Cartel in the Indian Cement Industry:
An Attempt to Identify It

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Abstract   This article is devoted to the problem of the detection of overt or tacit collusion equilibrium in the context of the choice of the appropriate econometric method, a choice that is determined by the amount of information that the observer possesses. The author addresses this problem in two steps. First, to provide a theoretical background, he uses a collusion marker based on structural disturbances in a price process' variance. Then, he applies a Markov switching model with switching in variance regimes. He considers this method adequate and coherent with the problem structure and the research objective, and useful for assessing the functionality of the collusion marker he uses. He uses the model to examine the Indian cement industry in the period 1994–2009 and finds some objective indications of collusion and competition phases. These phases are confirmed by certain historical facts as well as by numerous research articles.

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1. INTRODUCTION

One of the fundamental problems of competition policy is detecting and assessing various forms of non-competitive behaviours that are classified explicitly or tacitly in the sources of the anti-trust law. The most frequent practices that limit competition (and which are strictly forbidden in the majority of developed countries) include various forms of collusive agreements of market players on price fixing, dates of price changes, market shares or allocating groups of customers. In the meaning of the NEIO (and in the opinion of the author of this article) most of the non-competitive, horizontal behaviours that can be observed in the industries are the consequences of a strategic interactions held between market players that should be described by suitable models of game theory. The collusive equilibrium of market players in an industry as a result of the strategic interaction of players may take the form of either an overt or tacit collusion. Game theory models (usually non-cooperative, static or dynamic ones, with varied strategic and informational assumptions) that replicate the mechanism of an explicit or tacit collusion are precisely determined as research hypotheses concerning market players' behaviours. However, their empirical application seems to be very challenging. The causes of such a situation can be as follows:

- informational advantage of the participants of the collusive agreement over the observer – players possess private information that is protected by virtue of law (company's confidential information) or is protected because it is proof of breaching the law,

- scarce resources of publicly available statistical data at the levels of industrial disaggregation or individual players[1].

Taking into account the practical dimension, the possibility of objectively detecting and assessing collusions[2] is highly demanded and abundant research has already been done to find and test adequate methods for realizing the task. The present paper is also devoted to testing one of the econometric methods applied for the purposes of detecting collusion. The method in question, based on Markov switching model of the MS(AR)GARCH type, was proposed in

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[1] This remark is true especially in author's country of origin.

[2] As pointed out in Connor and Helmers (2006), in the time period 1990 – 2005 alone, the existence of 283 so-called 'hard core cartels' of domestic and/or global reach was proved. Financial penalties of the total nominal value of 25.4 billion USD were imposed on them. Therefore, the ability to prove objectively the existence of a collusive agreement in an industry is not only of a scientific character but also practical and constitutes an important (or key) element in anti-trust proceedings affecting the involved parties.

Bejger (2009), and the present paper is another attempt at its verification; however, it uses a sample of a considerably greater length for the data with higher frequency of observations. The data provided for the analysis concern the Indian cement industry. The unquestionable advantage of the research is the possibility of a critical confrontation of its results with other research already conducted for a similar purpose.

2. RESEARCH OBJECTIVE AND METHODOLOGY

The major objective of the research is an attempt to detect a collusive agreement of cement producers in India in the time period 1994 – 2009 with the use of the proposed econometric method. Other research objectives include: checking the functioning of the selected method for the data with the frequency of observations higher than those from the previous application (weekly data) as well as conducting a comparative analysis of conclusions which may be drawn from the present research and from other research with a similar objective but different methodology.

As can be inferred from the initial considerations, the underlying research objective is working out a method of detecting collusive agreements in a situation when statistical information is limited. Besides, if the method is to be useful it needs to be relatively cost-effective (requiring little human, time and hardware resources) and convincing. It can be assumed that such a method ought to meet, at least, the following three conditions:

- it needs to be data - efficient and be oriented towards the use of information on industries that is most frequently available in the resource of the public statistical data – these are usually series of price levels (price indexes) of suitable products at various stages of distribution and/or seriess of the product's sales levels (quantities or revenues),

- it needs to be a method of initial and quick verification of a hypotheses on the existence of a collusive agreement in an industry/a corresponding market[3] which may be applied straightforwardly for the existent data,

- it needs to be connected with a proper theoretical models generating collusive equilibria.

The methods within which the above postulates are attempted to be realized are the indirect methods of detecting collusion and they include the following:

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[3] In a product or geographical sense.

- identification of the so-called collusion markers[4] (non-competitive behaviours) which are certain disturbances typical of a collusive agreement and concern the following:

a) relationships held 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 capacity.

Some of the most promising collusion markers are those based on the analysis of changes in the variance of market price processes (point b). It is essential that players in the industry should manufacture a homogeneous product (of a high substitutability, based on a similar technology). We have to note that an analysis of price levels, price trends, or even of relationships between product prices and the prices of production factors (where the latter are available) cannot be regarded as a collusion marker. The exception, however, is an analysis of seasonal volatility related to a variability analysis, e.g. in Bejger (2010). A price variability analysis, in the other hand, has a strong theoretical motivation that makes it possible to connect disturbances in the variance of a price process and the possibility of occurrence of collusive equilibrium in an industry. The proposed method of the identification of collusive equilibrium is based on the following assumption:

- the variance of a price process is on average lower in collusion phases and may be subject to changes of the regime type.

2.1 THEORETICAL MOTIVATION OF THE METHOD

Why does the product price variability in the market collusion phase need to be relatively low and why is it to signal that kind of market equilibrium?

What is important for the objective legitimacy of this issue is the theoretical motivation for a selected marker. In the author's opinion, the basis for the specification of every detection method applied for collusive equilibrium as well as for collusive markers needs to be an adequate model of strategic interaction utilizing the instruments of the game theory. In a typical process of market price disturbances such models indicate primarily the disturbances of the process variance. The three most essential model specifications may be distinguished here and they constitute a source of testable hypotheses related to the price variance.

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[4] Introduced and determined in that way in Harrington (2005).

In their work Rotemberg and Saloner (1990) developed a repeated game with incomplete information corresponding to the phenomenon of collusive price leadership. The phenomenon consists in announcing by the leader a price change (usually it is an upward pricing) prior to the date when the new price becomes effective. Other market players follow the leader in establishing the price level and the date of the new price implementation. The most important, in a current research' context, conclusion drawn from the paper is the statement that in the equilibrium of the constructed game the market price controlled by the leader is characterized by some rigidity which means by a variance that is lower than the variance in the case of competitive equilibrium.

Athey, Bagwell and Sanchirico (2004) proposed a repeated game pricing model (a supergame) with egzogenic distortion of players' costs (which constitute their private information) and of observable prices. Therefore, this game is one with incomplete information where a stage game is Bertrand competition model with the Bayesian-Nash equilibrium. The authors, applying their own concept of the game equilibrium of the SPPE type, proved that in the equilibrium collusive prices can be observed and that they are characterized by rigidity (used to maintain the collusion). Therefore, in the collusion phase, the price variance should be lower. In addition, it must be added that on the equilibrium path price wars should not occur, which is typical of the majority of standard supergames based on punishment strategies.

In their article Maskin and Tirole (1988) introduced a repeated game model with players' asynchronous choices. Two players participate in the game and they take turns in movements. For the action space being a set of prices, reactions' functions of the Markov type and a sufficiently high discount factor there exists a unique equilibrium that is subgame perfect (MPE), Pareto dominates other equilibria and is characterized by rigid price at the monopoly level. That price is called 'focal price'. The Maskin and Tirole model is, in fact, a truly dynamic version of the mechanism of the kinked demand curve that has been known since the 1930s of XX century. Equilibrium strategies for the model (provided suitable assumptions are made) imply a small price variance in a collusive equilibrium.

Moreover, Bejger (2010a) shown that the supergame model with a constant structure of cartel quotas indicates the following:

- a possibility of the occurrence of the price war phase evoked by the player that did not intend to keep or enter a collusive agreement due to too low predicted or actual market share,

- on average, a lower market price variance in the collusive agreement phase caused by the price rigidity in the periods when the market was shrinking.

To recapitulate, if a collusive marker is to be based exclusively on an analysis of a price proces, then a hypothesis may be formulated that in the collusive agreement phase the price variance is on average lower than in the competition phase. We can also expect regime changes in the variance while passing from the collusive agreement phase to the competition phase; however, it cannot be stated whether that phase is the punishment phase in a repeated game, or a breakdown of an overt collusion cartel brought about by some other causes.

2.2 ECONOMETRIC INSTRUMENTS

Within the econometric methods[5] of detecting changes in the process variance, the most beneficial are the methods which are objective and coherent with theoretical motivation – that means those for which **the knowledge of the moments of changes in the variance is unnecessary**. This postulate is fulfilled by the following two instruments:

- Markov switching model of the MS(M)(AR(p))GARCH(p,q) type for the variance and/or for the mean of the price process. Applying such a model has the following advantages:

  a) a method is theoretically coherent with the strategy structure of the supergame model equilibrium,

  b) it enables us to model directly structural changes of the variance process without using any extra artificial variables; such modelling is not possible in, e.g., the ARCH/GARCH specifications,

  c) a method is coherent with informational asymmetry occurring between cartel members and an observer. The MS(AR)GARCH specification does not require observing (knowledge of) the state variable so it can serve actual detecting of the variance regimes and objective determining of the switching moments, so that it is detecting the phases of collusive agreements and competition. A general form of the MS(M)(AR(p))GARCH(p,q) model is a developmental version of a popular MS model.

- A wavelet analysis (used in Bejger and Bruzda (2010)), is characterized by the following:

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[5] The examples of works that apply the discussed marker with the use of various statistical and econometric instruments include Abrantes-Metz et al. (2006) and Bolotova et al. (2008).

a) economy of specification – as a non-parametric method it is not burdened with a specification error of an econometric model,

b) simplicity of application – the amount of effort necessary to apply the method for the data is minimal,

c) a precise indication of the moment of changes in the variance without any assumptions on their location. Therefore, the method can be said to be very objective,

d) a possibility of an initial graphical assessment of the 'behaviour' of the variance with the use of MODWT graphs and rolling wavelet variances.

The disadvantages of a wavelet analysis include relatively high requirements on the length of the observation series and lack of any direct relationship between the method and the structure of the equilibrium strategy.

For the purposes of the verification of the hypotheses on the existence of a collusive agreement on the Indian cement market, the MS(AR)GARCH model was selected as a research instrument to be applied.

3. EMPIRICAL ANALYSIS

The researched subject is the Indian cement industry. The research covers the time period from 1994 to 2009. The information on the industry is derived mainly from Anand (2009). Also, the article serves as a reference point within the research results analysis, since it is devoted to a similar problem – detecting the existence of a cartel formation in an industry.

3.1 CHARACTERISTICS OF THE CEMENT INDUSTRY

Cement constitutes one of the major building materials used in the world economy. It must be explained that, unless mentioned otherwise, while talking about cement production what we mean is the grey cement (Portland cement) widely used in the world construction industry. The cement production technology is typically based on the so-called 'dry method'. As a result of the process clinker is obtained which is then mixed with other ingredients to obtain a final product – cement. In fact, the same manufacturing technology is used worldwide. Also, cement use across the globe is similar; the majority of it goes for producing concrete, a relatively small part of cement production is used directly in construction works (for instance, subgrade stabilization in road building). For those reasons we can assume that Portland

cement is a homogeneous product[6] and does not have any near substitutes. The overall world production of cement in 2008 amounted to 2,000 Mt.

It must be emphasized that cement manufacturing is connected with certain considerable entry barriers (high costs of the installation of a production line, logistic barriers concerning the necessity of locating production facilities in the neighbourhood of raw materials, a very high energy consumption that characterizes the production process and due to which it is necessary to select a location with access to energy sources). That fact together with the lack of substitutes for cement and the strong links between the demand for cement and the civilisation development means that cement industries foster making collusive agreements and setting up cartels. Indeed, the cement industry is one of most cartelized industries on a global scale. To illustrate that phenomenon, in the time period 1994 - 2009 alone, the existence of 11 collusions in 11 countries and of one continent-spanning cartel was detected (the players were sued).[7]

The Indian cement industry (as at the beginning of 2009) had the installed capacity of approximately 217 Mt (in comparison, in Poland it was 17 Mt) and was the world's second largest producer (China ranked first). The industry comprised altogether 51 companies (in comparison, in Poland there were 6 main players) but 12 major players controlled 60% of the cement market. The yearly average rate of consumption growth in India in the years 2002 – 2009 reached 8.4% (the minimum value of 5.8% was reached in 2004 and the maximum of 11.35% in 2006).

It must be noted that up to 1989 the functioning of the cement industry in India had been controlled (regulated) entirely or partially by the state administration (some similarities can be spotted between the Indian and the Polish cement industries. In the latter the privatization process was commenced in 1991).

3.2 STATISITICAL DATA

A main characteristic of the cement industry that is going to be taken for the purpose of the empirical analysis is the average cement wholesale price. The research included the index

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[6] There are of course types of construction cement dependent on the content of clinker in its composition, e.g., in Poland this content ranges from nearly 100% in the CEMI class to 5% in CEMIIIC. However, a mention should be made that the majority of cement sold is either the CEMI or CEMII class.

[7] For detailed information see, for example Bejger (2011:3)

of average weekly cement wholesale prices [8] for the period from 02 April 1994 to 10 October 2009 (811 observations). The source form of the series is illustrated by Figure 1.

Figure 1. A weekly fixed base index of the cement wholesale price (the base: 26-03-1994).
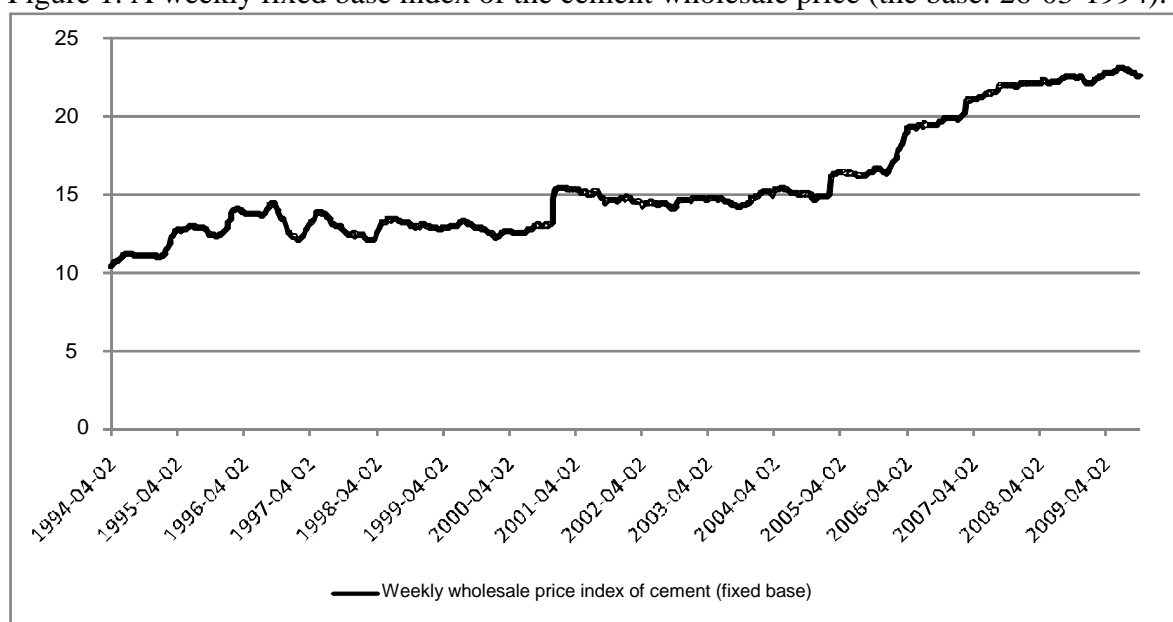
The source data presented in Figure 1 do not reflect precisely the phenomenon which is the subject of the research (changes within the variability of prices). However, what worked well here was the chain index for which the observations had been converted. The course of the index is shown on Figure 2.

Figure 2. A weekly chain index of the cement wholesale price

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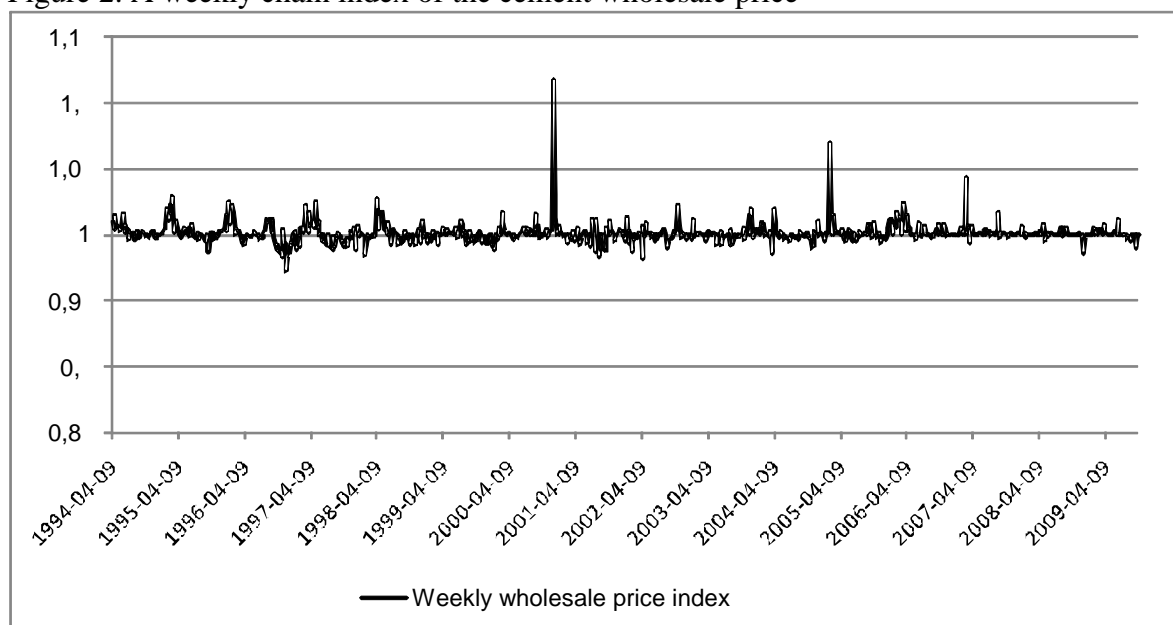
3 EMPIRICAL RESEARCH

While analysing Figure 2 the following can be observed:

- the significant variability differences in the subperiods, in particular at the end of the sample,

- the grouping of the variability,

- three outliers.

These observations reinforce our conviction that the analysis of changes in the process variance appears to be justified. Another step to be taken is examining the statistical properties of the series, in particular, the characteristics of distribution, autocorrelation and stationarity. The results are contained in Table 1.

Table 1.Series characteristics

Average	1,0009	Jarque-Bera	169191.2	ADF Test	-14.0165*
Min. value	0,9722	normality test	(0.0000)		(0.000)
Max. value	1,1181				
Standard dev.	0,0078				
Skewness	5,5261	Ljung – Box test	182.70	KPSS Test	0.0610**
Kurtosis	72,9351	for levels – Q(5)	(0.0000)		

p- values given in brackets, * value of *t-statistics* (critical values for 1%;5%;10% sig. levels - (-3,438);(-2,864);(-2,568), ** value of *LM statistics* (asympt. critical values for 1%;5%;10% sig. levels - 0.739; 0.463; 0.347).
Source: based on the author's own calculations.

The series is skewed and leptokurtic. The hypothesis on a normal distribution was rejected and by means of the tests of various configurations of the hypotheses[9] the lack of unit roots was confirmed.

Cement is a type of product that is characterized by a seasonal demand and, consequently, by a seasonal price volatility. In order to eliminate this source of price volatility before making further analyses, the series was filtered with the use of the Hodrick–Prescott filter. In addition, with a view to considering the impact of the three outliers, a 0-1 variables was implemented. Next, for the data prepared in such a way, a model was estimated that was sufficient for eliminating the autocorrelation of the residuals. The model that proved to be sufficient for the purpose was the autoregressive model AR(3). Table 2 contains the results of the estimation and Table 3 contains the assessment of the adjustment and the diagnostic tests.

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[9] This is a so-called 'confirming analysis' that proved to be effective in that case; however, as shown by simulation research, it may lead to erroneous conclusions when the analyzed process is a TS (stationary) process, see more in Piłatowska (2003: 113).

Table 2. The results of the AR(3) model estimation

Parameter	Estimation	Standard deviation	p - value
Constant	1,0009	0.0006	0
0-1 variable	0,0057	0.0011	0
AR1 term	1,8171	0.0915	0
AR2 term	-1,3099	0.1257	0
AR3 term	0,4005	0.0573	0

Source: based on the author's own calculations.

Table 3. Adjustment and diagnostic tests

Name of measure / test	Value	p - value
Log Likelihood	4120.53	-
R^2	0.93	-
The Jarque-Bera test	4646.09	0
The Ljung-Box test (residuals). Q(12)	13.92	0.306
The Ljung-Box test (squared residuals). Q(12)	279.07	0
The Durbin - Watson statistics	1.93	-
The LM test for the autocorrelation of residuals	13.54	0.331
The LM neglected ARCH test	246.75	0
The LM test for heteroscedascity of residuals	127.96	0

Source: based on the author's own calculations.

Having interpreted the content of Table 3, it can be stated that the model was well fitted to the data and that autocorrelation of residuals was not observed. The significant results obtained are: the maintained heteroskedasticity of the residuals and the result of the test for the neglected ARCH effect (associated with the autocorrelation of the squared residuals). They indicate the adequacy of a separate modelling of the process variance. That denotes that the marker of the changes in variance may be applied here.

In accordance with the methodology agreed at the beginning, to achieve the research objective an attempt was made to assess a switching model of the MS(M)(AR(p))GARCH(p,q) type with the following general formula:[10]

$$y_t = \alpha_{0S_t} + \sum_{m=1}^{p} \phi_{mS_t} y_{t-m} + u_t \tag{1}$$

where:

$u_t = h_t^{1/2} e_t \ and \ e_t \sim i.i.d.(0,1) .$

$$h_t = \beta_{0S_t} + \sum_{m=1}^{\infty} \beta_{mS_t} u_{t-m}^2 \tag{2}$$

The conditional variance equation (2) uses ARCH(∞) specification which also includes models of GARCH (p,q) class.

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[10] As regards the specification and estimation methods see Davidson (2004), Hamilton (1989), Hamilton and Susmel (1994), Krolzig (1998).

In model (1),(2) each parameter may be potentially a random variable switched between the values from a finite set of values depending on the current state S_t. where $S_t = 1, ..., M$.

Variable S_t is assumed to be the exogenous, homogeneous Markov process with fixed transition probabilities $\{p_{ij}\}$ where:

$p_{ij} = Pr(S_t = j \mid S_{t-1} = i)$.

The probability that the observed y_t process is in the j state in the t period is provided by means of the following filtering equation (updating equation):

$$Pr(S_t = j \mid \Omega_t) = \frac{f(y_t \mid S_t = j, \Omega_{t-1}) Pr(S_t = j \mid \Omega_{t-1})}{\sum_{i=1}^{M} f(y_t \mid S_t = i, \Omega_{t-1}) Pr(S_t = i \mid \Omega_{t-1})}. \tag{3}$$

where Ω_t denotes all the information (i.e. y_{t-j}, S_{t-j}, $j \geq 0$) that is available in the t moment and:

$$Pr(S_t = j \mid \Omega_{t-1}) = \sum_{i=1}^{M} p_{ij} Pr(S_{t-1} = i \mid \Omega_{t-1}). \tag{4}$$

where the transition probability p_{ij} constitutes M(M-1) parameters to be estimated.

The form of conditional density function of observed variable:

$$f(. \mid S_t = j, \Omega_{t-1})$$

requires accepting the assumptions on the type of distribution.

Estimation of model parameters may be obtained through maximum likelihood method. For this purpose a likelihood function is used:

$$L = \sum_{t=1}^{T} \log Pr \sum_{i=1}^{M} f(y_t \mid S_t = j, \Omega_{t-1}) Pr(S_t = j \mid \Omega_{t-1}). \tag{5}$$

The maximization of the function (5) is performed by means of a well-known method based on the EM or BFGS algorithms.[11]

After conducting a number of trials,[12] eventually, a model in the MS(2)(AR(3))ARCH(2) specification was developed and it had the following form:

$$y_t = \alpha_{0_t} + bD_t + \sum_{m=1}^{3} \phi_m y_{t-m} + u_t \tag{6}$$

where:

$u_t = h_t^{1/2} e_t$ and $e_t \sim i.i.d.(0,1)$.

$- h_t = \beta_{0S_t} + \beta_1 u_{t-1}^2 + \beta_2 u_{t-2}^2 \tag{7}$

and: $S_t = 1,2$.

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[11] For detailed information see: Krolzig (1998: 8).

[12] The estimation was made with the TSM package in the case of which a frequent problem was lack of convergence of the Broyden-Fletcher-Goldfarb-Shanno (BFGS) algorithm of the likelihood optimization function.

The model in the specification (6), (7) assumes controlling the observable price process through non-observable stochastic process of state variable S_t, which is assumed to be a homogeneous Markov chain of two states and proper matrix of transition probabilities between the states. The D_t variable, similar to the previous AR(3) specification, is a 0-1 variable with the value of one equal for three weeks with outliers and of zero for the remaining weeks of the sample. The parameter dependent on the regime is the constant in the conditional variance equation (7). The estimation output is presented in Tables 4 and 5.

Table 4. The results of the estimation of the MS(2)(AR(3))ARCH(2) model

Parameter	Estimation	Standard deviation	p - value
p_{11}	0.9655	----	----
p_{22}	0.9212	----	----
ϕ_1	1.5712	0.0475	0
ϕ_2	-0.9443	0.0646	0
ϕ_3	0.2397	0.0336	0
β_1	0.5861	0.1216	0
β_2	0.1795	0.0488	0
α_0	0.9998	0.0003	0
b	0.0035	0.0003	0
β_{01}	0.0005	0.00001	----
β_{02}	0.0013	0.0003	----

Source: based on the author's own calculations.

Table 5. Adjustment and diagnostic tests

Name of measure / test	Value	p - value
Log Likelihood	4344,32	-
R^2	0,92	-
Jarque-Bera test	17,97	0
The Ljung-Box test (residuals). Q(12)	12,92	0,346
The Ljung-Box test (squared residuals). Q(12)	17,89	0,119
The Durbin - Watson statistics	1,89	-
The LM test for the autocorrelation of residuals	12,56	0,401
The LM neglected ARCH test	3,56	0,736
The LM test for heteroscedascity of residuals	3,09	0,078

Source: based on the author's own calculations.

Based on the content of Tables 4 and 5 it is possible to state that the model represents properly the examined process. The estimates of all the parameters are statistically significant and the fit to the data is satisfactory (the value of the likelihood logarithm increased if compared with the specification without exact modelling of the process variance). The properties of the residuals were also improved, both the levels and squares do not show autocorrelation and the ARCH effect seems to have been incorporated properly into the model specification.

Within the research objective it should be noted that the earlier observations of the differences in the variability levels were proved. The assessed model indicates clearly a regime change in the variance, characterized by a significant persistance (the estimates of the transitions probabilities p_{11} and p_{22} are close to 1). In regime 1 the constant in the equation of the conditional variance is clearly lower than in regime 2, which indicates on average lower variability level in regime 1. The average process duration in regime 1 equals 29 weeks, and in regime 2, 13 weeks. However, the most essential seems to be the question whether the proposed model can serve to detect collusive agreements. That can be assessed based on the precision of regime detection. Figure 3 illustrates the course of the observed variable (the series filtered with the H-P filter) and the smoothed probabilities for regime 1 (i.e. conditional probabilities of the process is in state s1, while taking into account information from the entire sample).

Figure 3. Weekly wholesale price index (filtered) and the smoothed probabilities of regime 1
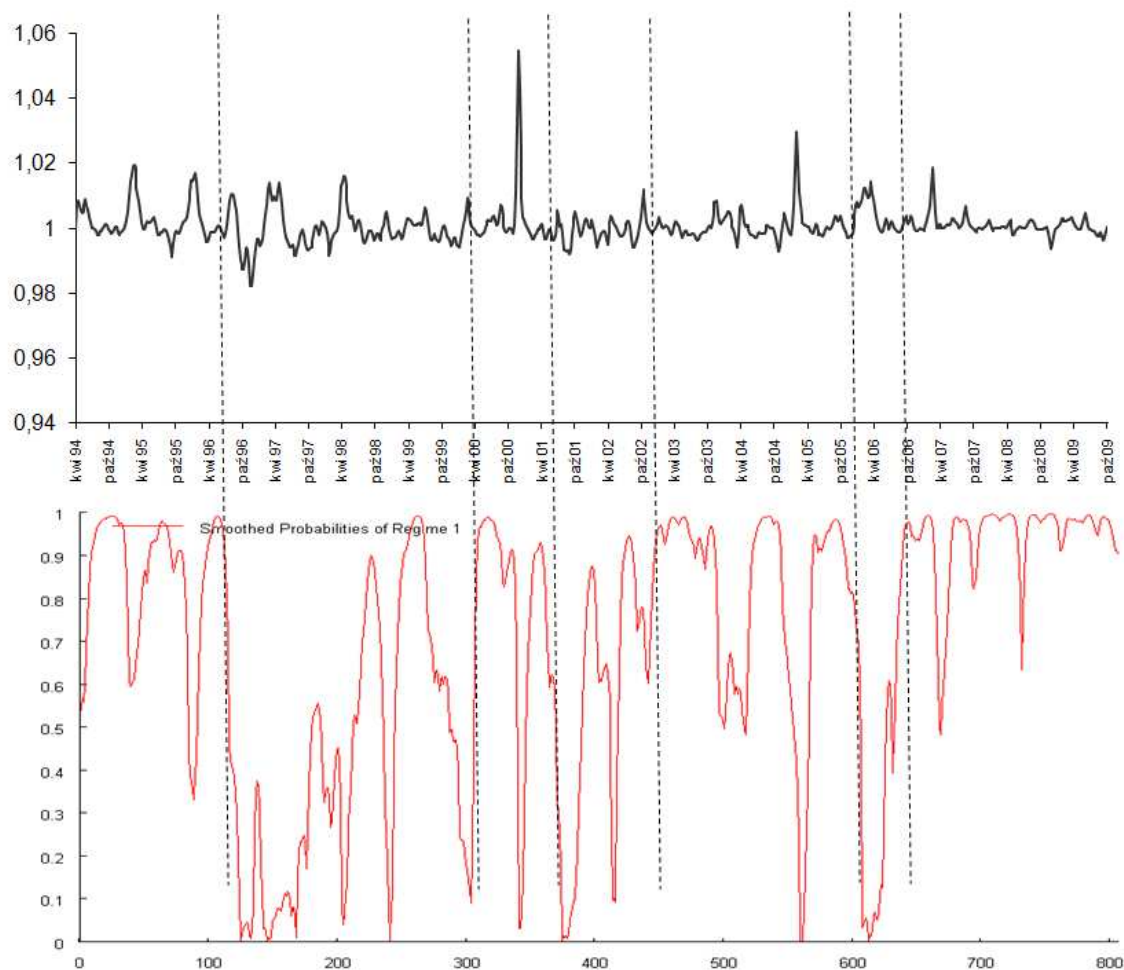
The broken lines represent approximately the phases of a potential collusive agreement. We should also consider the impact and importance of 3 deviated observations. They actually stand for (see Figure 1) a single gradual increase in an average market price which is followed

by stabilization at a new, higher level. Despite the fact that formally they denote a sudden increase in the process variance (therefore, in Figure 3 they are registered as rapid reductions in the probabilities of the occurrence of the process in regime 1) their actual economic functioning as coordinated actions should be taken into account while making attempts to identify the type of the market equilibrium. Based on Figure 3, it is justified to draw the following conclusions:

- the time periods below can be interpreted as the collusive agreement phase:

    o from 1994 – to mid-1996 (phase I),

    o from 2000 – to mid-2001 (phase II),

    o from mid-2006 to the end of the research sample (a particularly stable period) (phase III).

- the phase of a clear breakdown of the cartel (the competition phase) can be dated:

    o from mid-1996 – to mid 2000 (phase 1),

    o from 2001 to 2002 (phase 2),

    o the year 2006 (phase 3).

- the period from the beginning of 2003 to the end of 2005 cannot be classified explicitly (the periods with a low variance are alternated with periods of a high variance). An observation that the collusive agreement actually collapsed in the year 2004 may be risked here.

Obviously, a key question remains whether the assumed collusion detection mechanism really works. A verification may be performed only when the information on the conducted anti-trust proceedings and certain facts on the activity of the industry are provided. Below are presented the most essential facts related to the functioning of the Indian cement industry which may be vitally connected with the indicated phases of the collusive agreement.

Based on the decisions issued by the Indian Monopolies and Restrictive Trade Practices Commission[13] it is evident that:

a) on 05 July, 2000 in Jabalpur a meeting of the representatives of the major players was held (the players controlled then over 60% of the cement market) wherein they took a concerted action to fix the cement prices artificially and also decided to control the quantity of cement flowing in the market by suspending production and dispatches either from Dump or from factory to direct dealers for five days from 5th July to 9th

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[13] MRTPC (2001).

July, 2000. In the said meeting it was further decided to hike the price of cement from 10.7.2000 to Rs. 107/- Rs. 109/- per bag and arrangements concerning the establishment of the cement price and the supply level were made.

b) further coordinated suspensions of cement supplies were realized on the following dates: 27.11.2000 – 4.12.2000 and 12.01.2001 – 19.01.2001.

Other essential related facts are as follows:

c) in the years 2001 and 2004 there was a significant slow-down (if compared with the other part of the sample) in the annual growth rate in cement production,[14]

d) in year 2006 a sudden rise in cement consumption was observed,

e) in March 2004 a new, important player enter the industry – Shanghi Cement.

4. RESEARCH SUMMARY AND A COMPARATIVE ANALYSIS

To provide a synthetic overview of the results of the research conducted the following must be stated:

- assuming a certain theoretically justified mechanism that determines a market collusive equilibrium and its aftermath in the form of a price disturbance, it was possible to detect such a disturbance by means of a selected econometric instrument,

- based on the type of the disturbance determined, the possible collusive agreement phases and the possible competition (the non-cooperative equilibrium other than explicit or tacit collusion) phases were identified,

- comparing the identified phases with the historical facts the following must be noted:

  o facts a) and b) confirm the correctness of the detection of the collusive agreement phase II,

  o fact c) corresponds to the competition phase 2 (based on model in (Bejger 2010), within the market shrinking phase, a minimum market share when the least important player is ready to join the collusive agreement tends to increase and then a dissatisfied player may break off the agreement unilaterally),

  o facts c) and e) correspond to the breaking down of the collusion in 2004,

  o competition phase 3 in connection with fact d) and with an analysis of nature of price variance increase in that period (as we can observe in graph 2, the main cause of the increase of variance was fast, constant increase of price of

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[14] The data come from Cement Manufacturer Association Annual Report (2010).

cement that lasted half of the period followed by period of stable price that lasted to the end of the phase) can not be unambiguously qualified as real break down of the cartel without additional information about market level demand.

4.1 A COMPARATIVE ANALYSIS

In the quoted work Anand (2009), mainly due to the impact of facts a) and b), an attempt was made to arbitrarily divide the examined sample into the following sub periods: the period of competition (no cartel) comprising the years 1994 – 1999 and the period of cartel (2000 – 2009). The conclusions contained in the work (the research was conducted in subsamples) are as follows:

- no cartel formation was detected in the years 1994 – 1999,

- the cartel formation period was detected (2000 – 2003) with a few downturn phases,

- the critical period (the cartel phase) covers the years 2004 – 2009.

The above conclusions are based on the surveying of a trend function of an fixed base price index, the research of quarterly values of seasonal fluctuations and on the analysis of changes in the costs of basic production factors.

The outcomes of the two researches (the present and referential one) are partially congruent; however, some methodological differences should be taken into account:

- the objective of the present work is the verification of the functioning of the marker whose application is to serve the detection of a potential collusive agreement (without any initial information, in particular without any private information from players),

- detection of a collusive agreement is based on the theoretical assumptions (adequate equilibrium models) and uses the instruments of mathematical statistics with a view to evaluating objectively the value of disturbances treated as a marker of collusion/competition.

4.2 SUMMARY AND FURTHER RESEARCH DIRECTIONS

It appears that detecting an equilibrium type based on the described collusion marker proved satisfactory and was confirmed partially within the possessed information (derived from the anti-trust proceeding and economic environment). The econometric instrument applied gives clear indications; however, it does not meet fully the postulate of small outlays indispensable for the application (the aforementioned difficulties in the estimation of switching models caused an unplanned increase in the amount of time required). The main problem however, is lack of decisive conclusions in phase qualification in a period of rapid

market size increase. Another stage of the research should consist in conducting a wavelet analysis to determine more precisely the moments of changes in the level of the process variance and in using additional information on production and demand factors.

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