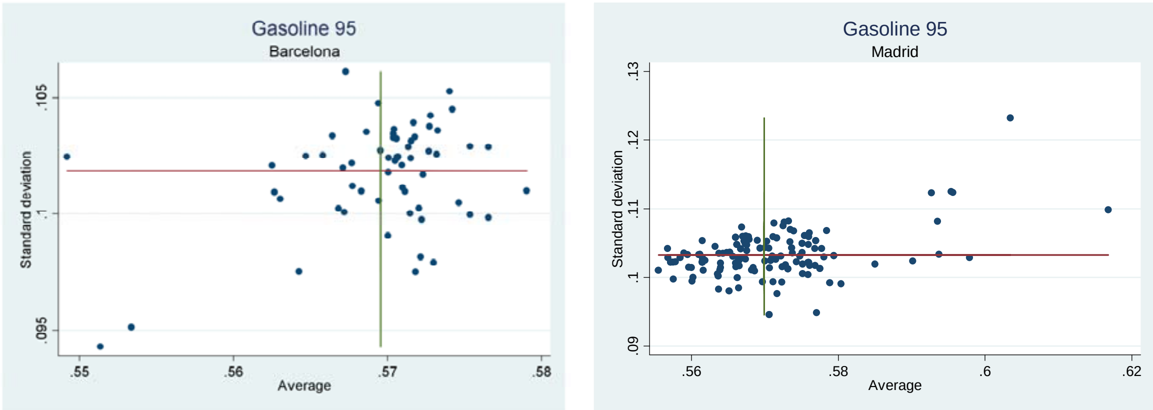
Figure 1: Average Deviation and Price. Petrol 95. Total Sample.



Source: own elaboration from data provided by the Ministry
Note: The average prices are expressed in euros per litre of fuel.

The results for petrol 95 are shown in Graph 2 and in Annex I, Graph 5. In them we can see that the competition behaviour at a local level is also homogeneous in the group analysis, given that no groups of stations are highlighted as having behaviour that is significantly different to the average result, especially in the II quadrant.

Figure2: Average Deviation and Price for Petrol 95 in Barcelona and Madrid

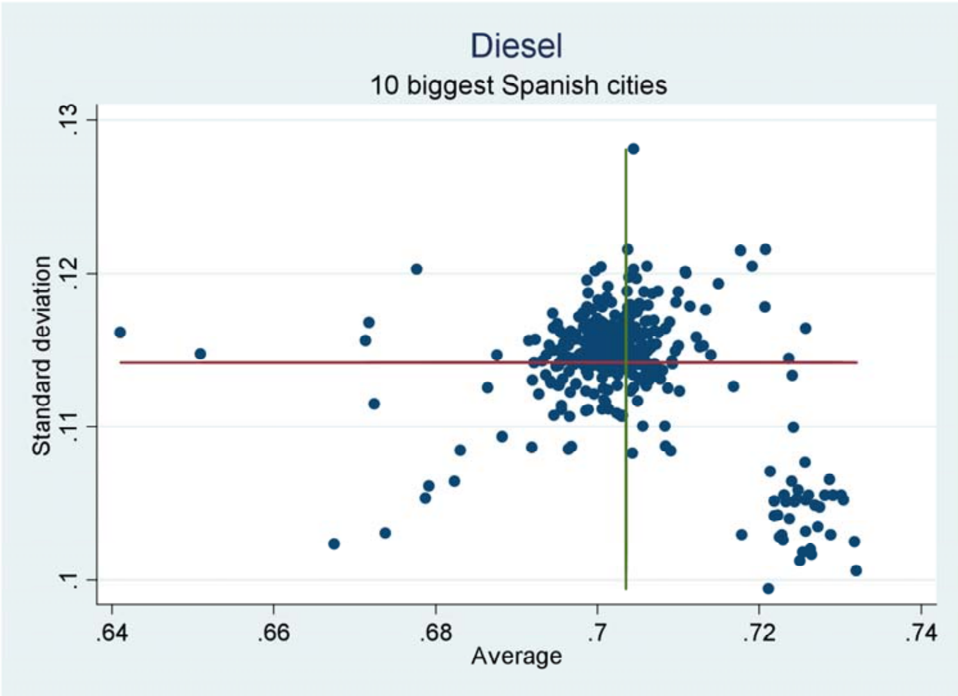


Source: Own elaboration from data provided by the Ministry.
Note: The prices are expressed in euros per litre of fuel.

The Graphs 3, 4 and 6 in Annex II show the values for diesel. Given the fiscal differences, the average prices for petrol 95 are higher in all the stations, 0.704 euros per litre versus 0.574 for petrol 95. As might be expected the standard deviation for this product is higher compared to petrol 95, possibly brought about by the aforementioned differences in price elasticity of demand, which in turn are due to the greater heterogeneity in the types of consumers.

In this case, the greater number of stations are in the II Quadrant (Gasoline 95). The distribution for cities is as follows: 47.4% for Las Palmas de Gran Canaria, 26.3% for Palma de Mallorca, 11.6% for Madrid, 8.4% for Sevilla, 2.1% for Barcelona and Murcia and 1.1% for Valencia and Zaragoza. Nevertheless, as with the other product, the threshold of a lower than 50% average deviation of population was not breached.

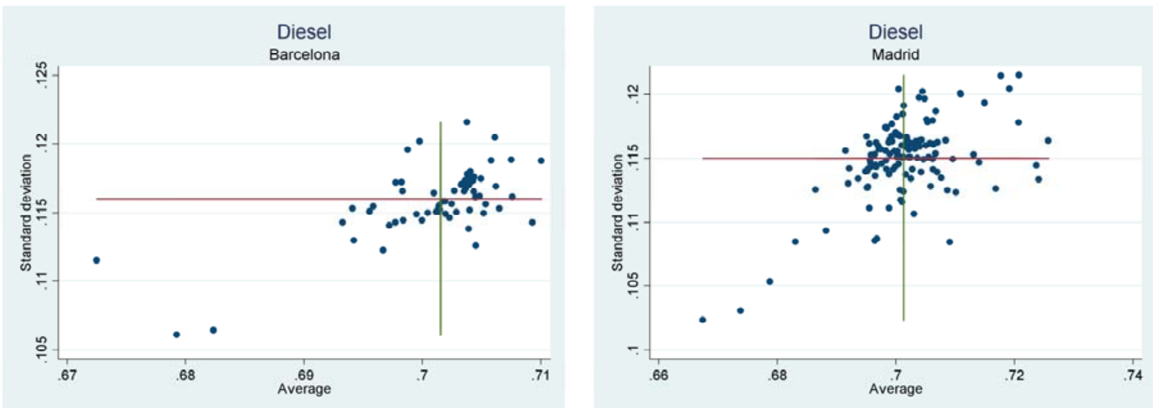
Figure 3: Average Deviation and Price. Diesel. Total Sample.



Source: Own elaboration from data provided by the Ministry.
Note: The prices are expressed in euros per litre of fuel.

In the analysis by city, no explicit evidence of anomalous behaviour has been found in any of the localities; see Figures 4 and 6 in Annex II. However, as previously mentioned in the combined Figure 3, the standard deviation is higher compared to the sample of petrol 95 for each city.

Figure 4: Average Deviation and Price for Diesel in Barcelona and Madrid.



Source: Own elaboration from data provided by the Ministry.
Note: The prices are expressed in euros per litre of fuel.
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When interpreting the previous results, one relevant aspect of the petrol industry should be borne in mind. Due to the large volumes and frequency of consumption, the petrol industry is not characterized by large margins from few sales. It gains huge profits through large volumes of sales, and for this reason small price changes can significantly affect profits causing prices to seem very similar. The 50% threshold, in terms of the difference in standard deviation as defined by Abrantes-Metz et al. (2006), may be excessive for this market. So, in the following table we present the mean and the standard deviation of those stations furthest from both of the means. This is in order to see whether, in spite of not dipping down to the 50% threshold, different behaviour is shown. These values show a maximum percentage of variation when compared to the average price and a minimum percentage in variation with respect to the average standard deviation.

Table 3: Maximum Range of Variation in Quadrant II by City

	% Maximum Highest Price Deviation with Respect to Average Prices		% Maximum Lowest Deviation with respect to the Average Standard Deviation	
	Petrol 95	Diesel	Petrol 95	Diesel
Madrid	3,90	3,49	-6,52	-11,05
Barcelona	1,08	1,21	-2,47	-8,55
Valencia	1,39	1,64	-4,74	-5,73
Sevilla	2,54	1,39	-1,81	-4,91
Zaragoza	0,78	1,50	-3,12	-5,87
Málaga	1,25	0,82	-4,05	-3,14
Murcia	0,78	1,39	-4,24	-3,64
Las Palmas de Gran Canaria	0,60	0,88	-1,56	-4,83
Palma de Mallorca	0,15	0,35	-2,04	-4,01
Bilbao	0	0	0	0

Source: Own elaboration from data provided by the Ministry.

As can be seen from this data, neither of the products have an accentuated difference, when compared to each other. The result for deviation is relatively different to the previous one and shows no clear pattern. Petrol 95, rather than diesel, is the product where there is the greater probability of collusion. Despite all this, the results are far from the thresholds established by Abrantes-Metz. The maximum deviation is close to 4% for the average price and 11% for the standard deviation, which is well short of the 50% defined by the authors.

Moreover, in terms of cities, there is no evidence of heterogeneous results among the service stations.

As it stands, it is not possible to conclude from these results that collusion exists in any of the markets. In fact, with exceptions, the symmetrical behaviour we have just demonstrated could equally represent either a highly competitive situation or perfect collusion. However, the empirical evidence from previous studies seems to support to a greater degree the existence of an uncompetitive equilibrium. For example, in his dynamic analysis Perdiguero (2006) concludes that the level of competition in the sector at a national level is low. Borrell and Perdiguero (2008) show the problems that still remain and impede the goal of improving market competition. While Perdiguero and Jiménez (2009) confirm, by using conjectural variation, that the behaviour of petrol retailers in the autonomous region of the Canary Islands is closer to tacit collusion than to any other market structure. This probably keeps the standard deviation of the service stations in Las Palmas lower, both for petrol 95 and diesel.

For this reason, the market results for Las Palmas de Gran Canaria may be considered "very uncompetitive", but can be viewed as a benchmark for the other cities. While the data for the average cannot be compared directly, the standard deviation can. By contrasting the average of the deviations for the stations in each city with the figure for Las Palmas, we have found that the Las Palmas prices are 10.1% higher for diesel and 11.5% higher than the other cities for petrol 95.

The closeness of the results indicate that the level of competition in the mainland cities and in Palma de Mallorca could be slightly higher that the level in Las Palmas. Nonetheless, the differences in the standard deviation for both groups are so small that we are unable us to assert that this competition is effective. They have very similar behaviour, which is close to collusion.

5. Conclusions

The first steps to liberalize the Spanish hydrocarbon market were taken over two decades ago, but the objective of reaching a competitive market doesn't seem to have been reached. Despite the importance of this sector within the economy, and the ongoing deregulation process, there are still impediments to the presence of competition that reduce the possibilities of improving social welfare.

The academic interest in this sector has now become international, although in Spain the interest is relatively recent and there is not an abundance of these analyses. Some papers have covered this area of analysis using dynamic, structural and rockets and feathers models. Alternatively, they have studied the problems for competition that the wholesale-retail vertical relationships or the distributors cause. To date the so called "variance filter" has not been used. This methodology is based both on theoretical articles, such as the empirical evidence that affirms that all markets in collusion show higher prices, and lower than market average standard deviation.

We used the sale price data for the twenty-seven weeks between April and December 2008, and started with the hypothesis that the markets in collusion have higher prices and lower standard deviation. Then we established a database for the ten largest cities in Spain terms of population, and for all the service stations that they have. We assigned figures for the missing values by using Markov chains.

The empirical results show that for the two types of fuel, the service stations set very homogeneous prices; i.e. their average prices and standard deviations are similar. Secondly, similar behaviour among the petrol stations is more evident for petrol 95 than for diesel. Thirdly, the margins in price variation, when compared to the average and standard deviation, are not significant enough to confirm heterogeneous behaviour among retailers, even when analysed city by city. The homogeneity of prices and standard deviation equally fit the dynamics of competition or collusion. Despite this, empirical results from previous papers, and the similarities in behaviour between Las Palmas de Gran Canaria and the rest of the cities in the study seem to support to a greater extent the possibility of there not being effective competition in this sector.

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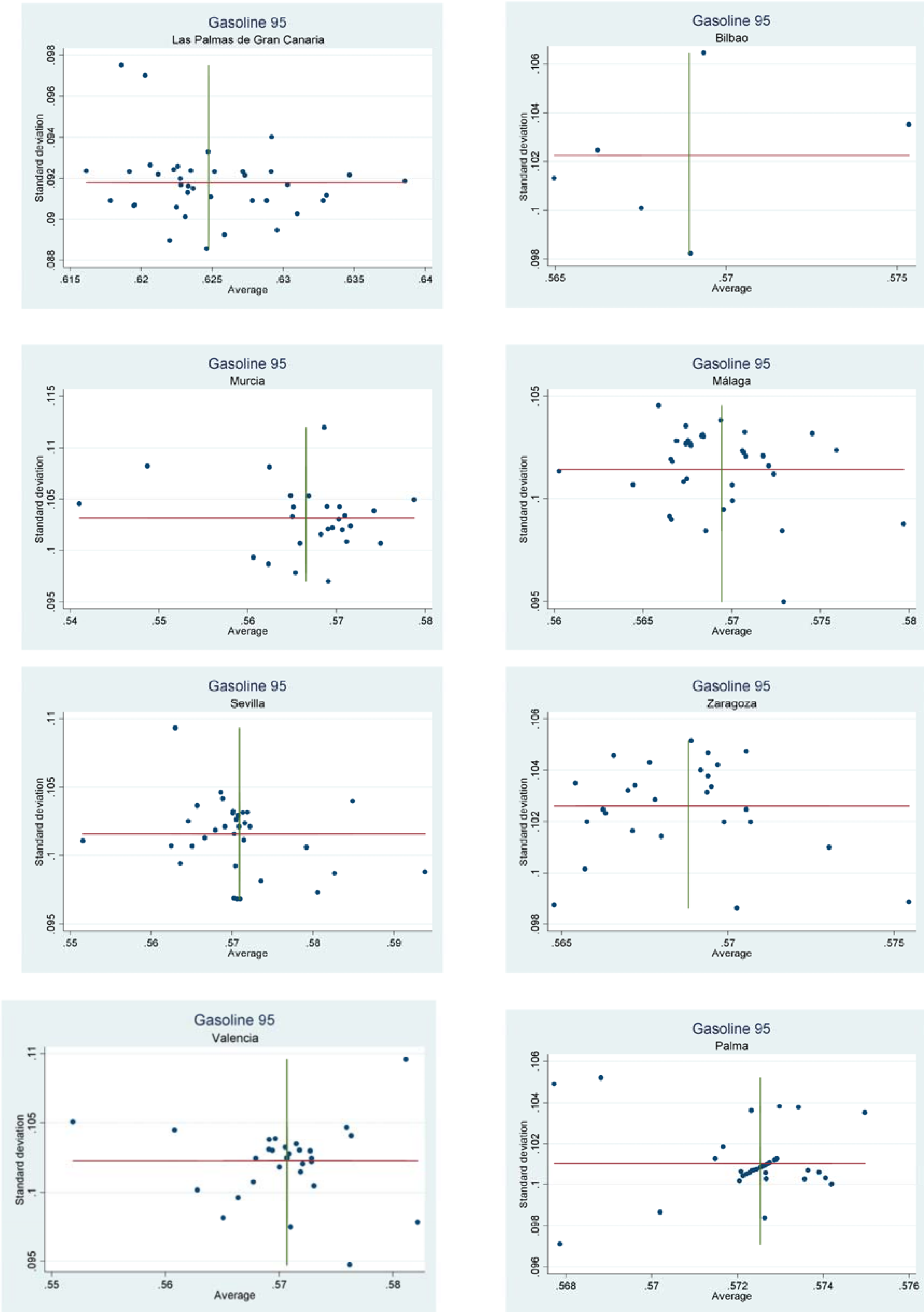
Anex I

Figure 5: Price and standard deviation analysis. Gasoline 95 (Other cities)

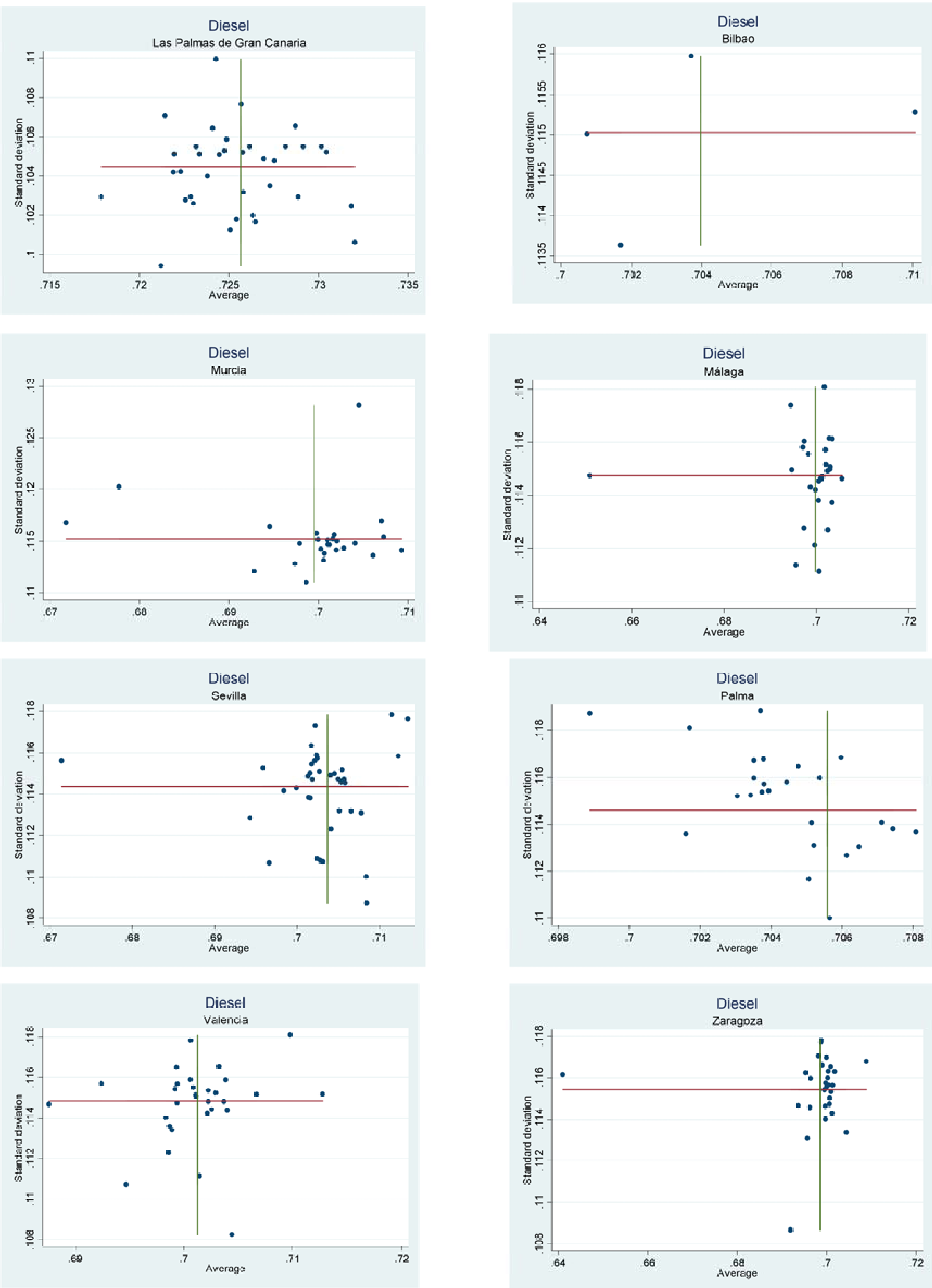


Source: own elaboration from data provided by the Ministry.

Note: The prices are expressed in euros per litre of fuel.

Anex II

Figure 6: Price and standard deviation analysis. Diesel (Other cities)



Source: own elaboration from data provided by the Ministry.

Note: The prices are expressed in euros per litre of fuel.

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