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## SCREENING FOR COMPETITION FAILURES: SOME REMARKS ON HORIZONTAL ANTICOMPETITIVE BEHAVIOR VISUAL DETECTION

### SUMMARY

Anticompetitive horizontal behaviors are very common and harmful for economy as a whole and consumer welfare especially. Such behaviors in most cases mean collusion. Pro-active anticompetitive policy we want to realize implies monitoring of huge set of markets and industries. As preliminary selection is possible on a basis of number of factors that enhanced collusion, there could be still big set of industries left. There is a necessity then for methods of collusion's detection which would be quick, resource — saving and understandable for economists, experts and lawyers without quantitative experience. We described here fairly simple but meaningful, graphical tools which could be used in process of screening for collusive behavior in the markets. We underlined that ability of graphical inspection depends on statistical/econometric tool of choice for particular screen, so we see a need for research and popularization of tools with that property.

**Keywords:** anticompetitive horizontal agreements, collusion detection, behavioral screening, time series

**JEL Classification:** K21, L41, C22

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## INTRODUCTION

The purpose of this paper is pointing out for fairly simple but meaningful, graphical tools which could be used in screening for collusive behavior in the markets. Such tools may be especially interesting for wide range of economists and lawyers who participate in anticompetitive procedures and want to make quick evaluation of the situation. We would like to point in this paper to three collusion cases and examples of screen and tools used that allowed graphical assessment of collusion possibility. We give short description of the case and screen, theoretical motivation and graphical assessment.

### 1. THE CURRENT STATE OF KNOWLEDGE

#### 1.1. HORIZONTAL ANTICOMPETITIVE PRACTICES

Competition can be defined as a process of rivalry between suppliers that takes place either in the market or for the market. Firms compete to attract customers by offering lower prices, higher quality of products or services, or innovative products and services. When competition is working effectively, the market will send clear messages to firms (for example, in the form of the prices they can charge and the profits they can earn) about which goods and services consumers want to buy. Efficient firms offering the products consumers want at low prices will prosper, and inefficient ones will not. Free competition enhances productivity in industries<sup>1</sup>. Free competition boosts in-

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<sup>1</sup> For empirical evidence see J. Haskel, *Imperfect Competition, Work Practices and Productivity Growth*, „Oxford Bulletin of Economics and Statistics”, Vol. 53, No. 3/1991, pp. 265–279; S.J. Nickell, *Competition and Corporate Performance*, „Journal of Political Economy”, Vol. 104, No. 4/1996, pp. 724–746; D. Blanchflower, S. Machin, *Product market competition, wages and productivity: international evidence from establishment-level data*, Centre for Economic Performance Discussion Paper, No. 286/1996. pp. 1–38; M. Maher, M. Wise, *Product Market Competition and Economic Performance in the United Kingdom*, OECD Economics Department Working Papers, Vol. 2005, pp. 1–53; I. Ehrlich, G. Gallais-Hammono, Z. Liu, R. Lutter, *Productivity growth and firm ownership: an analytical and empirical investigation*, „Journal of Political Economy”, Vol. 102, No. 5/1994, pp. 1006–1038; G. Nicoletti, S. Scarpetta, *Product Market Reforms and Employment in OECD Countries*, OECD Economics Department Working Papers, No. 472/2005, pp. 1–50.

novation<sup>2</sup> and quality. And last but not least, as Adam Smith noted<sup>3</sup> free competition drives commodity prices to its “natural level” which is:(...) “the lowest which can be taken, not upon every occasion, indeed, but for any considerable time together” and (...)“is the lowest (price) which the sellers can commonly afford to take, and at the same time continue their business”. In the same seminal work of Smith<sup>4</sup>we can read very clearly early concern that firm specific conduct might allow industries to collect economic profit over the long run natural level: “(...) People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices”. In present times we described such “conversations”, “conspiracy” and “contrivance” as anticompetitive practices which distort competition and welfare. Most of such behaviors are prohibited by antitrust (competition) law. Especially harmful and in the same time the most widespread<sup>5</sup> are horizontal anticompetitive practices (agreements) which encompass<sup>6</sup>:

- directly or indirectly fixing prices;
- fixing trading conditions;
- sharing markets;
- limiting or controlling production or investment;
- collusive tendering (bid-rigging);
- joint purchasing or selling;
- sharing information;
- exchanging price information;
- exchanging non-price information;
- restricting advertising;
- setting technical or design standards.

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<sup>2</sup> P. Aghion, N. Bloom, R. Blundell, R. Griffith, P. Howitt, *Competition and Innovation: an Inverted-U Relationship*, „The Quarterly Journal of Economics”, Vol. 120, No. 2/2005, pp. 701–728; M. Polder, E. Veldhuizen, *Innovation and Competition in the Netherlands: Testing the Inverted U for Industries and Firms*, „Journal of Industry, Competition and Trade”, Vol. 12, No. 1/2012, pp. 67–91.

<sup>3</sup> A. Smith, *An Inquiry Into the Nature and Causes of the Wealth of Nations*, The Modern Library, New York 1937, p. 42.

<sup>4</sup> *Ibidem*, p. 80.

<sup>5</sup> About 43.0% of formal European Commission decisions on competition till year 2009 was connected with horizontal agreements. see: F. Russo, M.P. Schinkel, A. Gunster, M. Carree, *European Commission Decisions on Competition. Economic Perspectives on Landmark Antitrust and Merger Cases*, Cambridge University Press, New York 2010.

<sup>6</sup> Antitrust Division U.S. Department of Justice, *An antitrust primer for federal law enforcement personnel*, Washington 2005.

Above list is by no means closed but exemplify the most popular horizontal practices which infringe free competition. For European (and Polish) competition legislation leading role plays the Treaty on the Functioning of the European Union (FEU Treaty). Competition rules are set out in Articles 101–106 of the FEU Treaty. Especially important in a case of horizontal practices is Article 101(1) FEU Treaty, which establishes the prohibition of agreements and concerted practices among undertakings affecting trade between Member States when restrictive of competition within the common market. The boundary between the concepts of agreement and concerted practice is still imprecise on a ground of law. The key difference is that a concerted practice may exist where there is informal co-operation without any formal agreement or decision. The category of horizontal agreements includes hardcore cartel cases of price fixing and market sharing, but also more sophisticated anticompetitive horizontal agreements such as joint sales agencies, agreements on limiting marketing activities, capacity restrictions and other aspects of production, information sharing on prices and sales, service and distribution agreements, export cartels, and exclusionary practices toward entrants. It further extends to specialization and licensing agreements, trademarks, agreements on (technical) standards, strategic alliances, trade associations, and the joint organization of exhibitions and fairs. While some of these forms of cooperation may have positive welfare effects, they also have an inherent danger of leading to collusion. The modern industrial economic and competition policy literature and case law distinguish two types of collusion — explicit and tacit collusion. The latter occurs when firms understand that if they compete less vigorously they can obtain market outcomes guaranteeing higher prices and thus higher profits without any direct interaction or communication to achieve a collusive price. Tacit collusion can occur also at price levels other than the joint profit maximizing level. In order to achieve the fully collusive price, firms can move from tacit collusion to explicit coordination. This would involve some form of explicit communication between them, which in turn might leave evidence of the antitrust infringement. The European cartel laws do in principle not extend to tacit collusion as they require evidence of an explicit cartel agreement. However, when primary goal is to detect collusion the difference between legal interpretation (a specific antitrust infringement) and economic understanding (a market outcome in which prices and/or other characteristics differs negatively from competitive level, independent of how this outcome is reached) of collusion is not so important as methods of collusion detection are based on the same statistical data which have to be observable.

## 2. THE METHODOLOGY OF RESEARCH

### 2.1. SCREENING AS A TOOL FOR ANTICOMPETITIVE PRACTICES DETECTION

Detection of any horizontal agreement in an industry in general and collusion in particular is not an easy task.

There is a reach set of theoretical models of overt or tacit collusion<sup>7</sup> which describes very well as research hypotheses concerning players' behavior, their empirical applications as collusion detection's tools presents great difficulties. It happens mainly due to the fact that the players participating in collusion have an advantageous position over the observer in the form of private information. Moreover, the resources of public statistics are frequently (in a case of Poland, for example) very humble on the disaggregation level of the industry or individual players. Last but not least is a problem of scale. As cartel (and more broadly speaking) collusion detection could be reactive or proactive<sup>8</sup> and reactive ones are not enough for collusion prevention, there is a need to actively monitor huge set of markets and industries. As preliminary selection is possible on a basis of number of factors that enhanced (supported) possibility of tacit and overt anticompetitive horizontal agreements, such as a small number of firms, barrier to entry, spare capacity, cross-ownerships and other links among competitors, symmetry in the cost structure, dimension and organization of the firms, product homogeneity, and absent or weak buying power, transparency of the market there could be still big set of industries left. In the other hand method used should be scientifically objective and (especially in their quantitative part) understandable for non-econometricians especially. Therefore, to actively monitor for collusion, good method should fulfill below mentioned postulates:

1. it should have theoretical motivation implied by proper model of strategic interaction;

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<sup>7</sup> For an comprehensive overview see for example: J. Tirole, *The Theory of Industrial Organization*, MIT Press, London 1998; X. Vives, *Oligopoly pricing. Old ideas and new tools*, MIT Press, Cambridge 1999.

<sup>8</sup> Reactive detection methods are based on information or evidence brought before the competition agency by third parties. Leniency or amnesty programs are considered the most effective reactive detection measure, especially because they provide the competition agency with direct evidence of a cartel. Pro-active methods of cartel detection are initiated from within the agency and do not rely on an external triggering events as customer complaints or factual evidences from whistleblowers. For cartel detection methods adopted by competition agencies see: International Competition Network, *Anti-Cartel Enforcement Manual, Chapter 4: Cartel Case Initiation*, 2010. pp. 1–62.

2. it should use as small amount of publically presented statistical data as it's possible;
3. it should not be resource intensive (it means, chip in terms of workload);
4. it should provide understandable indications of potentially collusive behavior, ideally in a graphical form.

Point 1 of above list deals with method's theoretical construction but points 2 to 4 depend on numerical (statistical, econometric) tool used for empirical work. We have to underline this point, as there could be many tools for the same method to choose.

The methods which could fulfill the above postulates are the indirect methods of detecting collusion which are defined as collusion (cartel) screens (structural or behavioral)<sup>9</sup>. Structural approach typically involves screening a series of industries or markets in the attempt to identify those which exhibit characteristics which make them more prone to collusion. Actual paper is devoted to examples of behavioral's approach screens which are generally designed to flag firms behavior or market outcomes which may raise suspicions that firms have in fact colluded. Cartel screens itself are economic tools designed to analyze observable economic data and information, such as information on various product and market characteristics, data on costs, prices, market shares, various aspects of firm behavior, etc. and flag markets which may either have been affected by collusion. Abrantes-Metz and Bajari<sup>10</sup> define a screen as 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". Harrington's<sup>11</sup> definition focuses on the monitoring process itself: "screening refers to a process whereby industries are identified for which the existence of a cartel is likely. (...) Screening methods (are) designed to pick up the transition from noncollusion to collusion — looking for a radical change in firm behavior — or the stationary collusive phase — finding differences in behavior from when firms compete".

According to Abrantes-Metz and Bajari<sup>12</sup>, there are four desirable properties of a good screen:

1. it should minimize the number of false positives and negatives;
2. it should be easy to implement;

<sup>9</sup> R. Abrantes-Metz, *Pro-active vs. Reactive Anti-Cartel Policy: the Role of Empirical Screens*, „SSRN Electronic Journal”, No. 2013, pp 1–28.

<sup>10</sup> R. Abrantes-Metz, P. Bajari, *Screens for Conspiracies and their Multiple Applications*, „Antitrust”, Vol. 24, No. 1/2009, pp. 66–71.

<sup>11</sup> J.E. Harrington, *Behavioral Screening and the Detection of Cartels*, „European Competition Law Annual: 2006”. pp. 51–68.

<sup>12</sup> R. Abrantes-Metz, P. Bajari, *op. cit.*, p. 66.

3. it should be costly for agents to disguise such behavior;
4. it should have empirical support.

There is substantial literature on behavioral screening based on various screening variables. Usually they include identification of the so-called collusion markers (non-competitive behaviors) which are certain disturbances typical of a collusive agreement and concern the following:

- a. relationships between players' prices and changes in the demand on the market;
- b. stability of prices and market shares;
- c. relationships held between players' prices;
- d. investments made in production potential.

In general we can say that, following Abrantes-Metz<sup>13</sup>, that screen, realizing postulates 1–4 from both lists could be based on any “(...) empirical evidence in the market and its apparent irregularities” and “(...) combined with the structural features of this market, raise red flags for possible anticompetitive practices”.

### 3. THE RESEARCH PROCESS

As we stated before, we consider as very important presentation level of a screen. The clearer message to receiver screen generates the more influential and convincing it is. We all know that one picture is worth thousand words (or numbers, sometimes). In a research process we would like to inspect if there are some tools for a graphical assessment of possible collusion existence. We studied than three collusion cases and examples of screen and tools used. We considered them as potentially useful for graphical assessment of market manipulation or potentially collusive behavior of market players. In a flow of a research we give short description of each case, then we present description and a meaning of a screen with reference to theoretical motivation, we note an econometric method in use and on the end of each case we analyze possibilities of meaningful graphical output of a particular screen with a conjunction with proper quantitative tool.

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<sup>13</sup> R. Abrantes-Metz, *Aluminum Market Dislocation: Incentives, Structure and Reform*, „SSRN Electronic Journal”, No. 2013, pp. 1–16.

## 4. THE RESULTS OF RESEARCH

### 4.1. CASE 1 (ON A BASIS OF BEJGER<sup>14</sup>) — POLISH CEMENT CARTEL

**Case description:** on 10th of December 2009 the Polish Office of Competition and Consumer Protection (OCCP) announced in press release the existence of a cartel in Polish cement industry<sup>15</sup>. This statement was a consequence of three year investigation. The President of the OCCP established that 7 companies were engaged in the market sharing and price fixing practices in 1998–2009 period.

We wanted to examine possibility of detection a collusive behavior of players on a basis of market screen (ex post examination) using statistical data we can actually obtain.

**Collusion screen description:** price movement — seasonality “smoothing”. In the industry that exhibits seasonal fluctuations of demand (which is an exogenous fact, know from economic theory) we can use seasonal price movement to detect or confirm cartel behavior of the players. In a collusion period seasonality of price is not maintained or substantially weakened. Price is rigid when market is getting smaller.

**Motivation:** Rotemberg and Saloner, supergame model developed in Bejger<sup>16</sup>.

**Analysis:** as we can see from figure 1 demand (as a proxy production data was used) exhibits clear monthly seasonality (also known from industry specifics). In comparison, price data did not follow that kind of market fluctuations. Further estimation of seasonality parameters confirmed that almost all of the seasonal parameters were significant in a case of demand and significant seasonal factors we have for February and March only in a price series. Comparing to results we could conclude that price does not follow seasonal shifts in production (demand).

**Conclusion:** visual assessment of figure 1 with screen of “seasonal smoothing” as a reference point implies abnormal behavior which could be warning of collusion. Implied collusion period is coherent with factual cartel existence.

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<sup>14</sup> S. Bejger, *Polish cement industry cartel — preliminary examination of collusion existence*, „Business and Economic Horizons”, Vol. 4/2011, pp. 88–107.

<sup>15</sup> See press release of Spokesperson for the OCCP from 10.12.2009.

<sup>16</sup> J.J. Rotemberg, G. Saloner, *A Supergame-Theoretic Model of Business Cycles and Price Wars During Booms*, „American Economic Review”, Vol. 76, No. 3/1986, pp. 390–407; S. Bejger, *Collusion and seasonality of market price — a case of fixed market shares*, „Business and Economic Horizons”, Vol 2/2010, pp. 48–59.



**Econometric tool:** models of seasonality.  
**Graphical assessment** (figure 1.).

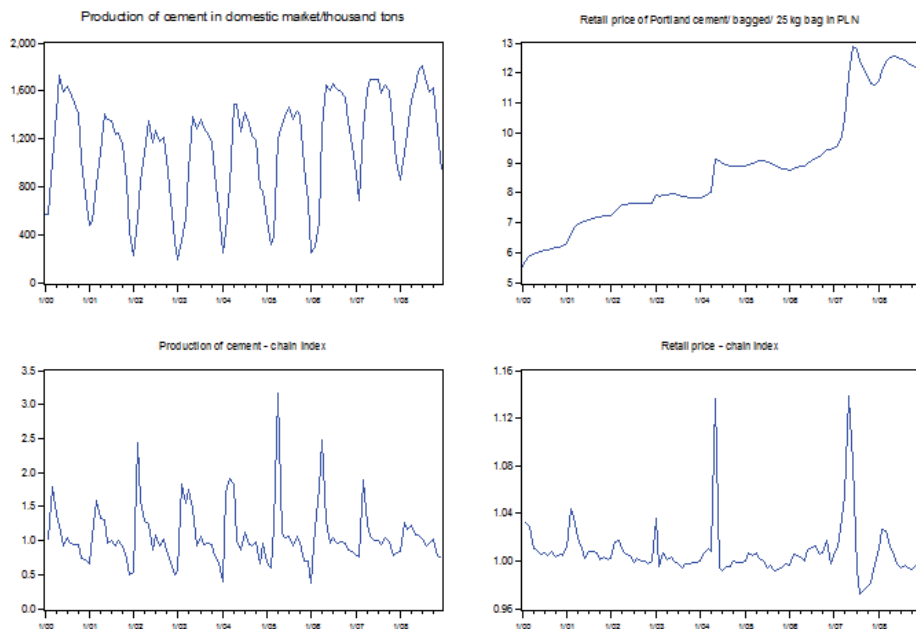


Figure 1 . Case 1 graphical assessment of collusion — looking for seasonality distortion

Source: own preparation

#### 4.2. CASE 2. (ON A BASIS OF BEJGER<sup>17</sup>) —LYSINE CARTEL

**Case description:** the collusion of lysine producers<sup>18</sup> was proved in 1996. The test includes monthly average lysine prices on the USA market in the period between 01/90–06/96<sup>19</sup>. Within this period, on the basis of collected evidence<sup>20</sup>the following phases may be distinguished (table 1):

<sup>17</sup> *Ibidem*, pp. 48–59; S. Bejger, *Econometric tools for detection of collusion equilibrium in the industry*, „Dynamic Econometric Models”, Vol. 9/2009, pp. 34–45.

<sup>18</sup> Lysine is a basic amino acid required as a feed component in hog, poultry and fish production.

<sup>19</sup> The prices are from J. Connor, *Archer Daniels Midland: Price-fixer to the World*, Staff paper No. 00–11, Department of Agricultural Economics, Purdue University, West Lafayette 2000, appendix A, Table A2.

<sup>20</sup> *Ibidem*, pp. 1–364.

Table 1. The statistics of lysine price (prices per pound)

| Phase                        | Months number | Average | Standard deviation | Coefficient of variation |
|------------------------------|---------------|---------|--------------------|--------------------------|
| 1. Competition (01.90–07.92) | 31            | 102.90  | 16.22              | 15.8%                    |
| 2. Collusion (08.92–03.93)   | 8             | 90.13   | 9.83               | 10.9%                    |
| 3. Competition (04.93–07.93) | 4             | 70.50   | 7.72               | 11.0%                    |
| 4. Collusion (08.93–06.95)   | 23            | 110.30  | 8.55               | 7.8%                     |
| 5. Competition (07.95–06.96) | 12            | 102.50  | 9.51               | 9.3%                     |

Source: own preparation based on J. Connor, *Archer Daniels Midland: Price-fixer to the World*, Staff paper No. 00–11, Department of Agricultural Economics, Purdue University, West Lafayette 2000, pp. 1–364.

We have then 2 factual collusion phases.

We wanted to examine possibility of detection a collusive behavior of players on a basis of two market screens (ex post examination) using statistical data we can actually obtain.

**Collusion screen 1 description:** price movement — seasonality “smoothing”. In the industry that exhibits seasonal fluctuations of demand (which is an exogenous fact, know from economic theory) we can use seasonal price movement to detect or confirm cartel behavior of the players. In a collusion period seasonality of price is not maintained or substantially weakened. Price is rigid when market is getting smaller.

**Motivation:** Rotemberg and Saloner, supergame model developed in Bejger<sup>21</sup>.

**Econometric tool:** models of seasonality.

**Graphical assessment** (figure 2.).

<sup>21</sup> J.J. Rotemberg, G. Saloner, *A Supergame-Theoretic Model...*, *op. cit.*, pp. 390–407; S. Bejger, *Collusion and seasonality...*, *op. cit.*, pp. 48–59.

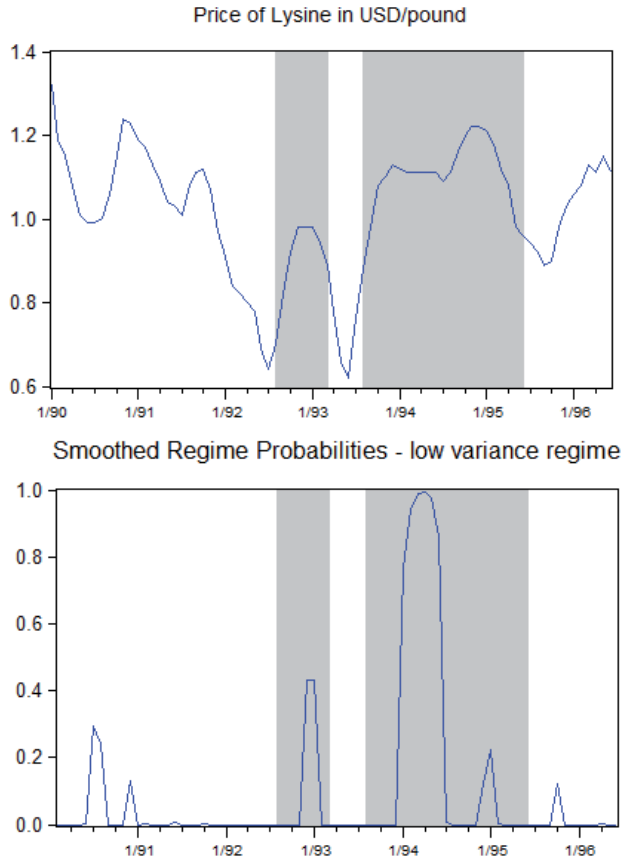


Figure 2. Case 2 graphical assessment of collusion — looking for seasonality distortion  
Source: own preparation

**Analysis:** we knew from market analysis<sup>22</sup> that demand for lysine was seasonal with the lowest level in first five months of the year and the lowest prices in the summer months. Figure 2, especially chain index of price confirms that regularity, but we can see distinct break in such a movement of price in a period of second cartel phase. First cartel phase is too short to be pointed out by that screen. Anyway, observed abnormality, in connection with motivation of the screen leaded us to further investigation. We use simple regression (1) of price on constant and eleven seasonal (0–1) variables:

<sup>22</sup> J. Connor, *op. cit.*, pp. 24.

$$\widehat{Y}_y = const + \alpha_2 D_{2t} + \alpha_3 D_{3t} + \alpha_4 D_{4t} + \alpha_5 D_{5t} + \alpha_6 D_{6t} + \alpha_7 D_{7t} + \alpha_8 D_{8t} + \alpha_9 D_{9t} + \alpha_{10} D_{10t} + \alpha_{11} D_{11t} + \alpha_{12} D_{12t} + u_t, \quad (1)$$

where:

$\widehat{Y}_t$  — average price of lysine;

$D_{2t}, \dots, D_{12t}$  — seasonal dummies.

and estimated it for a whole sample and in subsamples: subsample number one dated from January 1990 to August 1993 (non-cartel period) and subsample number two dated from September 1993 to June 1996 (detected cartel period). As the results we observed statistically significant seasonal dummies in the full sample (for June, July and August indicating a fall of average prices in that months). That was confirmed for June and July in non-collusive subsample. Interestingly, all seasonal factors occurred insignificant in subsample 2 (collusive period) which means that seasonal fall of prices was eliminated, prices stayed rigid. This price movement (seasonality “smoothing”) is consistent with the screen construction.

**Conclusion:** visual assessment of figure 2 with screen of “seasonal smoothing” as a reference point detects abnormal behavior of price series which could be warning of collusion. Implied collusion period is coherent with factual cartel existence in a time frame which is long enough to be noticed by the screen.

**Collusion screen 2 description:** well known collusion marker<sup>23</sup> based on the analysis of changes in the variance of market price processes. It is based on assumption that price process variance is on average lower for collusion phases and may undergo changes of the regime type<sup>24</sup>.

**Motivation:** Maskin and Tirole, Rotemberg and Saloner, Athey, Bagwell and Sanchirico<sup>25</sup>.

<sup>23</sup> Various so-called markers of collusion has been described by J.E. Harrington, *Detecting Cartels*, [in:] P. Buccirossi (ed.), *Handbook in Antitrust Economics*, MIT Press, London 2008, pp. 213–258.

<sup>24</sup> J. Connor, *op. cit.*, pp. 1–364; R. Abrantes-Metz, L. Froeb, J. Geweke, C.T. Taylor, *A variance screen for collusion*, „International Journal of Industrial Organization”, Vol. 24, No. 3/2006, pp. 467–486; Y. Bolotova, J.M. Connor, D.J. Miller, *The impact of collusion on price behavior: Empirical results from two recent cases*, „International Journal of Industrial Organization”, Vol. 26, No. 6/2008, pp. 1290–1307; J.L. Jimenez, J. Perdiguero, *Could Transport Costs be Lower? The Use of a Variance Screen to Evaluate Competition in the Petrol Market in Spain*, „International Journal of Transport Economics”, Vol. 38, No. 3/2011, pp. 265–284; R. Abrantes-Metz, M. Kraten, A.D. Metz, G.S. Seow, *Libor Manipulation?*, „Journal of Banking and Finance”, Vol. 36, No. 1/2012, pp. 136–150.

<sup>25</sup> E. Maskin, J. Tirole, *A theory of dynamic oligopoly II*, „Econometrica”, Vol. 56, No. 3/1988, pp. 571–599; J.J. Rotemberg, G. Saloner, *Collusive price leadership*, „The Journal of Industrial

**Econometric tool:** Markov switching model of the MSV type for the variance the price process.

**Graphical assessment** (figure 3.).

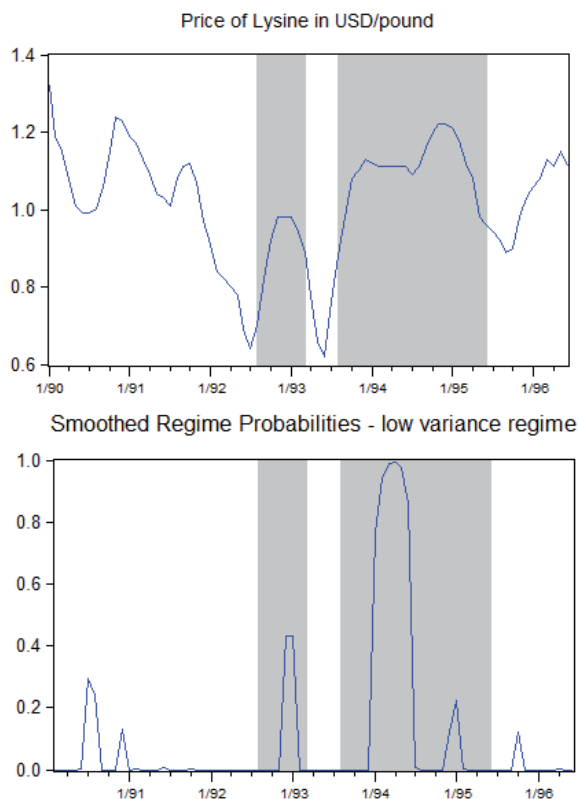


Figure 3. Case 2 graphical assessment of collusion — looking for variance switching distortion

Source: own preparation

**Analysis:** The basis for figure 3 was estimated MSV model of Markov-switching heteroskedasticity specification with invariant mean, intercept and autoregressive parameters (MSH in Krolzig terminology<sup>26</sup>) of general MS(M) specification. General formula of this model is given by (2)<sup>27</sup>:

Economics”, Vol. 39, No. 1/1990, pp. 93–111; S. Athey, K. Bagwell, C. Sanchirico, *Collusion and price rigidity*, „Review of Economic Studies”, Vol. 71, No. 2/2004, pp. 317–349.

<sup>26</sup> H.M. Krolzig, *Econometric Modelling of Markov-Switching Vector Autoregressions using MSVAR for Ox*, 1998, <http://fmwww.bc.edu/ec-p/software/ox/Mswardoc.pdf> (19.04.2015).

<sup>27</sup> As regards the specification and estimation methods see C.J. Kim, C.R Nelson., *State-Space Models with Regime Switching*, MIT Press, London 1999; J. Davidson, *Forecasting Markov-*

$$y_t = \alpha_0 + \sum_{m=1}^p \phi_m y_{t-m} + u_t, \quad (2)$$

where:

$$u_t \sim N(0, \sigma_{S_t}^2).$$

In the model (2) parameters  $\alpha_0$ ,  $\phi_m$  are state independent. Only regime dependant parameter is variance  $\sigma_u^2$  which is a random variable switched between the values from a finite set of values depending on the current state  $S_t$  where  $S_t=1, \dots, M$ . Variable  $S_t$  is assumed to be the exogenous, homogeneous Markov process with fixed transition probabilities  $\{p_{ij}\}$  where  $Pr(S_t = j | S_{t-1} = i)$ .

The MSV specification is coherent with screen functionality as it does not require observing (knowledge of) the state variable so it can serve for detecting of the variance regimes and objective determining of the switching moments, thou detecting the phases of collusive agreements and competition. We estimated the simplest specification of MSV(2)AR(1) to determine variance regimes only (if any). On the basis of estimated parameters values we concluded that there were two distinct regimes of high and low variance with statistically significantly different non-zero values of parameters. Figure 3 shows the values of the observed variable and smoothed probabilities (i.e. conditional probabilities of the process is in state  $s_2$ , while taking into account information from the entire sample) for regime 2 of low variance, together with marked factual collusion phases. As we can see there is a signal of regime change in period of first collusion phase and clear period of low variance (high probability of regime 2) in the beginning of second collusive phase.

**Conclusion:** visual inspection of figure 3 with screen of variance switching as a reference point detects and point to some periods of behavior of price series which could be warning of collusion. Implied collusion period is pointed in general accordance with factual collusion existence, however could not be treat as precise marking of cartel agreement but as preliminary leads for further investigation.

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*switching dynamic, conditionally heteroscedastic processes*, „Statistic and Probability Letters”, Vol. 68, No. 2/2004, pp. 137–147; J.D. Hamilton, *A new approach to the economic analysis of nonstationary time series and the business cycle*, „Econometrica”, Vol. 57, No. 2/1989, pp. 357–384; J.D. Hamilton, R. Susmel, *Autoregressive conditional heteroscedasticity and changes in regime*, „Journal of Econometrics”, Vol. 64, No. 1–2/1994, pp. 307–333; H.M. Krolzig, *op. cit.*

### 4.3. CASE 3 (ON A BASIS OF ABRANTES-METZ AND METZ)

**Case description:** very recently in 2008, empirical screens flagged the possibility of a conspiracy and manipulation of the USD LIBOR by major worldwide banks. Wall Street Journal first looked at LIBOR and found suspicious patterns in April and May of 2008. Next works of Abrantes-Metz, Kraten, Metz and Seow<sup>28</sup>, followed by empirical evidence provided in Snider and Youle, Abrantes-Metz, Judge and Villas-Boas and Abrantes-Metz and Metz<sup>29</sup> described and pin — pointed the LIBOR conspiracy. The initial 2008 screens preceded worldwide investigations on the matter which became public in March 2011. Only late in the Spring of 2011, did one of the LIBOR panel contributing banks, UBS, file for leniency with the U.S. Department of Justice. We could say that this is crucial and convincing example how screening should work and what is its place in anticompetitive behavior detection. Abrantes-Metz, Kraten, Metz and Seow<sup>30</sup> applied several different screening methods to determine if the U.S. dollar 1-month LIBOR rate had been manipulated by banks. The analysis is based on the comparison of LIBOR with other short-term borrowing rates, and analysis of individual bank quotes, and the comparison of individual quotes to the credit default swap (CDS) spreads during three different time periods. We wanted to include in this paper the simplest but graphical and thou very meaningful example of screen connected with LIBOR conspiracy.

**Collusion screen description:** collusion marker based on the analysis of changes in the variance of a series in consideration.

**Motivation:** Maskin and Tirole, Rotemberg and Saloner, Athey, Bagwell and Sanchirico<sup>31</sup>.

**Econometric tool:** analysis of variance.

**Graphical assessment** (figure 4.).

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<sup>28</sup> R. Abrantes-Metz, M. Kraten, A.D. Metz, G.S. Seow, *op. cit.*, pp. 136–150.

<sup>29</sup> C. Snider, T. Youle, *Does the Libor Reflect Banks' Borrowing Costs?*, „SSRN Electronic Journal”, No. 2010, pp. 1–25; R. Abrantes-Metz, S.B. Villas-Boas, G. Judge, *Tracking the Libor Rate*, „Applied Economics Letters”, Vol. 18, No. 10/2011, pp. 893–899; R. Abrantes-Metz, A.D. Metz, *How Far Can Screens Go in Detecting Explicit Collusion? New Evidence From the Libor Setting*, „Competition Policy International Antitrust Chronicle”, Vol. 1/2012, pp. 1–9.

<sup>30</sup> R. Abrantes-Metz, M. Kraten, A.D. Metz, Seow G.S., *op. cit.*, pp. 136–150.

<sup>31</sup> E. Maskin, J. Tirole, *op. cit.*, pp. 571–599; J.J. Rotemberg, G. Saloner, *Collusive price...*, *op. cit.* leadership, pp. 93–111; S. Athey, K. Bagwell, C. Sanchirico, *op. cit.*, pp. 317–349.

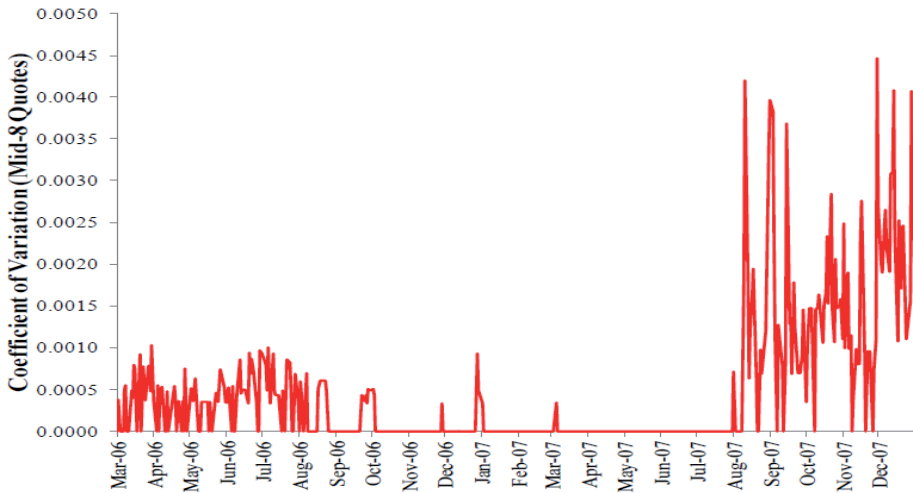


Figure 4. Coefficient of variation for the set of LIBOR quotes.

Source: Figure 1 from R. Abrantes-Metz, A.D. Metz, *How Far Can Screens Go in Detecting Explicit Collusion? New Evidence From the Libor Setting*, „Competition Policy International Antitrust Chronicle“, Vol. 1/2012. pp. 1–9.

**Analysis:** Abrantes-Metz and Metz<sup>32</sup> calculated the coefficient of variation for the determining set of LIBOR quotes each day which measures the variability in the daily quotes of the participating banks. For the first look it is obvious that hat from early August 2006 through early August 2007 there is period with very low variance of quotes. This means of course that banks were all submitting essentially the same quote in that period, in contrary to period before and after. Obviously that was a clear example of parallel pricing, which itself is not an evidence of collusion, but with some “plus” factor (additional evidences from economic environment) could be. Such a shift in a process variance should be a “red flag” for sure and, as in Abrantes-Metz and Metz<sup>33</sup> was followed by further investigation. Finally, their research was devoted to proving that such “parallel” behavior of banks had to be caused by explicit rather than tacit collusion, but for our paper it is very clear example of usability (and importance) of simple but suggestive (and convincing, when properly commented) graphical methods of collusion detection<sup>34</sup>.

<sup>32</sup> R. Abrantes-Metz, A.D. Metz, *op. cit.*, pp. 1–9.

<sup>33</sup> *Ibidem*.

<sup>34</sup> Similar, preliminary graphical reasoning, was used in R. Abrantes-Metz, *Aluminum Market...*, *op. cit.*, pp. 1–16 for aluminum market.



**Conclusion:** visual inspection of figure 4 with some knowledge about screen of variance functionality should be (and in LIBOR case, was) clear signal of market anomalous behavior. If we have anticompetitive behavior in mind, such graph should evidently trigger further investigation of relevant market.

## CONCLUSIONS

As anticompetitive horizontal behaviors are very common and harmful for economy as a whole, and additionally recently were discovered in a markets we have never been expected such a practices. If such behaviors in most cases mean collusion there is a need for methods of collusion detection which would be quick, resource — saving and understandable for economists, experts and lawyers without quantitative experience. We described here fairly simple but meaningful, graphical tools which could be used in process of screening for collusive behavior in the markets. We have to underline that ability of graphical inspection depends on statistical/econometric tool of choice for particular screen, so we see a need for research and popularization of tools with that property. When for scientific hypothesis testing we need precise numbers and carefully calibrated models, simple graphics could be very interesting for wide range of persons who participate in anticompetitive procedures and want to make quick evaluation of the situation. Our discussion is complementary to a path of research on methods of anticompetitive behavior detection, especially on screen's application. In Abrantes-Metz, Kraten, Metz and Seow<sup>35</sup> they observed very distinct patterns on various graphs that enhanced for additional statistical research, even more illustrative approach<sup>36</sup> was used in Abrantes-Metz. What is our point, and as we hope added value of that paper it is underlining and focusing on visual output of various reasonable selected quantitative methods connected with good theoretically motivated screens of market manipulation. We can say that such a visualization should be used as an “economic background” of anticompetitive cases not only in well known, quasi-experimental methods framework, including in particular the Difference in Difference method often used in such a context (which do not reflect economic theory but are data-driven) but in a more sophisticated research, as well. Even a body of the research is quite complicated we can almost always find a graphical representation of main idea which could be self-explained or need very short comment to be understandable.

<sup>35</sup> R. Abrantes-Metz, M. Kraten, A.D. Metz, G.S. Seow, *op. cit.*, pp. 136–150.

<sup>36</sup> R. Abrantes-Metz, *Aluminum Market...*, *op. cit.*, pp. 1–16.

Anticompetitive horizontal behaviors are very common and harmful for economy as a whole and consumer welfare especially. Such behaviors in most cases mean collusion. Pro-active anticompetitive policy we want to realize implies monitoring of huge set of markets and industries. As preliminary selection is possible on a basis of number of factors that enhanced collusion, there could be still big set of industries left. There is a necessity then for methods of collusion's detection which would be quick, resource — saving and understandable for economists, experts and lawyers without quantitative experience. We described here fairly simple but meaningful, graphical tools which could be used in process of screening for collusive behavior in the markets. We underlined that ability of graphical inspection depends on statistical/econometric tool of choice for particular screen, so we see a need for research and popularization of tools with that property. In Abrantes-Metz and Bajari<sup>37</sup> we can read: “As screens become more popular, and more data and computer power are available, their use by agencies, plaintiffs, and defendants is likely to play an ever increasing role in antitrust litigation”. We can derive a similar proposal in relation to a graphical analysis approach. We could imagine that with progress in in-memory computing and big data analytics tools with very intuitive user experiences<sup>38</sup> such way of detection and assessment of potentially anticompetitive behavior will quickly evolve.

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<sup>37</sup> R. Abrantes-Metz, P. Bajari, *op. cit.*, p. 70

<sup>38</sup> As an example we could point to SAP Lumira.

- Abrantes-Metz R., *Pro-active vs. Reactive Anti-Cartel Policy: the Role of Empirical Screens*, „SSRN Electronic Journal”, No. 2013, <http://dx.doi.org/10.2139/ssrn.2284740>.
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