Does rigidity on prices hide collusion?¹

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Abstract

Cartel detection is a major, but more complicated tasks of the Competition Agencies. In recent years variance filters have been developed as a simple tool and they require a low volume of data. However, it has not been applied intensively by those Agencies, primarily for two reasons: there is no unanimity on the behavior of prices under collusion and the interpretation of the results of the variance filter is often inconclusive. This paper shows evidence on these two constraints, by applying a variance filter on a fuel retail market with special features. The results confirm the positive relationship between monopoly and price rigidity, as well as the detection of non-competitive behavior in the market when compared to appropriate benchmarks. These empirical results can help to disseminate and implement this methodology by the Competition Authorities.

Keywords: Competition, Gasoline, Variance filter, Gibbs sampling, Markov chain.

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

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1. Introduction

Competition authorities pursue price-fixing conspiracies in three stages: detection, prosecution and penalization (Abrantes-Metz et al., 2009). However, detecting collusion is not an easy task. In fact, detection of cartels based on empirical data has always been a difficult task for antitrust agencies due to it needs a great amount of data to check if actual prices in a market area are above the competitive level and why it is so (Esposito and Ferrero, 2006).

Therefore, to define statistical and econometric tools to detect possible collusive behavior that require a low level of data and easy, fast and intuitive implementation is one of the objectives of any Competition Authority. Furthermore, these tools must be understandable to judges to show the existence of collusion.⁴

While leniency programs enhance the effectiveness of competition policy in countries that apply as Borrell and Jiménez (2008) show, and increase the number of cases handled by the Authorities, not everything is done. And a simple way to analyze the sectors is the "screening". As Abrantes-Metz and Bajari (2009) define, a screen is a statistical test designed to identify markets where competition problems exist and determine, if a problem does exist, which firms in that market are involved in a conspiracy. As these authors suggest, the implementation of this methodology can be done through two strategies: the first one is to search for events that are improbable unless firms in the industry have coordinated their actions; and the second one uses the idea of a control group: prices that are anomalous compared to other markets suggest a competition problem.⁵

These two approaches has to satisfy three criteria identified by Harrington (2006a): it must be discernible by just looking at prices; the test to be conducted should be routinizable; and the last one, the screen should be costly for the cartel to beat. The use of such methodologies can be extremely useful for Competition Agencies and is likely to be extended in the near future due to its simplicity, the low level of data required as a means

⁴ Werden (2004) summarizes the economics behind the collusion, the relationship with the legal aspects and its use in real cases, mainly in United States. As the title event, trying to reconcile with the Antitrust Law oligopoly theory. In fact, legal scholars and economists attach two different meanings to the word "collusion" (Buccirossi, 2006). The former employ it to denote a specific antitrust infringement, whereas the latter use it to mean a market outcome in which prices are above the competitive level, independent of how this outcome is reached.

⁵ Price parallelism has been considered as a collusive marker (Harrington, 2006a). Even the Department of Justice of U.S.A. has suggested that as in next reference: Department of Justice, 2004. Price fixing, bid rigging and market allocation schemes: What they are and What to look for. Available at: <http://www.usdoj.gov/atr/public/guidelines/211578.htm>

of enabling Competition Agencies to select potential cases on which to perform further analysis.

Despite these advantages, its application may still be limited by the competition authorities, mainly for two reasons. On the one hand, and despite some theoretical and empirical consensus on the behavior of prices in a cartel (we will see in Section 2), this consensus is not unanimous. The vast majority of theoretical models and empirical evidence in the literature shows that prices under collusion presented higher average prices and a lower standard deviation, that is a more rigid prices. However, Bolotova et al. (2008) show how the citric acid cartel actually presents a higher price, but also a standard deviation higher. Brannon (2003) had already shown that the relationship between collusion and variance could not be conclusive. Therefore, this may create doubts on Competition Authorities to interpret the results of analysis using this idea.

The second major problem is the lack of conclusive results when we are not sure that a cartel exists. While the results of higher average prices and lower standard deviation are observed in a relatively clear in other ways known cartels (leniency programs, etc.), few times in which it has been used to detect cartels, the result has not been satisfactory. The main problem is the result of a parallel behavior, this is similar prices and deviations, does not allow us to distinguish between perfect competition or a collusive behavior.

This article aims to shed light on these two aspects in the implementation of the methodology of filter variance in the market for fuel in the Canary Islands (Spain). The coexistence of islands in monopoly and oligopoly in the market in the Canary Islands petrol retail market will allow us, first, to test whether the prices are more or less rigid in an environment without competition; and on the other hand, noted the importance of finding a benchmark for comparison to help us interpret the results. To this last point are presented and discussed a set of alternatives (Section 5).

These two contributions are intended to clarify and strengthen the use of such methodologies for the detection of cartels, which precede an analysis in greater depth. The main results show that the relationship between collusion and price rigidity is more confirmed, and also the importance of having a benchmark of comparison in order to effectively interpret the results.

The rest of the article is structured as follows: section 2 presents the main theoretical and empirical literature about relations between collusive agreements and rigidity of prices. Section 3 describes the data and the characteristics of the Canary Islands's market, to show

the methodology and results in section 4. Section 5 discusses the interpretations of empirical results on different benchmarks, to finally present the conclusions in Section 6.

2. Rigidity on prices: theoretical and empirical literature

The Industrial Organization literature has not provided a satisfactory theory that links price rigidity with collusion (Athey et al, 2004). Despite criticism of this assertion, most classical studies relate positively collusion with low price variability, and outlines the work of Mills (1927), Means (1935), Stigler (1961, 1964), Salop (1977), Fershtman (1982), Carlson and McAfee (1983) or Carlton (1986, 1989), among others.

From a theoretical point of view, the most relevant work on collusion and price rigidity is Athey, Bagwell and Sanchirico (2004). They consider a model of collusion by an infinitely repeated Bertrand game, in which firms are privately informed as to their current cost positions. Assuming an inelastic demand they conclude that, among others, if firms are sufficiently patient and the distribution of costs is log-concave, optimal symmetric collusion is characterized by price rigidity and the absence of price wars on the equilibrium path.

Harrington and Chen (2006) is another theoretical study relating the existence of collusive agreements with price rigidity. These authors developed a dynamic computational model of cartel pricing with cost variability and endogenous buyer detection. Although the prices are sensitive to cost in the latter phase, they are less volatile than the non-collusive or monopoly price path because it takes longer for a cost shock to impact the price.

In terms of empirical evidence, one approach is the dispersion of prices in markets with homogenous products (Borenstein and Rose, 1994 and Tsuruta, 2008). Borenstein and Rose conclude that discriminatory price dispersion in airline fares in identical routes is explained by costs of whether cartel member cheated on the cartel's fixed list prices. So, dispersion increases on routes with more competition or lower flight density.

Tsuruta (2008) examines gasoline prices dispersion in Japan, considering both the wholesale and retail margins and the relationship of market structure with downstream behavior wholesaler. Using the brand and the distance of each service station to the closest, as a proxy of the level of competition, as determinants of retail margin and therefore price dispersion. The paper concludes that the degree of competition affects price dispersion, as traditionally accepted a greater competition, lower dispersion.

With regard to articles that present empirical evidence on the relationship between price level and its variance is to be noted by the Genesove and Mullin (2001). The authors review the rules and the impact of the Sugar Institute, a cartel of 14 firms included nearly all of the sugar cane refining capacity in the United States (from December 1927 until it was ruled illegal in 1936). The cartel did not fix output or set prices directly. But they instead homogenized business practices, thereby facilitating the detection of secret price cuts. They calculate the yearly margin on sugar refining in the United States in three stages: before, during and after the cartel period. The most important outcome is that the variance in the margin drops by nearly 100% during the cartel period.

Another example is the work done by Brannon (2003) for the retail market of gasoline in the United States. The author believes that the introduction of the "Wisconsin's Unfair Sales Act," legislation that would establish a minimum price in the market to eliminate potential sales below cost, facilitated collusive agreements. The article calculates the average margin and the variance for two markets affected by this legislation, as well as a similar market unaffected, allowing for comparison. The results show that the average is actually higher in collusive markets, however, the results in terms of variance is ambiguous.

Abrantes-Metz et al (2006) is other pioneering work, in which the authors examine a case of bid-rigging and, based on its results, then a study of possible collusion in a market. The authors find empirical evidence on higher prices and lower variability analysis of the cartel in the provision of frozen fish to the American army during the years 1984 to 1988. This cartel was detected and condemned by the Antitrust Division of the Department of Justice of United States. The authors note how the collapse of the cartel led to a decline in the prices of 16% and an increase in the standard deviation of 263%. With this empirical evidence the authors implement a filter of variance in the retail market for gasoline in Louisville to see if there are service stations with higher prices and lower standard deviations. This is the first implementation of a filter of variance in the economic literature and the results are not conclusive. Uniformity of behavior among all the service stations do not allow the authors to discern between a collusive behavior or competitive behavior.

Bolotova et al (2008) employ extensions of the traditional autoregressive conditional heteroscedasticity (ARCH) and generalized (GARCH) models, que resumen impactos sobre la media y la varianza simultáneamente, entre otras ventajas, a los cárteles del citric acid (1991-1995) and the lysine (1992-1995). They found mixed outcomes: the variance of prices during the lysine conspiracy was lower while the variance of prices during the citric acid conspiracy was higher than during more competitive periods.

Abrantes-Metz et al (2008), using the filter of variance to analyze whether the LIBOR (an indicator used by banks to determine the profitability of venture capital) was being manipulated by collusive agreements, as reported the Wall Street Journal . Although the variance was very low fees and the vast majority of banks were identical, the authors believe that compared to the benchmark can not be correct to say that the LIBOR is manipulated.

Muthusamy et al (2008) analyze the behavior of the price of potatoes in the market in Idaho. In this market measures were implemented to coordinate the supply through the United Fresh Potato Growers of Idaho. Using the same methodology as in Bolotova et al (2008), they find statistically significant evidence suggesting that fresh potato price volatility is lower during the period when the cooperative is in the market as compared to the pre-cooperative period.

Regarding the use of this methodology by competition authorities, Italian Antitrust Authority has only used it. Esposito and Ferrero (2006) applied a variance filter to two cases previously considered by the Authority: the retail gasoline market and personal hygiene products and baby food sales in pharmacies. The authors note how the retail prices of petrol in Italy are higher and the average standard deviation are lowest of all countries of the EU-15. In the second case perform a comparison of the prices set by the supermarkets, which the authors consider as the more competitive benchmark. The results, as in the previous case, are higher prices and lower standard deviations. As the authors point out, the results of applying the variance filter are the same as that which conclude the Competition Authority through other methodologies.

As we have observed and summarized in the table below, the results regarding the relationship between behavior and collusive price rigidity, despite a relatively clear point to the same scenario (higher prices and lower standard deviations) is not unanimous. Thus the work of Brannon (2003) and Bolotova et al. (2008) found no such relationship. We have also been observed that the works that they do not use a benchmark to compare the results obtained by the filter of variance hardly find a clear interpretation for them.

Table 1: Summary of empirical evidence on variance filter and on relationship between collusion and price rigidity

Authors (Year)	Sector	Results
Genesove and Mullin (2003)	Sugar (USA)	The variance of margin falls near 100% during cartel period.
Brannon (2003)	Retail gasoline market (USA)	By introducing a RPM Law in two cities, variance falls in one of them, while the other was unchanged. They use a different city as a benchmark.
Abrantes-Metz et al (2006)	Bid-rigging in frozen perch market (USA)	Standard deviation increase by 263% after cartel collapse.
Abrantes-Metz et al (2006)	Retail gasoline market (USA)	They don't show a collusive behavior.
Esposito and Ferrero (2006)	Retail gasoline market (Italy)	The standard deviation of the prices of gasoline in Italy are among the lowest in EU-15.
Esposito and Ferrero (2006)	Higienic products and baby foods on pharmacies (Italy)	The standard deviations of the prices of baby food are lower in pharmacies than in supermarkets.
Bolotova et al (2008)	Citric acid (USA)	The use of ARCH and GARCH models show that the variance is higher during the collusive period.
Bolotova et al (2008)	Lysine (USA)	The use of ARCH and GARCH models displayed that the variance is lower during the collusive period.
Muthusamy et al (2008)	Potatoes (USA)	The volatility of the price of potatoes is less during cooperative period.
Abrantes-Metz et al (2008)	Financial indicator (USA)	Although the variance is very low, using financial ratios and other benchmarks, found no evidence of manipulation of results.
Jiménez and Perdiguero (2009)	Retail gasoline market (Spain)	Only the comparison with the canary market seems collusive behavior.

Source: Own elaboration.

In summary, this methodology has an easy to use and interpretation, its use is widespread in the academic literature and in practical application, but suffers from some limitations, as already indicated. The empirical implementation that follows seeks to shed light on these limitations in order to assist the interpretation and dissemination of this methodology.

3. An example: retail gasoline market in Canary Islands (Spain)

Canary petrol market has certain characteristics that differentiate it from other markets, including national (Spain). Such differences can be summarized into four: First, greater experience in liberalizing the market, compared by the rest of the country. Secondly, most of the consumption comes from production (transformation) locally, which reduces the level of imports. Thirdly, the market is characterized by a high concentration at all industry processes. In the retail market, concentration for petrol 95 (similar to diesel) has a $CR_1=0.44$ and $CR_3=0.70$, being the leading company DISA. Notably, in the gasoline market in the Canary Islands there is only one independent company (PCAN), and there are no gas stations owned by supermarkets, as usual in the rest of Europe.

Fourth and finally, the aforementioned feature of a market structure featuring seven individual markets (islands), where in five of these companies operate under oligopoly and in two other there exist a monopoly, all simultaneously and with equal taxation (for further description of the market, see Perdiguero and Jiménez, 2009). In these islands, DISA is the only operating firm and its behavior with respect to prices is mimetic to the retailers of the two islands.

In this market we have taken the prices of all the service stations on the islands, both for petrol and 95 for diesel, the two products with higher demand from consumers. Data come from the website of the Ministry of Industry, Tourism and Commerce, Government of Spain, where a weekly (every Wednesday) we got the price, expressed in euros per liter.

Database includes 24 weeks in the period September 2008 to April 2009. On that basis there are a total of 420 and 391 service stations that sell petrol 95 and diesel, respectively. Of these, several did not provide all data in the sample period and if we exclude those with a remarkable number of missing values, we could incur a problem of sample bias. In this case, Petrol 95 shows 10.080 values and Diesel 8.993, and there is not available on 19 and 22% of the values, respectively. However, as explained in the subsequent section (4), this potential bias is minimized through the use of simulation techniques using Monte Carlo Markov chains for the imputation of these missing values.

Despite this, prior to imputation method, we analyze whether the stations with less information could lead us to a problem of self-sampling: the companies that may provide less information (or worse quality, in general) are those who behave in a "less competitive" manner. In this case, this potential problem is apparently less important, given that the

stations with missing values remain almost identical to the sample of each company in the total population, for both types of products.

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:

$$p(z^m, \theta | z^o) = \int p(z^m | z^o, \theta) p(\theta | z^o) d\theta$$

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 $E[g(\theta) | z^o]$, 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:

$$p(z^m, \theta | z^o) = p(z^m, z^o, \theta) / p(z^o) \propto p(z^m, z^o, \theta) = p(z, \theta) = p(\theta) p(z | \theta)$$

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

$$z_{it} - \mu_{it} = \rho_i (z_{it-1} - \mu_i) + \varepsilon_{it}$$

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

The next step is to obtain, for each station, the average price, its standard deviation, and to avoid problems of scale, the coefficient of variation⁶, for the period studied. Articles that have previously applied this methodology, Abrantes-Metz et al (2006) and Bolotova et al. (2008), using the standard deviation and comparing prices within a market. However, our analysis compares the performance of different markets, which may have different costs and different demands, which causes the standard deviation can be affected.

Also it should be noted that we are not looking at an anti-competitive practice that have already been reported, so we do not know neither the beginning of the period of a hypothetical cartel, nor the end. The aim is to detect possible deviant behavior from gas stations or groups of them. Figure 1 includes results for petrol 95 and diesel respectively. Green and red lines show the average and coefficient of variation for the entire sample, respectively.

Figure 1: Price and coefficient of variation for petrol 95 and Diesel (All petrol stations)

Source: Own elaboration from data provided by the Ministry.

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

From these graphs we can note that the result is very similar between the petrol 95 and diesel, while the cloud of points is apparently more dense in the center for diesel. It also gives a very similar among all stations. In fact, a symmetrical result is shared by both perfect collusion as well as the perfect competition, which as an advance in the previous section, the findings difficult to take.

⁶ The coefficient of variation is a dimensionless measure of dispersion which is the ratio of standard deviation and arithmetic mean.

Although the parallel behavior of prices has been indicated as a collusive marker, as pointed out in Harrington (2006a and 2006b), both in the United States and in European Union is not enough to discern the existence of collusion behavior. In fact there is a vast literature that indicates the possibility of observing parallels price without being under a collusive equilibrium, as indicated by Turner (1962), MacLeod (1985), Baker (1993) or Buccirosi (2006), among others.

Without having a clear benchmark, or to analyze a specific period in which companies have behaved so collusively, the analysis result is not conclusive. This problem is typical when we do not have a benchmark that allows us to interpret the results as seen in Abrantes-Metz et al (2006) and Jiménez and Perdiguero (2009). Without this benchmark of comparison, the best we can do is to locate those retailers that are located in quadrant II, i.e., higher prices and coefficient of variation below average.

This is precisely what is shown in Table 2, but with a nuance. We conducted the analysis by island, i.e., prices obtained and coefficients of variation means in each island, and for service stations were located in Quadrant II (with averages higher than the average island and coefficient of variation below), we obtained station further from the value that it meets both requirements. Table 2 includes the percentage change of maximum and minimum deviation with respect to the average island.

Table 2: Maximum Range of Variation in Quadrant II by Island

	% Maximum Highest Price Deviation with Respect to Average Prices by Island		% Maximum Lowest Deviation with respect to the Average Standard Deviation by Island	
	Petrol 95	Diesel	Petrol 95	Diesel
Gran Canaria	1,86	8,40	-7,70	-8,83
Tenerife	2,21	2,25	-13,08	-10,47
Fuerteventura	4,18	1,28	-12,03	-7,26
Lanzarote	1,52	5,86	-6,89	-5,90
La Palma	2,38	1,79	-11,47	-4,32
La Gomera	0	0	0	0
El Hierro	0	0	0	0

Source: Own elaboration from data provided by the Ministry.

As can be seen, the percentage differences in these extreme cases regarding the average values in the II quadrant of each island can never attain, even a 9% hike in prices, nor more than 13% for the low coefficient of variation. In fact, the variations are greatest in the coefficient of variation than for the prices.

Although there is no threshold set for determining collusion, Abrantes-Metz et al (2006) explain that it must at least be 50% higher average prices and a 50% lower standard deviation. Neither of the two conditions are met but, as set Perdiguero and Jiménez (2009), this is a market that is characterized by low margins for large quantities, so this 50% might be excessive. In summary, following this methodology and establishing a clear benchmark, we can not conclude the existence of any collusive agreement in this market, a result similar to that described for the city of Louisville (USA) by Abrantes-Metz et al. (2006).

5. Interpretation of results: a comparative analysis with different benchmarks

In practice, there are at least two screening approaches. The first one is to monitor the price variance and assess whether it is low relative to some benchmark. And the second one is to identify the transition from non-collusion to collusion or vice versa.

The latter approach includes some bias, because the cartel's behavior before and after the period collusively do not should be competitive, as mention below. The approach taken in this case is the former. Brannon (2003) took a city that had not been affected by legislative change. Perdiguero and Jiménez (2009) used as a reference the city who knew, other studies on the same sector and region, which was low competitive. In our case, we can use at least two different types of *benchmarks* and also highlights the problems that could arise with other third hypothetical *benchmark*.

i) If monopoly exists

The main advantage of this case is the existence of a real monopoly in two of the seven geographic markets analyzed, which in the literature (as far as we know), never has been. In fact, it is the ideal situation: to compare monopolistic islands with oligopolists markets. Petrol stations in monopolistic islands show same prices for all service stations and in both islands, but are the lowest of all markets. This is due to the vast difference in demand between these markets, since the population and economic activity in the monopolistic islands is up to 100 times lower than in the rest. In fact, Perdiguero and Jiménez (2009) analyze the same market through an analysis of conjectural variation and they emphasize

that the population is a statistically significant factor on the quantity sold and indirectly on the price.

But we can draw a significant conclusion: the standard deviation and coefficient of variation is always below the monopoly situation in respect to the oligopolistic islands. Table 3 shows the percentage change of the coefficient of variation in each island regarding the monopolistic ones, which varies between 1.06 and 8 per cent higher on islands where there is more than one operating company.

Table 3: Percentage variation of coefficient of variation of each island regarding to monopolistic islands (El Hierro and La Gomera)

	Petrol 95	Diesel
Gran Canaria	1,22	1,66
Tenerife	4,82	2,81
Lanzarote	5,06	3,89
Fuerteventura	8,00	5,28
La Palma	1,06	1,25

Source: Own elaboration

So the use of this *benchmark* allows us to change the perspective of the analysis shown in Figure 1. Now average price and average standard deviation shown by the green and red lines are of the monopolistic islands, thus reflecting the less favorable situation possible. In this case we are looking for service stations which have coefficients of variation similar to the worst possible situation (monopoly). And as we can see, the cloud of points for both products is close to the average coefficient of variation in monopolistic islands, and even some stations are below it.

Figure 1. Price and coefficient of variation for petrol 95 and Diesel (All petrol stations).
Monopolistic islands as benchmark

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

Taking as reference the behavior of the monopolistic islands, we can reach an important conclusion: the gas stations that operate in oligopoly have a higher coefficient of variation. This means that we obtain evidence for a positive relationship between collusive behavior and price rigidity. Therefore, our empirical results confirm the relationships established by theoretical models and most of the empirical evidence, and against the results obtained by Brannon (2003) and Bolotova et al (2008) for the case of citric acid.

ii) *If a very competitive firm exists.*

But, how to analyze it if we did not have a monopoly as a benchmark? One option is to locate companies that are known more competitive than the rest. This was done by Brannon (2003) and Esposito and Ferrero (2006) for their respective cases. In the retail market of oil, the work of Hastings (2004) and Clemenza and Gugler (2004) suggest that independent firms disciplined competition in this market.

In the Canary Islands, unlike in the rest of Spain, there are no service stations of supermarkets (which traditionally compete more aggressively on price), but there is a company that looks like this and in fact which is cheaper sale: PCAN. So, setting it as a benchmark, Table 4 shows the percentage of price variation and the coefficient of variation of the average for each brand respect to this company.

Table 4: Percentage variation of average prices and coefficient of variation of each brand regarding to PCAN (independent brand)				
	Petrol 95		Diesel	
Brand	Price	Coefficient of variation	Price	Coefficient of variation
Cepsa	1,1	-9,80	0,9	-5,89
Disa	1,1	-13,06	1,5	-5,63
Shell	1,3	-11,01	1,1	-7,70
British Petroleum (BP)	1,7	-11,38	1,1	-6,04
Repsol	1,1	-7,63	0,3	-5,33
Texaco	1,8	-10,42	1,4	-4,66
Others	1,5	-8,01	1,2	-4,52
Total	1,3	-9,93	0,9	-5,89

Source: Own elaboration.

The prices of other brands are superior to those of PCAN between 0.3 and 1.8%, while the coefficient of variation of PCAN is always greater than the other competitors, between 4.5 and 13.1 percent.

We have obtained two values (prices and coefficient of variation) in municipalities with PCAN service stations and without them, to test whether PCAN stimulate competition. The results suggest that prices are always higher and the coefficient of variation is smaller if PCAN is not in the municipality. In particular, prices in towns with PCAN stations are 0.5% lower for gasoline 95, 0.3% for the Diesel, and the coefficient of variation is 5.1% and 2% higher respectively.

Figure 3 uses average price and coefficient of variation for PCAN stations in the Canary Islands as a reference. The objective here is to find whether there are retailers in the second quadrant, with higher prices and lower deviations. And as can be seen, the vast majority of the stations are located in this quadrant.

Figure 3: Price and coefficient of variation for petrol 95 and Diesel (All petrol stations).
PCAN (independent) as benchmark

Source: Own elaboration from data provided by the Ministry.

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

The result of the comparison with the independent PCAN points to the same direction as when we used the islands of monopoly as a reference. Service stations outside PCAN have average prices higher and lower coefficients of variation. Therefore, we obtain empirical evidence of a positive relationship between less competition behavior and rigidity on prices.

iii) If a cartel breaks

The discovery and the breakdown of a cartel may also serve to analyze the behavior of firms before and after it, and to obtain a counter-factual analysis: how do the price should have been in the absence of the cartel? However, although the breakdown of a cartel can be used, as indicated in Harrington (2004) challenges this approach, arguing that post-prosecution prices are not good measures of the “but-for” price, that is, the price that would have obtained in the industry if not for the cartel, because firms have an incentive to maintain higher prices in order to limit their civil liability.

Moreover, cartel histories seem to demonstrate a greater proclivity for large price collapses after termination than price wars before termination (Connor and Bolotova, 2006), as in the most of the vitamin cartels (Connor, 2006). That is, cartels do not seem to end in price wars that lead them to a price competition level, but finished at higher levels. For this reason, although we could confirm the breakdown of a cartel in a given time, we must be cautious with the counterfactual analysis that we make.

Summary of results

Analyzing the results of the filter of variance without to compare it with any kind of benchmark we could not discern any conclusive results, applying the above two types of it yields to this conclusion: the service stations are behaving close to a collusive behavior and clearly less competitive than the independent firma PCAN.

Although the coefficient of variation of gas stations operating in oligopoly is higher than those of monopoly and smaller than the company PCAN, that petrol stations are more closely to the former not the latter. We can therefore conclude that the average performance of different service stations (excluding PCAN) is very close to a monopoly. This evidence would justify further investigation of the behavior of these service stations by the Authorities of Competition Policy.

This result is not surprising if we take into account the characteristics of the gasoline market in the Canary Islands and the empirical evidence obtained on it earlier. Moreover, this retail market meets most of the factors that facilitate tacit collusion described by Ivaldi et al. (2003): symmetrical costs, transparency of information, etc. As well this market meets some that produce rigidity on prices, as it is described in literature. For example, Athey et al (2004) confirm the rigidity on prices if companies know the costs of its rivals. In this case, all companies share the same wholesaler.

Genesove and Mullin (2003) suggest the market transparency as a way to control the variability in prices. And this market is one of the most transparent we know. Connor (2005) cites that preventing or limiting the entry, it increases the likelihood that the price variation is reduced. While not being formally accused of cartel, but that entry is reduced in this sector, either for environmental reasons or due to difficulty in obtaining licenses for opening new areas, especially with the current stagnation of demand, even at the high fixed costs (and sunk).

Empirical evidence obtained through other approaches also supports the conclusion of a non-competitive behavior. The results obtained by Jiménez and Perdiguero (2008) and Perdiguero and Jiménez (2009) using both conjectural variations analysis show an average behavior of the service stations that operate in oligopolistic markets closer to perfect collusion. In fact, the authors can not rule out that retailers behave as a monopoly.

Thus, while the aggregate analysis did not allow us to conclude the existence of a collusive behavior, using two different benchmarks (monopoly company and a company with more aggressive price competition), together with the results of other structural approaches to this sector, let us conclude that the market can be more competitive in what is now and, while there are no business exercising an effective competition (such as PCAN), the implicit behavior of firms is more pro-collusive than pro-competitive.

6. Conclusions

To detect, analysis and prosecution of cartels is one of Competition Agencies main tasks. However, detection of cartels is an extremely complicated task. Therefore, developing simple methods and requiring a relatively low level data, which allow to identify possible collusive behavior, can be very useful. Thus has been developed and popularized in recent years as the methodology of the variance filter, which satisfies the features described above. However, their dissemination and implementation by Competition Authorities is still limited, mainly for two reasons. On the one hand, there is no unanimity on the behavior of prices under a cartel. While evidence shows that higher prices and tighter under collusion, the evidence is not unanimous, which may hamper the interpretation of results. Furthermore, the results of implementing a variance filter are less explanatory when there is no benchmark for comparison to assist in its interpretation. Obtaining similar behavior to the average of all market participants makes it very difficult to draw conclusions from the analysis.

This article aims to shed light on these limitations by applying a variance filter in the retail market for gasoline in the Canary Islands (Spain). This market presents the peculiarity of being made up of five islands in oligopoly and two in monopoly of a firm (DISA). This market structure allows us to see if monopoly prices were more or less rigid with regard to a potentially more competitive market; and secondly to compare the results of this second potentially more competitive market and thus able to draw conclusions about the level of competition.

The empirical results show firstly how the monopolistic market shows lower coefficients of variation than the rest of the market, which would confirm the positive relationship between the existence of cartels and a lower price variability. Secondly, the comparison of results both with respect to the monopoly in gas stations, and to the independent firm (PCAN), we suggest a closer to perfect collusion than a competitive outcome. This evidence has already been shown by other authors through different methodologies such as Jiménez and Perdiguero (2008) and Perdiguero and Jiménez (2009).

As economic policy recommendations, we stress the appropriateness of such tools as collusive markers. The empirical evidence shown in this article can help consolidate methodologies such as confirming the existence of more rigid prices in the presence of a cartel, and helps the interpretation of results with the proposal of different *benchmarks*.

However we should note the importance of correctly defining the *benchmark* of comparison for this method, to give a real practical operation for the Competition Authorities. In this case we used monopoly situations, but if this is not possible nor is there a known period of collusion, we have seen that the behavior of independent service stations can be a reference.

In other sectors could be implemented in a similar way, as in the airline industry, where companies might be low-cost, or hard discount supermarkets in the case of retail distribution.

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