Collusion through delayed pricing: Evidence from the Italian petrol market

Patrick Andreoli-Versbach
International Max Planck Research School for Competition and Innovation & Ludwig Maximilian University

May 17, 2011

Abstract

This paper shows how price leadership and delayed price adjustments to cost shocks were used as a facilitating practice in the Italian petrol market to tacitly collude. The consequences of two shocks are evaluated: First the publicly announced price policy change by the market leader, ENI, who started changing its retail price less frequently but in bigger and less predictable amounts. Second, the investigation of the Antitrust Authority after a buyer's complaint of high and aligned prices. The effect of the announced price policy change was twofold: competitors aligned their prices to the market leader and margins rose. The cartel was then broken after the Antitrust Authority announced its investigation. As the identification strategy may suffer from omitted variable bias, e.g. demand and supply shocks, the same analysis is performed using a competitive benchmark as counterfactual. The results are unchanged. Sticky pricing and coordination through price leadership facilitated price alignment and helped maintain higher margins as mean of collusive behavior.

Keywords: tacit collusion, price leadership, delayed pricing, facilitating practice, competition policy
JEL codes: L13, L41

I would like to thank John Sutton, who advised me on the first version of this paper and helped me to highlight the important points. I greatly benefitted from the comments of Rosa Abrantes-Metz, who discussed this paper at the ZEW conference on "Quantitative assessment of Antitrust Analysis" in Mannheim and all the participants at the conference on empirical work held at Ammersee for their comments and especially to Stephen Ryan and Joachim Winter. I am also very grateful to Carlo Bardini, Fabio Massimo Esposito, Alessandro Noce, Pierluigi Sabbatini and all other participants at the internal seminar of the Antitrust Authority in Rome, Italy, for their numerous comments. I gratefully acknowledge financial support from the Deutsche Forschungsgemeinschaft through GRK 801 and all the participants of seminars at Max Planck Institute for Competition and Innovation and Ludwig Maximilian University for their comments, especially to Monika Schnitzer who gave me excellent comments on the structure of this paper.

1 Introduction

In most industries firms realize that their profitability strongly depends on the actions of their competitors. Colluding on prices or quantities raises profits and decreases consumers' welfare. While firms have strong incentives to collude, this is illegal and persecuted by Antitrust Authorities (AA) worldwide. Documentary exchange of sensible information and agreements can, if detected, lead to enormous fines. To obviate firms can tacitly collude, this is firms collude without explicit communication. In general this is legal, as without documentary evidence it very hard for AA to prove collusion[1] in courts. While tacit collusion has the same negative effects on welfare as explicit collusion, it is more difficult for firms to tacitly agree on a common, cartel-profit-maximizing, price or quantity and to punish in case a firm deviates as there might be uncertainty about the actual agreement and on how to respond to shocks. This paper analyses tacit collusion empirically through two practices: pricing leadership and delayed price responses. Price leadership refers to the situation where the market leader sets a price and the competitors follow, while delayed pricing refers to committing not to change its price according to costs on a short term time interval, but keeping the price rigid and the changes infrequent.

On the 6^{th} of October 2004 the CEO of ENI, Mr. Vittorio Mincato, publicly announced a price policy change that consisted in rigid pricing and slow adjustment to the major cost factor, Platt's Cif Med (Platts), which is the wholesale Mediterranean price of gasoline. The price policy change was called "New Method Mincato" and was designed to maintain sticky prices by committing not to change the retail price following the international quotation of gasoline. The average time interval between price changes went from 6 days before the new pricing policy was introduced, to 19 days after its introduction. The average absolute percentage change on the price increased from 1% to 4.5%. Prices, thus, changed less often, but when they changed, they did in bigger amounts. After 5 months, on the 25^{th} of March 2005, the Italian Trucker Association, FITA, publicly complained about high, rigid and perfectly aligned prices. This eventually triggered an Antitrust Investigation (AI), which was communicated to companies on 23^{rd} January 2007 and ended on 20^{th} December 2007 with the acceptance of behavioral remedies jointly proposed by the AA and by companies. The initial accusation of collusion was not investigated by AA, rather as soon as the companies proposed behavioral remedies these were accepted without further investigation on collusive behavior.

To show how the public announcement of pricing change functioned as an information exchange on intended future behavior and thus worked as a facilitating practice, I will apply four interrelated methodologies which can be generalized and used by AA to highlight behavioral shifts from competition to collusion and back.

First, I will briefly describe the main features of the industry to show that the ex-ante probability of cartelization is high. Second, I will show how the introduction of the new price policy helped the followers to align prices. Third, I will look at the effects of the new pricing policy on industrial margins and the price-cost correlation. Finally, I will consider a competitive benchmark and consider

[1] It is not the scope of this paper to analyse whether tacit collusion should be persecuted. Two quotes are reported here with opposite views: Judge Stephen Breyer (1988) "Courts have almost uniformly held [that] individual pricing decisions (even when each firm rests its own decision upon its belief that competitors will do the same) do not constitute an unlawf agreement. That is not because such pricing is desirable (it is not), but because it is close to impossible to devise a judicially enforceable remedy for 'interdependent' pricing. How does one order a firm to set its prices without regard to the likely reactions of its competitors?". While Richard Posner said:"one seller communicates his 'offer' by restricting output, and the offer is 'accepted' by the actions of his rivals in restricting their outputs as well. It may therefore be appropriate in some cases to instruct a jury to find an agreement to fix prices if it is satisfied that there was a tacit meeting of the minds of the defendants on maintaining a noncompetitive pricing policy."

the effects of the policy relative to it.

In the first part I will describe the main features of the Italian petrol industry and compare these with the factors facilitating collusion identified by the literature (Levenstein and Suslow 2006, Grout and Sonderegger 2005). This first qualitative step serves to minimize the possibility of false positives, rejecting the null of competition when it is actually true, and thus it ensures to focus the analysis on industries with a high ex-ante probability of cartelization.

In the second part price alignment and convergence to the price of the market leader, ENI, will be discussed. The aim is to show how the market leader's pricing served as a focal point to align prices and distort competition. I will create a variable which reflects the degree of price alignment and relate it to the price changes of the leader. This will show how the infrequent price changes were used as a focal point to align and agree on the optimal price, which was set by the market leader and copied by the followers.

The third part starts with the description of the price cost correlation. This is a key market variable as both petrol and its main component, crude oil, are internationally traded commodities. Thus it is easy to detect breaks in the price cost correlation over time, as the Italian wholesale price should, absent of shocks, be highly correlated with the Mediterranean price, the Platts. The correlation coefficients show a substantial drop in this relation from the beginning of the new price policy to the buyer's complaint and then a shift back to prepolicy levels. In addition I will conduct a critical event analysis on the effects of the policy on firms' profitability. I will explain changes in industrial margins, by considering events which could have formed and broken the cartel, the announcement of price policy change by the leader and the buyer's complaint followed by the AI, respectively. The regressions on mean margins on the different time periods, show a significant increase after the introduction of the policy and then a substantial decrease after the announcement of the AI. Finally prices will be regressed on lagged costs, period dummies and the interaction between time periods and costs. With this specification we can test whether the level of prices and the price cost relation changed in the period where firms were alleged of colluding. This last regression will show the break in the price generating process caused by the price policy change and the subsequent alignment.

In the final part a competitive benchmark will be used as a counterfactual in order to account for unobservable variables such as demand and supply shocks which could have caused an increase or decrease in margins, but are unobserved. Note that the benchmark does not need to be competitive, as even a cartel will set higher margins and shift the price according to costs, thus responding to demand and supply shocks. The important thing to note is that, absent of breaks, the price relation between the Italian and the benchmark should be constant over time. Thus a significant shift can be regarded as a break in the way firms compete. Depending on whether margins increased or decreased after the break, it can be argued to have created or broken the collusive agreement.

All regressions consider changes in the price cost relation or in margins rather than absolute values, as the aim of this paper is to show the shift from competition to collusion and then back. The focus is on the market impact of the coordination that can be inferred from the available data. The analysis will be based on relative measures, such as pre-post margins or price cost correlation, as higher margins itself could be due to demand and supply shocks or structural differences across markets. The methodology used must distinguish between all the plausible explanations for higher margins, and only a series of regressions controlling for costs and trends can guarantee with a high confidence level that all other competitive explanations were accounted for, but cannot explain the market outcome.

While this methodology will be applied to the case of the Italian petrol market, the scope of this

paper is potentially wider. The use of readily available data such as prices, an indicator of costs and a benchmark can provide AA with three useful tools to fight cartels. First, it may help to provide evidence on the anticompetitve behavior and to show the shift from collusion to competition and back. Second, if used as an ex-ante screen it can provide good information on where to trigger inspections. Finally, the use of economic screens lowers the ex-ante incentives of firms to collude by increasing the likelihood of detection and punishment.

This kind of empirical analysis is of great relevance for Competition Policy and could be used in addition to other screens and the leniency program, which accounts for 2/3 of the detected cartels. In the case of internationally traded commodities and national markets, it would be possible to collect data and program a software to search for significant shifts in the relation of market key variables, which are indicative for a change in firms' competitive behavior.

The paper is organized as follows. A review of the theoretical and empirical work relating to this paper is presented in Section 2. Section 3 describes the data used in the empirical part. In Section 4 the econometric analysis will be discussed. I will first outline the key elements of the industry, then analyze alignment. Finally the effects of the policy on the price cost correlatio, margins both in the Italian market and relative to a benchmark will be discussed. The last section, Conclusions, will present some concluding remarks and policy implications of the empirical findings useful for Antitrust Authorities to fight cartels.

2 Review of literature on empirical cartel detection

The most difficult part in an econometric analysis of cartel detection is to prove that the suspected behavior could have been generated by no other means than collusion.

A successful attempt to show how a competitive market outcome can be distinguished from a collusive one comes from Porter and Zona (1999). They show that in the case of the Ohio school, milk prices were lower when transportation costs were higher, a trait not in line with competition. Connor (2001) looks at events which could have caused a break or start of a cartel and in particular shows the role of trade association in the lysine cartel.

Brannon (2003) uses descriptive statistics to quantify the impact of collusive practices on the behavior of the first and second moments of price distribution and Abrantes-Metz et al. (2005) examine price movements over time around the collapse of a bid-rigging conspiracy. Both find that there was an increase in mean and a big decrease in variance of prices during the cartel.

Duggan and Levitt (2000) analyze cheating in sumo tournaments. They look at the final match, and consider the case of a wrestler with 7 wins, 7 losses, and one fight to go, fighting against an 8-6 wrestler. This case is of interest as the monetary difference between 7 and 8 wins in a tournament is very high. The 7-7 wrestler wins around 80% of the time, but when they meet again in the next tournament the opposite is true. This points to the exchange of favors, cheating, between wrestlers.

In a paper commissioned by the Office of Fair Trading Grout and Sonderegger (2005) investigate whether econometric techniques can provide useful information as to where cartels may be located. They use a structural approach to identify industries with characteristics facilitating collusion in order to estimate the ex-ante probability of cartelization through a logit model where the probability of market cartelization occurring is assumed to be a function of the market characteristics and previously detected cartels. They find that the three most relevant issues are: homogeneous product, stable demand and market shares. Even though cartel detection is not random, but might be

correlated with the industries' characteristics, this analysis can be of help to focus economic screens on specific industries with an high ex-ante probability of collusion.

From a theoretical perspective Green and Porter (1984) show that if demand is variable enough, firms can tacitly collude using a trigger strategy which eventually reverses and goes back to collusion. The occasional breakdowns from collusion to price wars, will happen even if in equilibrium no one actually cheats. Price wars in response to unexpectedly poor sales are necessary to keep the incentives to cooperate intact. This doesn't happen in non-collusive markets where the margins' variability will be lower and demand shocks will have a lower impact on prices.

In the seminal paper by Maskin and Tirole (1988), they analyze duopolies where firms take turns in changing prices. They show that taking alternating price changes works like a sort of commitment by firms not to change prices instantaneously, as in the classic Bertrand competition model. They show that there exists a perfect Markov strategy that allows firms to coordinate on the monopoly price. Interestingly they show that this is also true with endogenized timing, that is when firms choose when to change price but then have to stick to it for two periods. This setting is very similar to the situation of the Italian petrol industry. As their paper shows, the commitment to stick for a long period on a fixed price can lead to collusion and alignment.

3 Data

To empirically test for collusion in this setting three types of data are necessary: first a measure of profitability, second a competitive benchmark and third some crucial events which could have changed the way of how firms compete with each other. The time series must consist of observations before, during and after the cartel so as to have the possibility to compare these periods. A time series consisting of prices and event dates is not sufficient. Unless there is hard evidence of a cartel, observed prices are an equilibrium outcome and thus it is not possible to distinguish between a price increase caused by collusion or due to shifts in demand and costs.

The dataset consists of two parts, summarized in **Table I**. The first is a collection of daily pre-tax wholesale prices and wholesale prices as reported by the Platts' Index. The prices are from the nine major companies: Agip, Api, Erg, Esso, IP, Q8, Shell, Tamoil and Total. The time period goes from the 1st of January 2004 until the 31st of December 2008.

The most important cost for companies is the Premium Unleaded Gasoline Mediterranean price, which is reported by the Platts Cif Med. The retail price has two components, a fiscal and an industrial. It has been estimated by the Italian Union of Petrol Producers that the Platt's reflects 67% of the industrial price, while the rest is attributable to distribution, storage, administrative steps and the stations' margin. Taxes account for 63% of the final retail price in Italy. The Platts' can be considered as the opportunity cost of selling gasoline on the international market instead of selling it to the Italian petrol stations. Even though I do not observe firm specific costs, the main source of cost for firms is the Platt's Index. As companies are subject to the same opportunity cost it is easy to build a variable representing the industry's profitability, in this case industrial margin, which is defined as the difference between the mean Italian price and the Platts'.

The second dataset contains weekly average gasoline prices per country (Italy, Belgium, Netherlands, France and Germany) for the period January 2004 to December 2008, and was provided by The Energy Information Administration (EIA). These prices include taxes and were collected weekly.

The data about the difference in market shares of independently owned petrol stations and the petrol stations owned by big distribution, e.g. Auchan, Carrefour, and other hyper-stores, across

countries was published by the Italian Union of Petrol and Pöyry Energy Consulting.

[**Table 1: Summary statistic of the two datasets**]

4 Empirical Analysis

4.1 The Italian petrol industry

Until 1991 the pricing of petrol was controlled by the state through two institutions: the Italian ministry of industry and the Inter-ministry committee on prices. The final price was set in relation to the crude oil price, the European price and other "political" variables such as unemployment and inflation. From 1991 the liberalization process began with the "supervised" regime, where the ministry participated in the determination of the final price. In September 1993 a resolution by the Inter-ministry committee stated that "the prices of all petrol products [...] are freely determined by the companies"[2]. The only obligation for companies was to communicate their price to the ministry. In the time period of interest, going from January 2004 to December 2008 prices were freely determined by the market.

The industry under examination is the wholesale gasoline in Italy. Collusion among petrol station owners is not considered, as they don't have much leeway in the price setting compared to the nine integrated multinational suppliers. More than 95% of the market share is allocated among nine big players. All of them are at least in part vertically integrated, they either have access to crude oil or own shares in companies that have and have refineries in Italy or Europe. Finally they distribute gasoline to petrol stations which are committed to a single brand. These are owned in 60% of the cases by the oil companies and in 40% of the cases by private companies which manage on average 30 to 50 stations.

The distribution and price setting works as follows: The companies transmit to the manager of the station the so called "suggested price". This price is a non binding indication of what the final price for consumers should be. The owner of the station, who always has an exclusive contract with the company running over several years, receives a discount on the suggested price and is allowed to charge up to a certain percentage more of the suggested price. So even though he fixes the final retail price, his range is within his purchase price and the maximum price he is allowed to charge, as stipulated by the company. The suggested price represents a very good approximation of the final price charged to customers. This is important, as I will compare Italian prices to Belgium, Netherlands, France and German ones. There are structural differences between Italy and the rest of these countries, which are summarized in **Table 2**. For example, the big distribution owns considerably more stations in the rest of Europe than in Italy. Only 0.2% of Italian stations are owned by the big distribution, in contrast to 10% in Germany and 51.9% in France, the country with European lowest margins on fuel. The price setting mechanism is different here, as gasoline could be used to attract customers to the shops where they would then buy high margin goods in order to compensate the low margins on fuel. The incentive to sell at lower margins to attract customers increases competition for other petrol stations as well, leading to lower margins and an inferior number of stations with a larger amount of gasoline sold per station. As can be seen

[2] Gazzetta Ufficiale, 8 october 1993, number 237

in **Table 2** there are substantial differences across countries both with respect to taxation and distribution system.

[**Table 2**: Petrol industry characteristics in the selected countries]

The retail petrol market seems to be a market with characteristics facilitating collusion. It is characterized by a low number of firms, nine, and by a high Herfindahl-Hirschman index, 1952, that according to US standards would define the market as concentrated. As shown in **Table 3** ENI has a market share of 36.1%, more than double the market share of the second biggest firm, ESSO with 17.4%. 20.3% of its shares are owned by the Ministry of Economy and ENIs' market capitalization is of € 62 billion, making ENI one of the largest energy companies world wide. Except ENI and ESSO all other companies have similar market shares ranging from 5% to 10%.

[**Table3**: Market shares]

The findings of the previously discussed analysis by Grout and Sonderegger (2005) seem to suggest that the Italian petrol industry is a perfect candidate for collusion. The product is homogeneous, demand is stable over time and also market shares do not change substantially as the long term and exclusive contracts with petrol stations prevents competitors from expanding.

4.2 New pricing policy

The empirical analysis is based on a series of events summarized in **Figure 1**, starting with a publicly announced new pricing rule by the market leader, a buyer's complaint five month after the policy change and the subsequent investigation by the Antitrust Authority. Six months after the start of the investigation a series of remedies were proposed by companies and published by the AA. Eleven months after the start of the investigation, it was closed with the acceptance of the remedies.

[**Figure 1**: Time Intervals]

From the 6th of October 2004 onwards the CEO of the market leader ENI, Mr. Mincato, announced a change in price setting. Historically, after the end of the controlled price system in September 1993, prices were freely set by companies and since then responded to what is the main indicator of cost, the Platts Cif Med, the commonly used indicator for the Mediterranean wholesale price of gasoline.

The aim of the price policy, summarized in **Table 4**, was to make ENI's prices less responsive to the Platt's and carry out a pricing strategy where price changes were less predictable, on a longer term basis and the percentage change bigger than before . This policy was said to counter speculation on oil prices and maintain the buying power of consumers in times of volatile indices.

[**Table 4:** Price policy change summary]

A few weeks after the policy change the competitors started to follow ENI's pricing policy and the margins rose to levels higher than the pre policy ones. Five months after the change the Italian trucker association, FITA, signalled to the AA that petrol companies were charging high, aligned

and rigid prices over the last months. This eventually triggered the AI, which was communicated to companies on the 23^{rd} of January 2007, 22 months after the buyer's complaint. The initial scope of the AI was to prove unlawful behavior by firms and in specific to prove whether firms broke Article 101[3] of the EC Treaty that prohibits cartels and other agreements that could distort competition. A series of behavioral remedies was proposed by companies and announced on the 12^{th} of July 2007. Finally the investigation was ended on December 23^{rd} 2007 with the acceptance by the AA of the remedies. It is important to note that the AA accepted the remedies, without establishing whether an infringement under Article 101 occurred.

In **Table 5** a summary of periods and the corresponding dummy variables name is presented. These will be used throughout the rest of the paper.

[**Table 5:** Summary of variables]

The scope of the following sections will be to quantify the effects on margins of these events in order to demonstrate how the frequency of price changes was used as a facilitating practice to coordinate and maintain higher prices.

4.3 Alignment

The main feature of collusion is the agreement between firms on a profit-maximizing price or quantity. This agreement cannot be reached explicitly through communication as this is illegal, but could be reached through a facilitating practice[4]. This refers to a situation where an activity or behavior makes collusion more likely or more effective, either by making coordination easier or making it easier to sustain a collusive agreement. The price policy change by ENI could have had this intended meaning. ENI could have used its market power and in specific its pricing leadership to create a focal point and make it easy for competitors to align prices. In this case the facilitating practice may be to agree to change the price in accordance with the leader. Thus, if this is true, we would observe that each time the leader changes its price the followers react and align to it. In this case the market leader acts as the cartel leader indicating the price to charge and everyone else follows. Such behavior, which is not per se illegal, can be detected econometrically. If through the announcement of a price policy change the market leader acted as cartel leader, then within a few days after the leader changes its price the followers should change their price and align.

To show that this in fact happened during the collusive period I will construct two variables: $allignment_t$ and $pchangeEni_t$. The first variable indicates the number of competitors which charge the same price as the market leader, ENI, on day t, while the second variable is a dummy variable, being 1 if on day t ENI changes its price and 0 if the price stays constant. $dummyperiod_r$ is a dummy being 1 in the period of interest.

I will run two sets of regressions, in the first only period dummy variables will be included. These show if the average number of aligned competitors changed significantly over time, while the second regression will show how alignment was sustained through pricing leadership.

[3] Article 101 of the Treaty on the Functioning of the European Union prohibits: "...all agreements between undertakings, decisions by associations of undertakings and concerted practices which may affect trade between Member States and which have as their object or effect the prevention, restriction or distortion of competition within the common market..."

[4] For a discussion on whether facilitating practices should be illigal and persecuted see Hay (2000).

$$allignment_t = \alpha_0 + \sum_{r=1}^{n} \alpha_r dummyperiod_r + u_t \quad (1)$$

As in all regression the omitted dummy will be pre-policy and the coefficients are estimated with OLS. **Table 6** shows the result. The columns differ as different time periods were considered, but the results are unchanged. While over the whole period 1.5 competitors have on average the same price as the leader, this number increases to 2.8 during the collusive period and then decreases to .8 during the Antitrust investigation, with all coefficients significant with a p-value below 1%. This shows a clear and significant break in the alignment relation over time.

[**Table 6: Average alignment**]

In the next regression the pricing leadership by ENI will be tested by adding the price changes of ENI to the equation to show how alignment was achieved. The regression model will capture whether during the collusive period ENI's price changes induced the competitors to align their prices to ENI. If this is the case we should observe that within a few days of a price change by the leader, the $allignment_t$ variable increases meaning that competitors changed their prices and aligned to ENI.

$$\begin{aligned} allignment_t &= \alpha_0 + \sum_{l=0}^{3} \alpha_l pchangeEni_{t-l} + \sum_{r=1}^{n} \alpha_r dummyperiod_r + \\ &\quad \sum_{r=1}^{n} \theta_r (\sum_{l=0}^{3} pchangeEni_{t-l} * dummyperiod_r) + u_t \end{aligned} \quad (2)$$

where l is the number of lags[5] used, in this case $l = 0, .., 3$ and $dummyperiod_r$ is a dummy variable being 1 in period r. The dummy left out is the pre-policy period so that changes will be compared to it. In this regression there is both a constant shifter, α_r, which is the coefficient on the dummy variable and a slope shifter, θ_r. If the alignment behavior of the followers changed, we should observe a significant and positive constant shifter as more firms align in general. In addition, and most importantly, if the policy change introduced a facilitating practice through pricing leadership, the slope shifter should be positive, as the companies align after the leader changes its price. **Table 7** shows the results.

[**Table 7:** ENI's signals and followers alignment]

The previous results are confirmed. Both the slope and constant shifter are significant and go in the expected direction. The collusion dummy variable is significant and positive as in the previous regression and also the second and third lag on *pchangeEni* in the collusive period are positive and significant meaning. Over the collusive period, three days after a price change by the leader, on average four out of eight competitors had exactly the same price as the leader. During the AI this number dropped to one out of eight. Thus the introduction of the new price policy facilitated the

[5] The selection of the number of lags in all regressions was done after comparing the following criteria: Schwarz's Bayesian information criterion, the Akaike's information criterion, and the Hannan and Quinn information criterion

alignment of prices in the market and was in fact used as a facilitating practice. The next section will evaluate the effect on margins of this alignment. This is important as it is not clear yet that the facilitating practice had anticompetitive effects.

4.4 Prices and Costs

The pricing function is the most relevant tool for companies to compete in this market. Firms, given a certain fixed capacity in the short run, compete in prices which clear the market. ENI used to change its price weekly following the Platts. After its pricing change it publicly committed to decrease the relation to the Platts and increase the unpredictability of its price changes. In fact, as shown in **Table 4**, this policy increased the average time interval of price changes from 6 to 19 days and the average absolute percentage change from 1% to 4.5%. As shown in the previous section competitors aligned their price to the leader's one just after price changes. The commitment by the leader of sticky prices and the alignment from the followers could have been used as a facilitating practice to increase their profits. Increasing the time interval of price changes in a market with observable costs and a strong position by the market leader lowers uncertainty and helps to coordinate price reactions.

In this section I investigate the effect on profitability of the pricing policy. The data used are daily prices without taxes of the nine companies over the period 1^{st} January 2004 to 31^{st} December 2008. The first measure is a price-cost correlation over time. This is especially important in an industry such as the petrol one, where the main source of cost is the Platts and the good is homogeneous and internationally traded, which guarantees no cost information asymmetries among firms. In a competitive industry price and cost must be highly correlated and thus move together. Note that this could also happen in a collusive market, as firms could agree on a larger mark-up and then adjust their prices to costs. This correlation measure can provide a good proxy for behavioral shifts as it highlights the effect of the new policy on the price cost relation.

[**Table 8 – Correlation of price and costs over the relevant time periods**]

In **Table 8** a clear structure emerges. Dividing the period in five parts, before price policy change, collusion, buyer's complaint, the AI and finally post AI it emerges that this correlation dropped dramatically during the collusive period, from .88 in the pre-policy to .58 and then went back to the pre-policy levels after the buyer's complaint.

After the 6th of October, the correlation coefficient dramatically changed to almost half of the previous level. ENI's price for example went from a correlation with the Platts of .899 to .57 reflecting the new policy introduced, the aim of which was to break the retail price from the volatility of the Platts. After the buyer's complaint the levels came back to the ones of the first period. Even though a low correlation in a given period doesn't imply collusion and a high correlation doesn't exclude collusion what is important to note is the "change" in the relation of market key variables. In the collusive period firms did not set prices in relation to their costs. These correlations must now be compared with prices of commodities traded on international markets. By comparing the Platts to the Brent, the price of crude oil, it is immediate to see that this relation did not change over time, but is constant at about .9. This shows that while the Italian price cost relation suffered from a considerable drop, the relation between the internationally traded commodities was unchanged.

Figure 2 summarizes the path of the Italian price, the Platts and the average industrial margin over the same time periods considered before. The Industrial Margin is defined as the difference

between pre-tax price and the Platts. The relation between the price and the Platts exhibits a strong and positive trend, which will be controlled for in the regressions.

[Figure 2: Average Industrial Margins]

The relation between firms' behavior and their profitability can be evaluated econometrically with a series of dummy variables indicating the different time periods. What these dummies capture is the effect of the three main shocks (ENI's pricing change, the buyer's complaint and the Antitrust intervention) on margins. Further I subdivided the second period "in-between" in two periods, the first period before the buyer's complaint, which will be called *collusion* and the period between the complaint and the beginning of the AI which will be called *bcomp*.

$$indmargin_t = \alpha_0 + \sum_{r=1}^{n} \alpha_r dummyperiod_r + \alpha_1 trend + u_t \tag{3}$$

Where $indmargin_t$ is the mean industrial margin and the other variables are dummies being 1 in the period they represent and 0 elsewhere, while trend is a linearly increasing variable. In the regression reported in **Table 9** the average industrial margins are regressed on different time periods to see if the industries' profitability changed significantly over time. If there were no shocks in the market and no break occurred we would expect all the dummies to be insignificant, controlling for trends and other shocks. **Table 9** shows how margins changed on average over time. From the policy change to the AI industrial margins rose significantly, and then went back to prepolicy levels during the investigation. By dividing the first period in two, before and after buyer's complaint the relation is even clearer. Margins rose significantly before the buyer's complaint broke the cartel down. Margins decreased even more after the communication to companies by AA of an investigation. After the end of the AI margins returned to their pre policy level.

[**Table 9**: regressions on margins]

In the last regression the price is modeled as a function of lagged costs, period dummy variables and intersections between period dummies and lagged costs. Similarly as in the regressions on pricing leadership, this functional form captures breaks in the data generating process. If firms colluded we should observe an higher average price controlling for cost shifts.

$$\begin{aligned} price_t \quad = \quad & \alpha_0 + \sum_{l=0}^{8} \alpha_l Platts_{t-l} + \sum_{r=1}^{n} \alpha_r dummyperiod_r + \\ & \sum_{r=1}^{n} \theta_r (\sum_{l=0}^{8} Platts_{t-l} * dummyperiod_r) + \alpha_1 trend + u_t \end{aligned} \tag{4}$$

Table 10 shows the results, where lagged costs are omitted for brevity.

[**Table 10**: Price and cost relation]

The results are in line with the collusive hypothesis. During *inbetween* prices rose controlling for costs and a trend, while during the investigation prices went back to pre-policy levels. By dividing up the *inbetween* period in *collusion* and *bcomp* the relation dose not change. Prices were higher in both periods. Interestingly if *antitrust* is divided into pre and post remedies proposal, prices drop at the beginning, but they rise again as soon as the remedies were made public, probably because companies knew that the AA was going to accept those without establishing whether an infringement under Article 101 occurred.

4.5 Competitive Benchmark

In this section the Italian petrol market is compared to a competitive benchmark, Central Europe, which will work as the counterfactual. As one cannot know what would have happened in Italy without ENI's change we need other, more stable, markets which we can relate the Italian to.

In order to have a causal interpretation of the regressions above we need to show that the shocks distorted the Italian outcome, but not only with respect to the pre policy levels but most importantly with respect to a competitive benchmark.

Central Europe provides a good comparison for the Italian market. The currency is the same, the market is similar and geographically close, but as shown before a larger percentage of the retail market is managed by the big distribution, hyper stores such as Auchan and Carrefur. The entry of the big distribution as petrol seller has been argued to decrease prices and strongly increase competition because of the additional profits that come from selling other consumer goods to customers. In addition unobserved shocks on demand or supply can bias the coefficients through the omitted variable problem. Thus regressing Italian margins relative to a competitive benchmark should reflect anti-competitive behavior in the Italian market. The data used in this section are weekly average prices in Belgium, Netherlands, Germany, France and Italy.

The first measure presented in **Table 11** are correlation coefficients of prices. Similarly as before the pattern shows a decrease of correlation in the in-between period and then a return to pre-policy levels. The price cost correlation dropped in Italy while keeping constant in the other countries and for the Brent.

[Table 11: Correlation Italy benchmark]

As discussed before the aim of a cartel is to raise its profitability, thus if the Italian market was cartelized we should observe higher margins relative to the European during the cartel and then a shift back to pre policy ones, or lower, during the AI. In **Table 12** four different regressions comparing either prices or margins relative to the EU are presented:

$$\ln(\frac{ITprice_t}{EUprice_t}) = \alpha_0 + \sum_{r=1}^{n} \alpha_r dummyperiod_r + \alpha_{n+1} \ln(Platts_t) + \alpha_t trend + u_t \tag{5}$$

$$\frac{ITprice_t}{EUprice_t} = \alpha_0 + \sum_{r=1}^{n} \alpha_r dummyperiod_r + \alpha_{n+1} Platts_t + \alpha_t trend + u_t \tag{6}$$

$$ITprice_t = \alpha_0 + \sum_{r=1}^{n} \alpha_r dummyperiod_r + \alpha_{n+1} EUprice_t + \alpha_t trend + u_t \tag{7}$$

$$ITprice_t - EUprice_t = \alpha_0 + \sum_{r=1}^{n} \alpha_r dummyperiod_r + \alpha_{n+1} Platts_t + \alpha_t trend + u_t \qquad (8)$$

In the first the ratio of the logarithms of the Italian and European price is regressed on period dummy variables and the Platts. While in the second regression the same is done using the price ratio. In the third regression the European price is used as a control variable, while in the fourth regression the "country mark-up", the difference between the Italian and European price, are considered.

These regressions highlight that even though margins can be higher because of different levels in demand, cost structure or taxation, the relation between them should be constant over time, absent of market specific shocks. In addition note that this regression has causal meaning even though the competitive benchmark might be colluding! This is because the competitive benchmark could have a price above the competitive one, but would not be influenced in case of a cartel in Italy.

All four regressions show a positive and significant increase in the price measure during the collusive period and a significant decrease during the AI. If these margins are due to transport or storage cost we would expect them not to change significantly over the time period analyzed. Thus the significant shift shows that Italian firms were able to increase their profits during the collusive period, wich followed the new pricing policy, with respect to European firms.

[Table 12]

Considering all these different measures there is strong evidence that firms were colluding from the policy change to the buyer's complaint as margins increased significantly in this period. After the buyer's complaint prices went back to pre-policy levels. The AI had a negative impact on them, lowering on average prices more than in the pre-policy period. This could be indicative that firms were colluding even before the policy change.

5 Conclusions

The aim of this paper was twofold: First, to show how pricing leadership and delayed price responses can be used as facilitating practice by firms to tacitly collude. Second, to show how Antitrust Authorities might detect collusion through an easily to implement but sound econometric analysis.

A successful strategy in detecting this anticompetitve behavior is to consider a measure of profitability, dummy variables representing the different time periods suspected of collusion and a competitive benchmark. As the aim of a cartel is to increase profits, margins increases following the introduction of facilitating practices and controlling for costs and demand, can be indicative for collusion.

In the case of the Italian wholesale petrol industry five shocks are considered: First, the publicly announced price policy change by the market leader, ENI, who made its price changes less predictive, not following its major cost, the Platt's Index, and changed its price by a bigger amount than before. Price changes happened every 19 instead of every 6 days and the average absolute change was 4.5% instead of 1% on price change days. The second shock is a buyer's complaint five months after the policy was introduced. This, eventually, led to the third shock, the announcement by the Antitrust Authority of an investigation. Six month after the announcement the behavioral remedies were

published (fourth shock) and eleven month after the Antitrust Investigation was announced it was closed (fifth shock) without establishing whether an infringement under Article 101, which forbids collusive agreements, occurred. The AA rather accepted the proposed remedies.

The announcement of a new pricing policy could have been used as a facilitating practice for aligned and higher prices. On the contrary, the buyer's complaint and the investigations could have caused a break in the cartel due to an uncoordinated reaction by cartel participants. The evidence shown, strongly supports this hypothesis. After the policy change prices were more aligned than before and after a few days the leader had changed its price the followers aligned to the leader's price. In addition the price-cost correlation dropped significantly. The same relation can be found in margins, which increased after ENI's policy and decreased after the buyer's complaint and the investigation. As there might have been other reasons for such an increase depending on supply or demand shocks, the EU price was considered as a benchmark. The regressions considering a relation of the Italian and EU price show the same results. The Italian price relative to the European increased after the introduction of the policy and decreased during the investigation.

No matter what specification, relative to cost or margins, the results are the same indicating that the effect of ENI's policy was to decrease competition, align prices and obtain higher margins.

This methodology can be generalized and applied by AA to detect unlawful behavior. Recently an increasing number of AA worldwide have started to adopt different economic screens. Their use can increase the effectiveness of AI, decrease the ex-ante incentives to collude and may serve to calculate damages of firms' anticompetitive behavior. As screens become more popular, effective, and more data is available, their role in antitrust will certainly increase.

Table 1: Summary statistic of the two datasets

Dataset:	Italian Prices, Brent Platts Cif Med	EU Prices
Time interval	daily	weekly
Observations	1741	246
Length	01. 2004- 12.2008	01. 2004- 12.2008

Table 2: Petrol industry characteristics in the selected countries

	Italy	Germany	France	Belgium	Netherlands
Taxes €/1,000 l	564	670	607	623	689
VAT (%)	20	19	19,6	21	19
Petrol Stations	21.919	14.447	14.578	3.192	4.223
Petrol sold per station (1000)	1.816	4.268	3.583	2.036	2.006
Petrol stations /100km	7,27	4,05	2,68	10,47	10,22
Petrol stations owned by big distribution (%)	0,2	10	51,6	N/A	0,9

Note: Data from Unione Petrolifera and Pöyry (2009)

Table 3: Market Shares (%)

	Unleaded		Diesel	
	2003	2004	2003	2004
Agip/Ip	36,1	35,5	38,4	38,2
Api	5,1	5,2	4,6	4,7
Erg	7,8	7,8	6,2	6,4
Esso	17,4	16,0	19,7	17,9
Q8	10,8	11,0	10,2	10,3
Shell	6,7	7,0	6,3	6,5
Tamoil	7,6	8,4	6,9	7,7
Total	5,7	6,3	5,7	6,0
Others	2,8	2,9	2,0	2,3

Source: Staffetta Quotidiana, several issues

Figure 1: Time Intervals

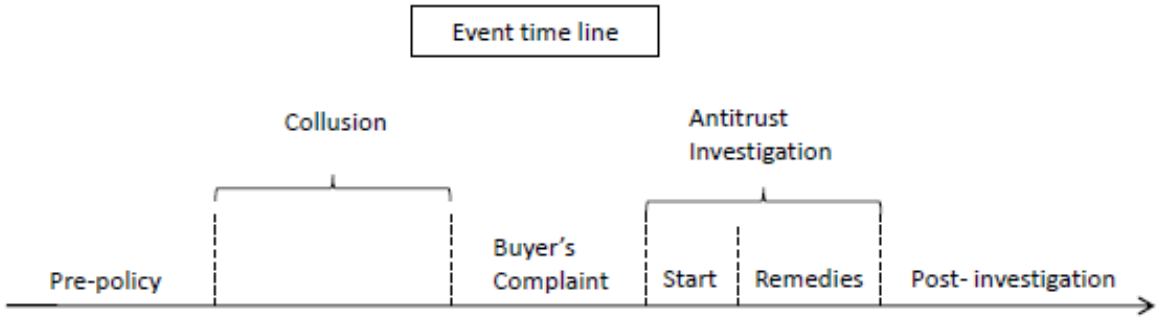

Table 4: Price policy change summary

Period:	Pre-Policy	Collusion	Buyer's Complaint	Communication of Antitrust Investigation	Publish of Remedies	Post AI
Dummy names:	*prepolicy*	*collusion*	*bcomp*	*anticom*	*remcom*	*afteranti*
Dummy names (cont.)		*inbetween*		*antitrust*		
Days	280	158	669	171	161	377
Price changes	47	9	55	97	78	180
Average time between Changes	6	18,7	12,1	1,7	2	2,1
Average price change (%)	1,01	4,5	3,93	0,35	0,34	0,55
Std. Dev.	.0071	.044	.023	.009	.009	.009
Abs. daily Platt's changes (%)	1,3	1,5	1,4	1	1	1,1
Std Dev.	.016	.018	.018	.012	.011	.015

Note: inbetween refers to the periods *collusion* and *bcom* together, while *antitrust* refers to the periods *anticom* and *remcom* together

Table 5: Summary of variables

Period:	Pre-Policy change	Collusion	Buyer's Complaint	Communication of Antitrust Investigation	Publish of Remedies	Post Antitrust Investigation
Dummy names:	*prepolicy*	*collusion*	*bcomp*	*anticom*	*remcom*	*afteranti*
Days	280	158	669	171	161	377
Dummy names:		*inbetween*		*antitrust*		
Days		827		332		

Note: inbetween refers to the periods *collusion* and *bcom* together, while *antitrust* refers to the periods *anticom* and *remcom* together

Table 6: Average alignment

	Number of followers with same price as leader	
inbetween	1.295***	
	(0.0978)	
collusion		0.754***
		(0.161)
bcomp		1.432***
		(0.103)
antitrust	-0.798***	
	(0.126)	
anticom		-1.021***
		(0.160)
remcom		-0.553***
		(0.164)
afteranti	-0.286**	-0.286**
	(0.121)	(0.120)
Constant	1.553***	1.553***
	(0.0736)	(0.0732)
Observations	1741	1741
R-squared	0.156	0.165

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: ENI's signals and followers alignment

	Number of followers with same price as leader (1)		(1) cont.
collusion	0.386**	ecp*bcom	-1.486***
	(0.171)		(0.299)
bcomp	1.210***	L. *bcom	-0.00560
	(0.117)		(0.299)
anticom	-0.619**	L2.* bcom	1.064***
	(0.306)		(0.299)
remcom	-1.325***	L3. *bcom	1.412***
	(0.300)		(0.299)
afteranti	-0.876***	ecp*anticom	0.291
	(0.139)		(0.319)
ecp	-0.551***	L. ecp*anticom	0.160
	(0.179)		(0.320)
L. ecp	-0.361**	L2. ecp*anticom	-0.0996
	(0.179)		(0.319)
L2. ecp	-0.282	L3. ecp*anticom	0.0461
	(0.179)		(0.312)
L3. ecp	-0.416**	ecp*remcom	0.616*
	(0.179)		(0.322)
ecp*collusion	-0.103	L. ecp*remcom	0.602*
	(0.606)		(0.320)
L. ecp* collusion	0.926	L2. ecp*remcom	0.551*
	(0.606)		(0.320)
L2. ecp* collusion	1.181*	L3. ecp*remcom	0.916***
	(0.606)		(0.317)
L3. ecp* collusion	1.387**	ecp*afteranti	0.470**
	(0.606)		(0.207)
Constant	1.827***	L. ecp*afteranti	0.486**
	(0.0907)		(0.209)
		L2. ecp*afteranti	0.312
			(0.209)
		L3. ecp*afteranti	0.430**
			(0.207)
Observations	1741		
R-squared	0.228		

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: ecp refers to "ENI changes price". LX.ecp is the Xth lag of ecp. ecp*dummy is an interaction term (the slope shifter).

Table 8 – Correlation of price and costs over the relevant time periods

	pre-Policy	collusion	bcom	antitrust	afteranti
			Platt's Index (cost)		
ENI	0.8917	0.5982	0.8767	0.9254	0.9820
Api	0.8917	0.5820	0.8840	0.9387	0.9763
Erg	0.8947	0.5869	0.8514	0.8827	0.9764
Esso	0.8861	0.5625	0.8762	0.9520	0.9766
IP	0.8817	0.5535	0.8848	0.9387	0.9767
Q8	0.8966	0.5483	0.8819	0.9378	0.9764
Shell	0.8826	0.5892	0.8747	0.9456	0.9745
Tamoli	0.8873	0.6057	0.8813	0.8784	0.9742
Total	0.8904	0.5777	0.8840	0.9376	0.9748
Brent	0.8932	0.8822	0.8906	0.9309	0.9812
Obs:	280	169	669	332	377

Note: Observations are counted in days; correlation is linear correlation

Figure2

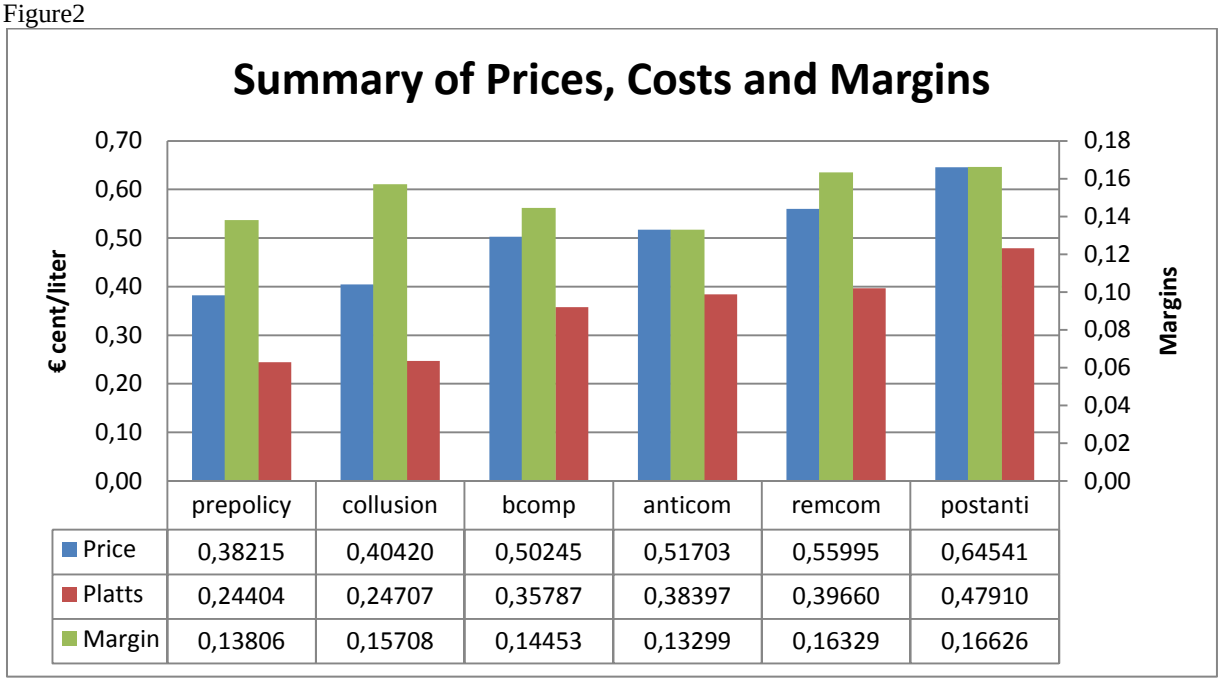

Table 9: Industrial margins

	Industrial Margin	
inbetween	0.00580**	
	(0.00234)	
collusion		0.0143***
		(0.00230)
bcomp		-0.00674**
		(0.00299)
antitrust	0.00308	
	(0.00398)	
anticom		-0.0268***
		(0.00473)
remcom		8.16e-05
		(0.00535)
afteranti	0.0199***	-0.00149
	(0.00487)	(0.00607)
trend	5.68e-06*	2.04e-05***
	(3.08e-06)	(3.97e-06)
Constant	0.135***	0.128***
	(0.00207)	(0.00238)
Observations	1,741	1,741
R-squared	0.118	0.220

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Price and cost relation

	Mean Italian price	
inbetween	0.0354***	
	(0.00554)	
collusion		0.0482***
		(0.00736)
bcomp		0.0297***
		(0.00648)
antitrust	-0.00873	
	(0.00797)	
anticom		0.000186
		(0.00893)
remcom		0.0331***
		(0.0107)
afteranti	0.00184	0.0157*
	(0.00898)	(0.00909)
trend	2.61e-05***	1.95e-05***
	(2.26e-06)	(2.52e-06)
Constant	0.149***	0.153***
	(0.00522)	(0.00529)
Observations	1,741	1,741
R-squared	0.979	0.982

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Note: all the coefficients on lagged costs were omitted for brevity

Table 11: Correlation Italy benchmark

	pre-policy	collusion	bcomp	anticom	afteranti
			Platt's Index (cost)		
Italy	0.8720	0. 5659	0. 8889	0. 8166	0. 9854
Netherlands	0.9588	0. 9370	0. 9461	0. 9649	0. 9752
Germany	0. 8937	0. 7524	0. 9046	0. 8756	0. 9764
France	0. 8569	0. 8041	0. 9268	0. 9160	0. 9808
Belgium	0. 8440	0. 7297	0. 8951	0. 7865	0. 9620
EU	0. 9200	0. 8202	0. 9333	0. 9003	0. 9864
Brent	0. 8716	0. 8522	0. 8677	0. 6049	0. 9751
Observations	40	24	96	47	54

Note: Observations are counted in weeks; correlation is linear correlation

Table 12: Margins in the international comparison

	ln(PIt/PEU)	PIt/PEU	PItaly	PIt-PEU
collusion	0.0212***	0.0227***	31.14***	30.18***
	(0.00640)	(0.00704)	(11.65)	(11.49)
bcomp	-0.00262	-0.00990	-9.569	-8.769
	(0.00880)	(0.00950)	(15.79)	(15.50)
anticom	-0.0333**	-0.0416***	-72.42***	-68.93***
	(0.0135)	(0.0147)	(24.33)	(24.02)
remcom	-0.0240	-0.0321*	-45.67*	-48.52*
	(0.0151)	(0.0165)	(27.52)	(26.93)
afteranti	-0.0134	-0.0158	-25.02	-26.92
	(0.0176)	(0.0193)	(32.23)	(31.56)
ln(Platts)	-0.103***			
	(0.00860)			
Platt's		-7.78e-05***		-0.0818***
		(7.06e-06)		(0.0115)
meanEu			0.922***	
			(0.0120)	
giorni	0.000177**	0.000173**	0.380***	0.363***
	(7.63e-05)	(8.39e-05)	(0.139)	(0.137)
Constant	0.771***	1.146***	184.8***	159.6***
	(0.0587)	(0.00952)	(19.15)	(15.55)
Observations	246	246	246	246
R-squared	0.606	0.585	0.987	0.358

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

References [To be completed]

Athey, Susan, Kyle Bagwell, and Chris Sanchirico, “Collusion and Price Rigidity,” Review of Economic Studies, 71 (2004), 317-349.

Bajari, Patrick, “Comparing Competition and Collusion: A Numerical Approach,” Economic Theory, 18 (2001), 187-205

Block, Michael K., Frederick C. Nold, and Joseph G. Sidak, “The Deterrent Effect of Antitrust Enforcement,” Journal of Political Economy, 89 (1981), 429-445

Brusco, Sandro and Lopomo, Giuseppe (2002), .Collusion via Signalling in Simultaneous Ascending Bid Auctions with Heterogeneous Objects, with and without Complementarities., The Review of Economic Studies, 69 (2), 407-463

Connor, John M., “How High Do Cartels Raise Prices? Implications for Reform of the Antitrust Sentencing Guidelines,” American Antitrust Institute, Working Paper

Friederiszick H. and Maier-Rigaud F. (2007), “The Role of Economics in Cartel Detection in Europe”, Working Paper.

Green, Edward J & Porter, Robert H, 1984. "Noncooperative Collusion under Imperfect Price Information," Econometrica, Econometric Society, vol. 52(1), pages 87-100, January

Grout, Paul A. and Silvia Sonderegger, “Predicting Cartels,” Office of Fair Trading, Economic discussion paper, March 2005

Harstad, R.M. and Phlips, L., 1995. Informational requirements of collusion detection: Simple seasonal markets. In: Mimeo., European University Institute, Florence

Harrington, Joseph E., Jr. 2005 “Detecting Cartels” published in "Advances in the Economics of Competition Law" edited by Paolo Buccirossi

Harrington, Joseph E. Jr., “Cartel Pricing Dynamics in the Presence of an Antitrust Authority,” RAND Journal of Economics, 35 (2004b), 651-673

Motta, Massimo “Competition policy: theory and practice” Published by Cambridge University Press, 2005

Neven, D., P. Papandropoulos and P. Seabright (1998). Trawling for Minnows: Agreements in EC Competition Policy, CEPR, London.

Porter R., 2005. "Detecting Collusion," Review of Industrial Organization, Springer, vol. 26(2), pages 147-167, December

Porter, Robert and Douglas Zona, “Detection of Bid-Rigging in Procurement Auctions,” Journal of Political Economy 101 (1993), 518–538.
Porter, Robert and Douglas Zona “Ohio School Milk Markets: An Analysis of Bidding,” Rand Journal of Economics 30:2 (1999), 263–288.

Symeonidis, G. 2002. The Effects of Competition: Cartel Policy and the Evolution of Strategy and Structure in British Industry. Cambridge: MIT Press.

Symeonidis, G. (2003) "In Which Industries is Collusion More Likely Evidence from the UK", Journal of Industrial Economics, vol. 51

Slade, M.E., 1987. “Interfirm rivalry in a repeated game: An empirical test of tacit collusion” Journal of Industrial Economics 35:499