CARTELS, COOPERATION AND RIVALRY

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1. INTRODUCTION

A cartel is defined as a kind of organization of a branch such that firms agree on coordinating individual decisions in order to avoid competition among them. In this case, the lack of competition is a relevant factor in market price formation, and consequently it may be expected that companies should have sufficient power and feeling of mutual cooperation to impose a monopoly price. The objective of this paper is to develop the hypothesis that firms in a certain economic sector do follow a joint maximization procedure and set the common price at the monopoly level.

This method is based upon a direct comparison between the actual market price and the theoretically calculated monopoly price. The latter is obtained following a profit maximization procedure, in relation to the actual demand curve, under the assumption that the branch acts as a monopoly. Accordingly, a simultaneous supply-and-demand market model has firstly been estimated in order to identify the actual industry demand curve. The synthetic approach to market analysis presented here stems from the theoretical and empirical works by PORTER (1983) and BRESNAHAN (1989), who proposed a general model of price formation in which no special degree of competition between producers has been assumed ad hoc.

An empirical example that supports this approach is here given by data from the Brazilian cement industry. The main practical result obtained, more extensively discussed in LIMA (1992), is that the actual price is always lower than the hypothetical monopolistic one. Therefore, the conclusion is that besides cooperation there is also rivalry between companies in this industrial branch, and both driving forces combined together bring about some intensity of competition in the market. Furthermore, it is observed that rivalry is greater in times of economic expansion, while cooperation among firms becomes tighter during stagnation.

The market model is described in section 2, while the methodology of empirical analysis is put forward in section 3. The organization of the industry and the cooperation between companies in price-setting are outlined in section 4, where the main econometric results obtained are also presented. The monopoly pricing hypothesis test is developed in section 5, and section 6 contains an analysis of the relation between cartelization and profits. Finally, main conclusions are offered in section 7.

2. THE MARKET MODEL

In the Handbook of Industrial Organization edited by SCHMALENSEE & WILLIG (1989), BRESNAHAN suggests a comprehensive development of the notion of supply. Considering an imperfect competition situation, he defines as a supply relation the equation which is the first

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order condition for profit maximization, subject to an index of competitiveness which stems from a mixed situation where there is some intensity of competition and some degree of cooperation between producers. This section briefly presents this notion of supply. Consider a market whose demand is described by:

(1) $D_t = \alpha_0 - \alpha_1 P_t + \alpha_2 F_t$

where D is consumption, P is price, and F is a demand-related shifting variable such as consumer income. The assumption of linearity is not necessary; however, it will here be assumed that a is constant for the sake of simplicity in the mathematical treatment. Moreover, a may in fact be a function of the consumption level, but this is a possibility which may be detected by econometrics, and which in any case has no influence on the general results obtained. Therefore, given the production capacity, the maximum profit will be obtained as a solution for the following equation:

(2) $P_t + \lambda_i (dP/dD) Q_{it} - c_i'(Q_{it}) = 0$

where (dP/dD) is the slope of the inverted demand function, c' is the marginal cost which depends upon the individual level of production Q, and λ is the index of competitiveness which, for the purpose of this study, is the same as an individual conjectural variation parameter. This is a fairly general expression which may be seen as a "natural way to parameterize various oligopoly solution concepts" (GEROSKI, PHLIPS & ULPH, 1985, page 378). It has been taken as the point of departure in many theoretical and empirical studies, such as those by IWATA (1974), COWLING & WATERSON (1976), APPLEBAUM (1982), CLARKE & DAVIES (1982), DICKSON (1982), LAU (1982), KWOKA & RAVENSCRAFT (1986), DIXIT (1986) and GEROSKI, ULPH & ULPH (1987).

Equation (2) is defined as the individual short run supply relation because it contains all (and only) the points which maximize profit; it contains all equilibrium solutions which are desired by the producer. Demand equation (1), plus n (one for each producer) equations (2), will allow for the determination of the equilibrium price and production. The summation of all individual production at each price level leads to the industry supply relation, which becomes:

(3) $P_t - (\lambda / \alpha_1) Q_t - c_j'(Q_t) = 0$

where Q is the total industry production, α_1 is the demand slope, and c' is a function of all individual marginal cost curves. Equation (3) merges all the individual equations (2) and may be defined as the industry short run supply relation because it contains only (and all) those points which maximize profit; it contains all equilibrium solutions which are desired by the entire set of producers. Equations (3) and (2) play the role of the law of supply and demand.

The parameter λ in (3) results from the interests of all companies in the branch, which are not necessarily coincident. λ is somehow a composition of the λ_i of individual firms, which "are conjectural variations that are best interpreted as reduced form parameters that summarize the intensity of rivalry that emerges from what may be a complex pattern of behavior" (SCHMALENSEE, 1988, page 650). The value of λ may range from zero (maximum rivalry between partners) to unity (maximum cooperation) passing through a special value, equal to the firm's share of the market (Cournot's solution), providing thus a general relation appropriate for econometric application. The slope of the industry short run supply relation will therefore be given by:

(4) $\delta Q/\delta P = \beta_1 = 1/(\lambda/\alpha_1 + \delta c_j'/\delta Q_t) > 0$

This expression shows that the supply slope is a function of λ, which stems from the complex oligopolistic pattern of interaction of producers in an industrial branch. λ must thus vary from branch to branch, but it may be expected that the pattern of interaction will be constant in a given branch. This assumption does not imply that λ is itself constant; it may for instance display a "scale-effect", varying as the production level varies. This is a detail to be analyzed in the econometric treatment; for expository purposes it will be assumed that λ is constant. The same procedure applies to the marginal cost, whose derivative will also be supposed to be constant; therefore, the short run supply relation may be written as a linear function such as:

(5) $Q_t = \beta_0 + \beta_1 P_t - \beta_2 W_t$

where W is an exogenous cost-related variable, such as input price, which shifts the supply relation either to the left when increasing, or to the right when it falls. In addition to this, the industry is assumed to consider not only the actual price but also an expected price which is formed in accordance with a learning process based upon past experience. The supply relation may thus be defined by the following equation:

(6) $Q_t = \beta_0 + \beta_{11} P_t + \beta_{12} P_{et} - \beta_2 W_t$

where P_{et} is a rational expectation for price with arguments on present and past values of the exogenous variables, defined as satisfying:

$$P_{et} = E\ \{\ P_t \mid W_{t-\omega}, F_{t-v}\} + \mu_t$$

where W and F are the exogenous variables of the model and μ is a white noise. The indefinite lag structure represented by ω and ν forms the base for expectation formation, which will be determined by econometrics: "the rational expectations are given as linear combinations of the predictions of the exogenous variables, and the relevant information on which to base these is the set of past values" (WALLIS, 1980, p. 332) of the exogenous variables. Therefore, the structural model is composed of the demand equation (1) and the supply relation (6), and for equilibrium to prevail it is necessary that consumption and production match. Formally:

DEMAND CURVE: $D_t = \alpha_1 - \alpha_1 P + \alpha_1 F$

SUPPLY RELATION: $Q_t = \beta_0 + \beta_{11} P_t + \beta_{12} P_{et} - \beta_2 W_t$

EQUILIBRIUM CONDITION: $D_t = Q_t$

EXPECTATION FORMATION: $P_{et} = A_p + A_{p1}(L)W_t + A_{p2}(L)F_t + \mu_t$

where A_{pi} are lag operators in the exogenous variables W and F, and μ_t is a white noise.

3. THE ECONOMETRIC METHOD

In order to avoid the intrinsic bias of the simultaneous equation models, and taking into account that all structural equations are perfectly identified, the empirical estimation procedure could alternatively follow the indirect least squares (ILS) or the two-stages least squares (2SLS) methods. In both cases a reduced model is estimated in a first stage, while in a second stage the structural parameters are computed from the coefficients obtained in the reduced model. In a general reduced model all endogenous variables may be described by the set of exogenous variables. In this case, given that the expected price P is a function of exogenous variables which have been lagged, all the endogenous variables will be functions of the same set of lagged exogenous variables. Formally, all equations of the reduced model may be represented by:

$$Y_{it} = A_{i0} + A_{i1}(L)W_t + A_{i2}(L)F_t + \mu_{it}$$

where Y_i represents the endogenous variables (D, P, and Q), A_{i0} allows for constants, A_{ij} (L) are lag operators in the exogenous variables W and F, and μ_i are white noises. Every endogenous variable, and thus the model taken as a whole, will have a double behavior: the actual and the equilibrium status. The former is obtained by computing the value of the endogenous variables from the lagged values of the exogenous variables set, while the latter is derived by assuming that all exogenous variables are fixed at their last observed levels. Therefore, the equilibrium, or "intrinsically economic" status, is a theoretical consequence of the model; it would only be observable if and when all exogenous variables would have stopped varying. The spread between actual and equilibrium values is thus a trend component. This trend component may be eliminated because, supposing that external shocks are identically and independently distributed, after several shocks it will become random, displaying then no systematic behavior.

It is interesting to note that, as a matter of consequence, according to this methodology the reduced equations of actual and expected prices will be the same. As a corollary, under equilibrium conditions, when all exogenous variables are supposedly constant, equilibrium and expected prices are the same. In the long run the only price one may expect to prevail is the equilibrium price. This is to say "that expectations, since they are informed predictions of the future events, are essentially the same as the predictions of the relevant economic theory" (MUTH, 1961, page 316).

Consequently, the econometric treatment of the model will make it impossible to disentangle the coefficients of the actual and the expected prices in the supply relation: only the composed parameter may be obtained. As stated by MUTH (1960, page 324), unless relevant expectation data were available, it is impossible to distinguish β_{11} from β_{12} in equation (6); all that the econometric work can bring about is the composed parameter β_1 of equation (5). Therefore, the long run structural supply relation, instead of being given by equation (6) as proposed before, will become that of equation (5), provided that P refers to the long run equilibrium price.

Summing up the methodology, the first step is to calculate the reduced equilibrium model, for this combining the coefficients of each exogenous variable of each reduced equation. It will then be possible to compute, from these coefficients, the parameters of the structural market model or the series of theoretical equilibrium values of the set of endogenous variables. In these series the trend, which can be seen as a normal random-walk around the equilibrium level of an endogenous variable, has been eliminated.

4. EMPIRICAL EVIDENCE: THE BRAZILIAN CEMENT MARKET

4.1. Some Important Peculiarities

Following a widespread tendency, there is a sharp concentration of production in the Brazilian cement industry, which could lead to the coordination of individual marketing policies, and eventually to a central decision entity. For an outsider it seems that decisions about price and individual production are made during a monthly meeting of the industrial groups representatives at the National Cement Industry Syndicate. Analyzing data published by the Syndicate, it would seem that there is a rule of homogeneity in capital idleness, and that production is divided among partners in accordance with production capacity.

Exception made to the short-lived price wars of 1974 and 1984, companies normally follow a common price procedure which buyers suppose to be fixed by an agreement; there is no competition in price, either directly or indirectly, via hidden discounts, for instance in the delivery of greater quantities. However, this information does not justify the conclusion that rivalry is totally absent. Competition could be observed in periods of rising demand when producers could compete between themselves, each one trying to capture the largest share of the market rise.

On the supply side, it is important to stress that, despite the large amount of funding provided by government until the end of the seventies, production was constrained by the industrial capacity then available. On the demand side, it must be observed that cement satisfies one of the basic needs of mankind: housing. Cement is not a final product; it is bought as a raw material in an industrial market. At least in Brazil, substitutes for cement are few in number, have higher prices and require special utilization techniques. Moreover, the proportion of cement in building costs is very low. All these features combine to bring about a low elasticity of demand, although is not expected that demand is independent of prices, as if it were a vertical line.

4.2. Basic Econometric Results

Endogenous data on production and consumption were obtained at the National Cement Industry Syndicate, but the price was taken from a monthly independent magazine on building costs. In this analysis the income-related exogenous variable F refers to the national gross fixed capital formation, while the cost-related exogenous variable W is the average cost of production as regularly calculated by the Syndicate. Considering that the industrial capacity in the nineteen-seventies was limited, a dummy variable (D1) has been included in both quantity equations. D1 is defined as equal to 1 when the restriction prevailed, and zero otherwise. Sample data are presented on an annual basis, from 1970 to 1986, and monetary values are in constant terms of November 1986. The estimated equations of the reduced model are presented below, where "t" statistics are in brackets.

ESTIMATED REDUCED MODEL

CONSUMPTION:
$D_t = 9.896 - 0.312\ W_t + 30.234\ F_{t-1} - 2.958\ D1$
(5.17) (-2.91) (13.07) (-3.76)
$R2 = 0.98$ DW = 1.90 F (3,12) = 162.48

PRICE:
$P_t = 16.791 + 1.102\ W_{t-2} + 11.967\ F_{t-1}$
(6.33) (6.04) (2.32)
$R2 = 0.87$ DW = 2.24 F (2,12) = 40.64

PRODUCTION:
$Q_t = 9.362 - 0.304\ W_t + 31.048\ F_{t-1} - 2.960\ D1$
(4.69) (-2.72) (12.87) (-3.60)
$R2 = 0.98$ DW = 1.94 F (3,12) = 158.10

Statistical results are sound and signals are in accordance with what can be predicted from the structural model. For each equation the choice of the lag structure was based on the statistical performance of the whole equation. Considering that simplicity is preferable, several possible combinations of simultaneous lags were tested, with the exception of D1, which evidently cannot be lagged. As usual, the purpose was to obtain the best multiple correlation coefficient, provided that:

a) autocorrelation has been eliminated;
b) specification is always the same: the linear lagged exogenous model where each and all endogenous variables are functions of the lagged set of exogenous variables;
c) exogenous variables have the same definition in all equations, that is, they are not transformed from one equation to other;
d) all parameters are individually significant; and
e) all signals of the coefficients are in accordance with deductions from the structural model.

Then, in order to obtain the reduced equilibrium model presented below, where asterisks refer to equilibrium values, all the exogenous variables are supposed to be constant at the last given level. From now on the dummy variable will be considered as being always zero.

ESTIMATED REDUCED EQUILIBRIUM MODEL

consumption: $D_{t*} = 9.896 - 0.312\ W_t + 30.234\ F_t$

price: $P_{t*} = 16.791 + 1.102\ W_t + 11.967\ F_t$

production: $Q_{t*} = 9.362 - 0.304\ W_t + 31.048\ F_t$

The equations of the reduced equilibrium model give the total effect of the exogenous variable over the endogenous variables, whose mutual structural relations may thus be estimated. Keeping in mind that both structural equations are perfectly identified, they may be deducted in accordance with an indirect least square (ILS) procedure. Alternatively, it is possible to use the two-stages least squares (2SLS) method. Following the latter, in the first stage the series of equilibrium values of the endogenous variables are generated based upon the estimated reduced equilibrium model. These series are then used in the second stage to estimate the structural equations of the model. Resulting regressions are:

ESTIMATED STRUCTURAL MARKET MODEL

DEMAND CURVE:

$D_{t*} = 14.649 - 0.283\ P_{t*} + 33.620\ F_t$

(7242) (-4258) (13284)

R2 = 1.00 DW = 1.97 F (2,12) > 10000

SUPPLY RELATION:

$Q_{t*} = -\ 34.722 + 2.628\ P_{t*} - 3.218\ W_t$

(-55.1) (90.3) (-82.2)

R2 = 0.99 DW = 2.63 F (2,12) = 4206.7

The structural model presented is thus supported by empirical data from the Brazilian cement market: all parameters and equations are significant and all the signals are coherent. An increase in cost has no influence over demand; what is affected is the supply: greater cost means a shift to the left in the supply relation and then in the new equilibrium point price will be higher and production lower. On the other side, a fall in F means a fall in demand, but supply is not influenced; in the new equilibrium position both price and consumption will be lower.

The econometric results obtained reflect the characteristics that can normally be expected from the cement market: supply is quite elastic and demand is inelastic. Under the equilibrium conditions for 1986, the estimated price elasticity of supply is 3.96, while for demand the estimate is minus 0.43. One may say that the demand curve is "almost vertical" while the supply relation lays near the horizontal line. The intensity of equilibrium shifts will thus depend on the origin and size of exogenous shocks. For instance, when there is a variation on the cost side only, the supply relation will be shifted, but the demand curve will be unaffected. In this case the production level is less influenced than the price level: after an exogenous shock on the cost side the adjustment of the market is primarily made via price.

On the other hand, variations in consumer income bring about shifts in demand, thus leading to larger variations in production. However, price in this case is less affected. In relation to shocks from the demand side, prices are sticky: the elasticity of price in relation to demand variations is only 0.21, in equilibrium terms of 1986. For example, for any given level of the production costs, after an expansion of 10% in demand, the final effect on price will be an increase of only about 2%. Additionally, this suggests that the mark-up over cost is not so rigid as it could be expected in such a highly concentrated industrial branch. Prices are sticky but not fully rigid. This seems to be in contrast with an oligopoly-pricing policy based upon an "orthodox" Keynesian mark-up principle with a demand-insensitive profit margin.

To sum up: given a certain level of the cost W, the supply relation contains all possible points of equilibrium of the market. Upward and downward shifts of demand will create a series of equilibrium points: on connecting them the long run supply relation will be outlined. In BRESNAHAN (1989) words: "When demand is shifted by some exogenous variable, it tends to trace out the supply relation, which is after all what we are trying to estimate" (page 1039).

Therefore, after elimination of the short term disturbances, all possible equilibrium points of the market fall simultaneously on the demand curve and the supply relation.

5. THE MONOPOLY PRICE HYPOTHESIS

It has widely been accepted that if a market displays high levels of price-homogeneity and price-stickiness, then certainly firms in this market act as a cartel with a centralized decision-making process. In this case, joint profit-maximizing seems to be the best rule for firms to follow, thus maximizing a "corporate" profit which will be divided among them under rules other than competition in the market. The hypothesis that in this case, or in any other market structure, firms impose a monopoly price to consumers can be tested empirically. For instance, a test may be constructed by supposing that λ in the industrial supply relation (equation 3) is equal to the unity (maximum cooperation), thus leading to an equilibrium relation like:

$$P_{t*} - (1 / \alpha_1)\, Q_{t*} = c'_{t*}(Q_t)$$

This relation, combined with the demand curve (1) will allow for the estimation of a series of hypothetical monopoly prices which can be compared with actual data to support the test conclusion. A particular complication will probably be given by the marginal cost component in the supply relation, once costs estimations are usually subject to polemics. However, it may be expected that sometimes this problem may be circumvented by supposing that the marginal cost is zero, what additionally leads to the estimation of the lowest theoretical monopoly price. In this case the industrial supply relation will become:

$$(7) \qquad P_{t*} = (1 / \alpha_1)\, Q_{t*}$$

Considering that the Brazilian cement market prices are quite homogeneous and very sticky, the data obtained above may be used to illustrate such a test. Indeed, the subject of this section is the hypothesis that there is a full agreement between companies to act in collusion, or the proposition that a central institution, such as the Syndicate for instance, fixes a profit maximizing price as if in a monopoly situation. The theoretical monopoly price (MP) is the price-solution to the system composed of the hypothetical monopolistic supply relation (7) and the demand equation (1). Combining both expressions one may obtain:

$$MP = (1/2\alpha_1)(\alpha_0 + \alpha_2 F)$$

This expression allows for the estimate of the series of theoretic monopoly prices MP, which is presented together with the actual price P in table below.

Considering that the theoretic monopoly price MP is always above the actual market price P, the main observation is that the Brazilian cement industry does not impose a monopoly price on consumers. Even if some individual companies would like to set a profit-maximizing price, on the whole this intention has no success. There is a permanent spread between the monopoly and the actual prices: the (P/MP) ratio, called Z in the table below. One possible explanation for this spread is that it is a consequence of some rivalry between companies, a rivalry put forward either in the market or in the decision-making process on pricing.

BRAZILIAN CEMENT INDUSTRY

YEAR	MONOPOLY PRICE (MP)	ACTUAL PRICE (P)	Z = P/MP (%)
1971	41.27	32.84	79.6
1972	43.88	29.44	67.1
1973	49.05	30.33	61.8
1974	53.98	29.99	55.6
1975	58.97	38.17	64.7
1976	60.81	37.69	62.0
1977	61.40	35.76	58.2
1978	64.02	36.59	57.2
1979	69.06	36.90	53.4
1980	69.48	40.09	57.7
1981	66.87	41.54	62.1
1982	63.78	46.73	73.3
1983	56.23	45.69	81.3
1984	55.94	40.40	72.2
1985	62.41	47.16	75.6
1986	68.59	46.27	67.5

The conclusion is thus that empirical data gives no support to the hypothesis of a joint profit-maximization procedure in the Brazilian cement industry. Reminding that for a monopoly profit-maximizing behavior to exist the equilibrium point must always be in the elastic part of the demand curve, this empirical result is in line with the estimated inelasticity of demand. It is thus possible to identify a certain rivalry in the branch, and clearly it is not a result of some governmental intervention such as price control: companies are free to set the price they want.

Pure competition is naturally ruled out in the cement industry, and the Syndicate fosters a certain degree of collusion. In spite of that, some firms, probably the smaller ones, are "competing-oriented" and do prefer to expand their own sales, and thus their market shares, instead of supporting a higher common price level. The existence of competition, or at least the departure from the monopoly model in markets where collusion seems to be the rule, is a conclusion shared in much other empirical research, such as CUBBIN (1975) on automobiles in the United Kingdom; MERRILEES (1983) on Australian newspapers; BAKER and BRESNAHAN (1985) on beer in the United States; ASHENFELTER and SULLIVAN (1987) on American cigarettes; SLADE (1987) on gasoline in Canada; MARLOW and WRIGHT (1987) on the loans and savings market in the United States; and ALEXANDER (1988), on American lumber.

KWOKA and RAVENSCRAFT (1986) pointed out that competition in the American industry is a widespread phenomenon; DOMOWITZ, HUBBARD and PETERSEN (1987) stressed that the pricing process in the American industry mainly follows a Cournot model with independence between firms, and that the market price is always significantly lower than the monopoly price. A special reference must be made to the work of GEROSKI, ULPH, and ULPH (1987), in which they have analyzed the OPEC crude oil cartel, demonstrating that there is a pattern of cooperation/rivalry which is moreover variable.

It is possible to imagine that, immediately after the commented cement industry's price-fixing monthly meeting, each company takes the price as given and tries to maximize profit by maximizing sales. This behavior could be not explained by factors like the natural perishability of cement or some individual financial weakness: it is possible that competition prevails in relation to the supposed agreement on a monopolistic behavior. Whether there is or not a formal or informal agreement, this competitive behavior could be understood as an individual decision to obtain an individual higher profit. Each producer may believe that if he does not sell more, thus increasing his gains, some competitor would do so. Of course this does not mean that the actual level of competition is the greatest possible nor the "desired" one.

As noted by SCHUMPETER (1954, page 981, footnote 25), the natural monopoly solution would be the only stable one, especially if there is no agreement between producers. "If they do co-operate, there arises the question how to divide the monopoly gain which they are making jointly, a question for which there is no unique solution or no solution at all". Thus, for monopoly to prevail, it would seem that an agreement is not sufficient: the impossibility of deriving benefits from any individual action would also be a necessary condition. In other words, supposing that an agreement does exist, and that the actual market price is below the monopoly price, such an agreement is probably not sufficient to overcome the tendency towards permanently disputing a higher market share.

Suppose a "small" company, with a market share of 10% of the total: if this company decides to increase sales by about 10% then total industry sales would increase no more than a simple 1%, and this company would probably succeed in its intention. However, given the low elasticity of demand, this simple 1% of increase in production corresponds roughly to 2.5% of price fall. Or rather, as in the Brazilian cement industry the price is the same for all firms, what happens is that a price rise of 2.5% would be curbed. Our small sample company would then have greater profits, because it would sell 10% more than before, losing only 2.5% in price; but the others would lose.

When producers' price decisions are independent this question is simpler to analyze, because individual demand is expected to be elastic, especially for smaller firms. High demand elasticity means that one company may increase sales with a smaller loss in price, what generally means more profits. Therefore, it becomes justifiable to wonder whether it is really the largest company that imposes the market price, or if it is more appropriate to say "that the weakest members of a combination are frequently its rulers" (MARSHALL, 1890, page 312, footnote 1).

6. FURTHER COMMENTS ON CARTELS AND PROFITS

A specific definition of the intensity of cooperation may be formulated for analytical purposes. For instance, one may define a "degree of cartelization" named Z by taking the actual price as a percentage of the theoretic monopoly price, as presented in the table above. Z would then be an endogenous variable of the market model, with which a reduced equation must be associated. Accordingly, the above data on the Brazilian cement market allows for the estimation of the following reduced equation:

$$Z_t = 68.656 + 1.930\, W_{t-1} - 54.789\, F_t$$

(12.26) (4.88) (-5.01)

$R2 = 0.71$ $DW = 2.05$ $F (2,13) = 15.58$

This expression implies that, ceteris paribus the production cost, cartelization falls with the gross fixed capital formation F. Consequently, when F increases Z diminishes, which means that the actual price is moved away from the monopoly price. Given that an expansion of F is an expansion of the economy itself, it is possible to say that rising market opportunities leads to more rivalry in the industry. A growing market gives room for more intense disputes over individual larger shares: each firm would be trying to increase production, which could allow for lower average cost and hence higher profits.

On the other hand, a falling aggregate demand induces a higher level of solidarity among firms: when facing collective difficulties in profit making they agree, formally or informally, upon not proportionally reducing the selling price. Despite the fact that tighter cooperation may mitigate a situation of decreasing profits, an inverse correlation between cartelization and profits may be expected. This proposition can be tested by developing a model in which the degree of cartelization of a branch is a function of the profit, ceteris paribus demand and costs conditions. For example, in order to analyze this proposition in the Brazilian cement market, an effective profit margin ME has been defined by the expression:

$$ME_t = P_t - W_t (K_t / Q_t)$$

where K is capacity of production. ME takes into account the actual capacity utilization rate, and thus the effective average cost of production. The corresponding reduced equation is:

$ME_t = 21.043 - 1.921\ W_t + 62.871\ F_{t-1} - 19.104\ F_{t-4}$

(2.96) (-3.81) (5.56) (-2.03)

$R2 = 0.88$ $DW = 2.16$ $F (3,9) = 22.76$

Collecting then the parameters of both reduced equations above, the following reduced equilibrium model will be obtained:

$$Z_{t*} = 68.656 + 1.930\ W_t - 54.789\ F_t$$

$$ME_{t*} = 21.043 - 1.921\ W_t + 43.767\ F_t$$

Utilizing the ILS procedure, the parameters of both the relations connecting cartelization and profits may be computed from the coefficients of the two reduced equilibrium equations above, thus bringing about the relations:

$$Z_{t*} = 89.798 - 1.005\ ME_{t*} - 10.817\ F_t$$

$$Z_{t*} = 94.998 - 1.252\ ME_{t*} - 0.475\ W_t$$

These equations show that cartelization Z and effective profits ME are always negatively correlated, independently of the origin of the exogenous shock, whether on the demand F side or on the cost W side. This means that it seems to be the fall in profit that convinces firms about the need for cooperation; and cooperation does prevent profits from being excessively reduced. However, when profits are "sufficiently" high, rivalry overcomes cooperation and then competition prevails.

This is in line with the common observation that, in any agreement among producers, if profits are "too high" there will be a tendency towards individual commercial "hidden" concessions. Every company would then try to pick up higher benefits from the common action - a common action that each one thinks only the others will follow. Despite the high degree of organization of the cement industry, companies seem to know that setting an excessively high price is useless because "the larger the profits in cooperative periods, the greater the marginal benefit to secretly cutting price" (PORTER, 1983, page 305). In other words, the probability of cheating increases with the level of profits.

7. CONCLUSIONS

This empirical study develops the method of analysis of price formation proposed by PORTER (1983) and further formalized by BRESNAHAN (1989), which is based upon a structural supply and demand market model. In this model a rational expectation price schedule has been added to the general supply equation derived from a profit maximization procedure subject to conjectural variation considerations. The main feature of this model is that although the exact pattern of competition is not known ex ante, a general supply relation may be econometrically estimated. The model may be used to generate a series of theoretical monopoly prices which can be compared to actual market prices in order to test the hypothesis that firms in a certain branch act as if it were a monopoly.

A practical application of the model and the monopoly test is made into the Brazilian cement industry data, which supports the general theoretical propositions presented here. The natural characteristics of cement lead to a low demand elasticity, to a highly concentrated industry, and to a very elastic supply relation, which means that prices are sticky. It is expected that in this industry the price is uniform among firms, and that price is not a strategic variable utilized by companies to compete with each other. These features have frequently been pointed out as evidence of a cartel with a central decision entity which would follow a joint profit-maximizing marketing policy. This paper analyses the degree of competition in the cement market, formally testing the hypothesis that price is formed as if in a monopoly situation.

Companies in the cement industry are financially powerful, and their mutual confidence is supposedly enhanced by a formal agreement, in such a way that each one may trust that its rival will abide by the principle that the common market should not be spoilt. However, empirical results obtained demonstrate that there is also a certain degree of competition which depends upon the strength of demand. There is always a gap between the monopoly price and the short run common price, and this gap will be shorter or larger in accordance with the industry's need for a tighter cooperation to defend the overall profit. This "self- protectionism" of the industry allows companies to avoid some major causes of failure, leading to a complex question involving simultaneous trade-offs between cooperation and rivalry, short run and long run profits, failure and capital idleness.

The empirical application supports the theoretical proposition that cooperation between companies, even if improved by a formal agreement, may be partially offset by rivalry. However, it is impossible to know how these two tendencies are combined, because they are simultaneously considered in the same individual decision-making process: one cannot imagine firms deciding separately on how much to cooperate and how much to compete. Accordingly, all that can actually be modeled is the resulting composed effect, represented by a parameter which may just be called "competition". However, it is possible to estimate the combined parameter of the slope of the supply relation, which is sufficient for economic analysis based upon supply and demand, therefore making this methodological approach worth its while.

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