# Collusion in the Brazilian steel sector: A new industrial economy approach[1]

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## Abstract

The Brazilian Law of Competition Defense does not have a special system of collusion proofs to be adopted by the Antitrust Authority. The usual procedure consists in analyzing the structure and conduct characteristics of anticompetitive actions. Nevertheless, this method presents remarkable restrictions, such as the supposition of a causal relationship between structure, conduct and performance variables. The objective of this paper is to present a complementary methodological instrument for the detection of collusion that can contribute towards obtaining indirect evidence. For this purpose, we apply the results of a model of strategic choices of capacity in a Brazilian steel segment, recently condemned by collusion. The test shows that it is possible to proceed by using an auxiliary path that verifies collusive results and not only those related to market power, even when the information about the firms are difficult to obtain.

*Key Words: Partial collusion; collusion proofs; antitrust regulation .*

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**Resumo**

A Lei de Defesa da Concorrência brasileira não possui uma disposição especial sobre o sistema de provas de colusão a ser adotado pela Autoridade Antitruste. O procedimento de avaliação tradicional tem sido analisar os condicionantes estruturais e de conduta de ações ditas anticompetitivas. Entretanto, este método possui limitações significativas, como a suposição de uma relação causal entre as variáveis de estrutura, conduta e performance, e a ênfase em comportamentos anticompetitivos. Este artigo tem por objetivo apresentar um instrumento metodológico complementar de detecção de colusão que possa contribuir na obtenção de provas indiretas. Aplica-se, para tanto, os resultados de um modelo de escolhas estratégicas de capacidade em um segmento siderúrgico recentemente condenado por colusão. O teste mostra que é possível utilizar um caminho auxiliar de atuação das autoridades antitruste, de verificação de resultados colusivos e não somente de poder de mercado, por mais escassas que as informações sobre as firmas venham a ser.

## 1. Introduction.

In a recent decision by the Administrative Council for Economic Defense (CADE)[4], three large Brazilian steel companies were condemned for cartel formation: Companhia Siderúrgica Nacional (CSN), Usinas Siderúrgicas de Minas Gerais (USIMINAS) and Companhia Siderúrgica Paulista (COSIPA). These companies were accused of colluding in the price setting of common flat steel, in 1996. The condemnation was supported by the analysis of the market power of these three companies, with indirect evidence of cartel formation[5].

The assessment of market power considered the definition of relevant and geographic markets, concentration, presence of barriers to

[4] Autarky linked to the Economic Law Office (SDE), Ministry of Justice, Brazil.

[5] The direct evidence shows the existence of cartel formation, as described in the legal documents, whereas the indirect evidence shows another situation, from which we can draw a logical conclusion about the facts described in the legal documents: this is the indicative evidence, which can serve as the basis for condemnation (Theodoro Júnior, 1988, p. 182). These two types of evidence have the same value in terms of legal appreciation (Santacruz, 1999, p. 4).

entry and structure of demand. Indirect evidence was obtained from a meeting between sector representatives, from the subsequent publication of price readjustment for 1996, and from the announcement of price readjustment for the following year.

These procedures meet the standards established by the concurrence policy for market conduct regulation. As stated by Salgado (1995, p. 5), the regulation of the conduct of market agents included in such policy consists in establishing proper behavior rules, whose noncompliance will lead to punishments. Therefore, some information and the analysis of the characteristics, reasons and effects of conduct on the market may be necessary.

However, the way this information should be used for deciding on the existence of collusion is not defined in the Competition Defense Law (Brazil, 1994), since there is no special provision on the system of evidence to be adopted by the Antitrust Authority.

In this context, the approach used by CADE to obtain *ex post* evidence of collusion should be discussed, based on two aspects that support this statement. Firstly, it is questionable whether the use of evidence of market power, such as concentration and existence of barriers to entry (information on structure) and meetings between firms for the announcement of price readjustment (information on conduct), is enough to show the existence of collusion (conclusions on performance). This procedure supposes the existence of a causal relationship between structure, conduct and market performance variables, which is contested by Tirole (1994, p. 2). According to this author, the existence or not of associations between the variables should be interpreted as correlation instead of causal relationship, what can be used as a complementary tool for the analysis.

Secondly, collusive behavior is not enough for the detection of collusion: it is necessary to observe whether the results go in the same direction. Statements about the existence of collusion due to

signs of collusive behavior (meetings with companies, announcement and concomitant price setting) are based on market conduct, when the concept of collusion is expressed in Economic Theory as market results.

Therefore, the meetings between company representatives and behaviors, such as anticipated announcements of price increase, cannot be considered as the only evidence of collusion. According to Phlips,

"(...) given the difficulties of collusion enforcement, it is clear to me that the simple exchange of information cannot, as such, be constructed as implying that a collusive *outcome* is being achieved. All it could show is that there is a collusive *conduct*, in the sense that the oligopolists are trying to achieve a collusive outcome. In this restrictive sense, information sharing could play the same role as 'meeting competition' or 'most-favoured-customer' clauses, which are often called practices that 'facilitate' tacit collusion" (Phlips, 1995, p. 82).

In addition, anticipated price announcements do not necessarily mean that a collusive conduct and, consequently, an agreement have been adopted: for instance, firms that produce substitute goods tend to respond to demand shocks or costs at the same time. Likewise, if the product in question is exposed to price setting by the international market, similar responses will obligatorily occur.

The previous considerations show the need to substantiate the decision-making processes regarding collusive behaviors of market agents, in terms of the results obtained and not only in terms of behavior. Given the economic impact of the decisions made by the Antitrust Authority, there must be undeniable proofs, both in conceptual and methodological terms. The New Industrial Economy[6]

[6]The term New Industrial Economy was attributed to the current that is mainly characterized by the use ofthe game theory as an analytical tool (Kupfer and Hasenclever , 2002, p. 32). Tirole (1994, p. 1-3) classifies this trend as a second wave of interest of the industrial organization, which

has built a theoretical framework that allows supporting the decisions on the adoption of anticompetitive practices.

This article uses the theoretical framework developed by the New Industrial Economy to analyze the existence of collusive practices by Brazilian steel industries. In this sense, section 2 introduces a summarized formal model for noncooperative choices of capacity. The subsequent section assesses the case of Brazilian steel companies from this standpoint. Section 4 presents the final considerations.

## 2. The noncooperative choice of production capacity.

In 1987, Osborne and Pitchik used a duopoly model, showing how the noncooperative choice of production capacity can lead to collusion[7]. The model is presented next, with special emphasis on its major conclusions.

### 2.1 Osborne and Pitchik model.

Consider an industry composed of two firms (1 and 2) producing the same goods, with:

- $k_1$ and $k_2$ the capacities of firms 1 and 2, respectively, where $k_1 \geq k_2 > 0$;

began in the 1970s and was mainly theoretical, offering a unified methodology for the analysis of the strategic conflict: the noncooperative game theory. Consequently, the contributions of this second trend (the first one consisted of the Structure-Conduct-Performance approach) produced an immediate response in terms of empirical analysis, summarized into the so-called new empirical intra-industry studies. A significant literature review of these empirical studies can be found in Bresnahan (1989). We should not forget, however, that the contributions regarding the evidence of cartel formation are still incipient.

[7] In fact, this is a semicollusion model or a model of partial collusion because the decisions to invest in capacity are made in a competitive fashion, with the perception that there will be collusion in the goods market.

- identical unit capacity installation costs;
- unit costs $c$ of constant production, with $c \geq 0$;
- $\exists$ a price $p_0|$ demand $d\left(p \geq p_0\right) = 0$;
- $p$ is the excess price over unit cost and $p_i \in [-c, p_0], i = 1, 2$;
- $p^M$ and $y^M$ represent the price and quantity of monopoly, respectively;
- there is no entry.

As can be observed, if $k_2 > d(0)$, then each firm can individually supply the whole market, which leads to the standard Bertrand model.

According to the selection of prices by the firms, which is made simultaneously and independently, we can have three situations:

- $p_1 < p_2$, where consumers prefer to buy from firm 1. This firm will produce the amount demanded from the market up to $d(p_1)$, going as further as its capacity $(k_1)$ allows, Firm 2 will meet the residual demand and will sell according to its capacity or residual demand, $d(p_2) - k_1$, up to the limit of its capacity $k_2$;
- $p_2 < p_1$, where the same reasoning applies, with proper modifications;
- $p_1 = p_2 = p$, where the firms can produce up to the limit of their capacity or share the market proportionally to their capacity, that is, firm 1 will sell $k_1/k$, where $k = k_1 + k_2$ is the total capacity of the industry.

Consequently, with prices $(p_1, p_2)$, the profit of firm 1 will be given by:

$$\pi_1\left(p_1, p_2\right) = \begin{cases} p_1 \min\left(k_1, d(p_1)\right), & \text{if } p_1 < p_2 \\ p_1 \min\left(k_1, \max\left(0, d(p_1) - k_2\right)\right), & \text{if } p_1 > p_2 \\ p_1 \min\left(k_1, \frac{k_1}{k} d(p)\right), & \text{if } p_1 = p_2 = p \end{cases}$$

With the necessary changes, we have the same for firm 2.

The process used to define production capacity, and negotiation of quotas and prices can be represented by a game, with the following structure:

- $t = 1$: each firm simultaneously chooses its production capacity;
- $t = 2$: given the known installed capacity of each firm, the firms negotiate their production quotas, being supported by the threat of nonmonopolistic prices;
- $t = 3$: the quotas are produced and sold by the monopoly price.

The selection of capacity defines the bargaining power of the firm at the time of negotiation of the quotas, since with installed capacity, it is able to threaten the price level to be adopted. Such threats are determined according to four situations:

**Case I:** $k = k_1 + k_2 < y^M$

In this situation, the industrial capacity is too small and therefore it cannot meet all the demand. Consequently, the companies have no option other than to charge $p(k)$[8]: fixing a lower price would allow meeting a potential demand, but this is not possible due to the restricted capacity, which is totally used; fixing higher prices would reduce profits. Therefore, to charge $(p(k), p(k))$ is a credible threat.

**Case II:** $k_1 < y^M, k_2 < y^M$ and $k \geq y^M$

In this case, the capacity of the industry is small and no firms can supply the market on their own; however, if they cooperate, they can reach the monopoly profit, producing less than the total capacity. Thus, charging the monopoly price is an equilibrium, since any deviation from it by the companies will result in lower profits, if the threat of fixing $(p(k), p(k))$ is fulfilled.

[8]Observe that $p(k)$ is the price in which $pk_1 = p(d(p) - k_2)$ and $pk_2 = p(d(p))$, where the sum of capacities is equal to the market demand.

**Case III:** $k_1 > y^M, k_2 > y^M$

As it is possible to observe, each firm is able to meet the whole market demand: this is the standard Bertrand situation without restrictions of capacity, in which the threat is to fix the same price of the marginal cost;

**Case IV:** $k_1 > y^M, k_2 < y^M$ or vice versa

The capacity of the industry is such that one firm could meet the whole market demand. This is the situation of the industry that Osborne and Pitchik (1987) define as being "neither too large nor too small". In this case, there are several possible threats of equilibrium[9]. One of these threats is to fix $p_1 = p_2 = p(k)$, but firm 1 is encouraged to increase its price, that is, it is more likely that the firm with higher capacity will fix a higher price than the other firm[10].

Given the threats, the firms negotiate their quotas and the Nash bargaining solution is to equally divide the unrestricted excess monopoly profit by the one obtained under threat. If a cartel agreement is made, the profit of each firm will be in the function of their threats and not necessarily proportional to their capacity, since the smaller firm can have the same share than the larger firm, as in case III.

Whenever the firms do not fit into case I, the sum of the selected

[9] Osborne and Pitchik (1987) and Kreps and Scheinkman (1983) have shown the existence of such equilibria.

[10] As Kreps and Scheinkman have stated (1983, p. 332), "at first glance, it might be thought that the firm 1, having the larger capacity, would profit more by underselling his rival, and therefore it would name the (stochastically) lower prices. But (as is usual with equilibrium logic) this is backwards: each firm randomizes in a way that keeps the other firm indifferent among its strategies. Because firm 1 has the larger capacity, firm 2 is more at risk in terms of being undersold, and thus firm 1 must be less aggressive".

capacities exceeds the sum of the negotiated quotas. Therefore, part of the capacities is destined for severe punishments if the cartel negotiations fail. If the firms fit into case III, there will be overcapacity, allowing each firm to supply the whole market. However, in this case, an extra unit of capacity results in no marginal benefit, but only increases the cost of capacity.

The conclusions drawn from the model are the following:

1. a collusive equilibrium implies excess capacity of the industry;
2. in this equilibrium, the profit per unit of capacity is higher for the smaller firm;
3. the higher the total capacity in relation to the market demand, the higher the profit per unit of capacity the smaller firm will have on the larger firm.

These conclusions provide us with a criterion for testing the existence of tacit or explicit collusion (Phlips, 1995, p.164). The idea is to assess the profit per unit of capacity and conclude whether the results are collusive or competitive. According to Osborne and Pitchik (1987, p. 414), there are two alternatives: in the perfectly competitive result, the firms sell for the same price and the profits per unit are the same. The result of competition between firms with restricted capacity, predicted by Bertrand-Edgeworth model, consists of the same profit per unit for both firms, for a large amount of pairs of capacity (unless the larger firm has enough capacity to meet the demand at price $p = 0$). Therefore, whenever the capacity of the industry is neither too small nor too large in relation to the market demand, the profit per unit will be the same for both firms in terms of competitive results, whereas the smaller firm will be better off in the cartel.

## 3. Empirical evidence of collusion.

As examples of empirical studies that consider the existence of a positive correlation between excess capacity and collusion, we have the one carried out by Phlips (1995, p. 166), whose ideas mirror those of Rees (1993)[11]. To find out whether explicit collusion had been replaced with tacit collusion, Rees used a repeated game to analyze the British salt market, including British Salt (BS, the smaller firm) and Weston Point (WP, with higher installed capacity). The data were obtained from a report of the UK Monopolies and Merger Commission (1975 to 1984). Prices showed a typical parallelism: for all the announced price increases, one of the firms announced the change and the other one decided to increase the price in the subsequent month, with alternate announcements.

Rees has attempted to identify the potential gains and losses originated by deviations, which were accompanied by punishments, so as to know whether these punishments could satisfactorily explain the fact that there was no deviation of parallel prices during the analyzed period. However, we should not regard the nonexistence of deviations as evidence of collusion, because if the fixing of parallel prices stems from noncollusive Nash equilibrium, there is no reason for deviations.

Phlips (1995) used the same data obtained by Rees for the salt market to test the presence of collusion based on the conclusions made by Osborne and Pitchik (1987). Phlips observed that both firms had a significant excess capacity in the periods between 1980 and 1984 (approximately 26% for BS and 37% for WP, on average) comparatively to the period between 1975 and 1979 (approximately 13% and 17%, respectively). This increase was justified by the firms

[11] Also available in Phlips (1998).

as a result of the reduced market demand.

However, Phlips has given an alternative explanation: according to him, the maintenance of excess capacity was supposed to strengthen collusion. He carried out the following test: first, he computed the total output of each duopolist and the share in the industry output, and found out that they were practically stable in time. If a cartel negotiation existed, the quotas of each firm would be approximately 45% of the industry output for the smaller firm and 55% for the larger one. Later on, a comparison between the total sales in the United Kingdom and the capacities showed that the capacity of WP was higher than the domestic demand in 1983 and 1984. However, the capacity of BS was always below demand, which means that these firms did not fit into case III. On the other hand, they did not fit into case I, once the total capacity was enough to obtain the monopoly output, and neither into case IV, as price leadership occurred and, therefore, there was no random price setting. Thus, case II was characterized by Phlips as relevant in the analysis of the British salt market.

To conclude the analysis, Phlips observed that there was a higher profit per unit of capacity for the smaller firm and that this profit increased in relation to the larger firm when the joint production capacity increased in relation to the market demand. This way, he discovered the existence of some strong evidence of collusion in the salt market in the considered period.

The same reasoning applies to the analysis of the Brazilian market of common flat steel, as shown in the subsequent section. Since the proposed test applies to the case of homogeneous products, this and all other suppositions of the model underlie the subsequent discussion.

### 3.1 The sector of common flat steel in Brazil.

The Brazilian production of steel and common flat steel was incumbent upon the government until the late 1980s, when the steel industries started to be privatized. Since COSIPA is associated with USIMINAS, the segment of common flat steel is actually formed by two consolidated groups of companies: CSN and USIMINAS/COSIPA[12].

The total production of common flat steel in Brazil increased between 1993 and 1997, and this can be mainly attributed to the performance of CSN and USIMINAS comparatively to COSIPA. The participation of companies in the total production of common flat steel is relatively constant and, in this case, CSN accounts for the larger share. If an agreement on production quotas has been established, it was established at approximately 40% of the total supply of common flat steel for CSN, 34% for USIMINAS and 26% for COSIPA (table 1).

Table 1 - Brazilian production of common flat steel per company - 1993–1999

| COMPANY | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|
| Total(1) | 9,535 | 10,217 | 10,234 | 10,651 | 10,883 | 9,966 | 9,601 |
| COSIPA | 2,463 | 2,723 | 2,654 | 2,796 | 2,582 | 2,424 | 2,320 |
| CSN | 3,894 | 3,981 | 3,984 | 4,159 | 4,530 | 4,146 | 4,197 |
| USIMINAS | 3,178 | 3,513 | 3,596 | 3,696 | 3,771 | 3,396 | 3,084 |
| Share(2) | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| COSIPA | 25.8 | 26.7 | 25.9 | 26.3 | 23.7 | 24.3 | 24.2 |
| CSN | 40.9 | 38.9 | 38.9 | 39.0 | 41.6 | 41.6 | 43.7 |
| USIMINAS | 33.3 | 34.4 | 35.2 | 34.7 | 34.7 | 34.1 | 32.1 |

Source: Anuário Estatístico (1999 and 2000, p.1/8) and Gazeta Mercantil (1998, p.18).

(1) In thousands of tons.

(2) In %.

[12] CSN was privatized in 1991 and COSIPA and USIMINAS, in 1993.

This sector has a large concentration of companies, and this is due to some of the following characteristics: restrictions on the replaceability of common flat steel; barriers to entry, such as unrecoverable costs and significant, minimal initial capital requirements; large economies of scale; low competition with imported products (national geographical market); totally heterogeneous consumer sector with lower bargaining power in relation to suppliers (Santacruz,1999, p. 18-21).

In the discussion about the profile of the segment of common flat steel, we should ideally analyze the evolution of prices per product and per companies in order to know whether a parallel behavior exists. However, the series of domestic prices of common flat steel (and steel in general) is not available.

The amount of common flat steel exported by Brazil has decreased since 1993, except in 1996. The exports of common flat steel in 1999 dropped approximately 46% in relation to the total export registered in 1993. On the other hand, in the domestic market, the apparent demand for common flat steel has increased around 28% in 1999 in relation to 1993 (Table 2).

Comparatively to exports, the behavior of Brazilian imports of common flat steel grew significantly between 1993 and 1999. The difference in imports in 1999 in relation to 1993 was almost 185% (Table 2). However, the amount of imports is not comparable with that of exports, once, even if we consider the year in which the amount of imports reached a maximum within the period (1999), they reached only around 13% of the total amount of exports.

Table 2 - Apparent consumption, exports, total demand and imports of common flat steel, in thousands of tons, Brazil - 1993–1999

| YEARS | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|
| Apparent consumption[(1)] | 5,859 | 6,858 | 6,900 | 7,343 | 8,614 | 7,795 | 7,518 |
| Exports | 4,192 | 3,711 | 2,950 | 3,273 | 2,416 | 2,234 | 2,251 |
| Total demand[(2)] | 9,880 | 10,376 | 9,755 | 10,506 | 10,709 | 9,684 | 9,434 |
| Imports | 98.57 | 45.06 | 82.33 | 95.85 | 245.84 | 264.08 | 280.62 |

Source: Anuário Estatístico (1995, 1999 and 2000)

(1) Internal sales plus imports.

(2) At the industrial level (Internal sales and exports).

In addition to the low competition with imported products, the segment of common flat steel has the largest installed capacity in comparison to other sectors[13]. Table 3 shows that the excess production capacity of crude steel has increased since 1993, reaching more than 18% in 1999. However, an accurate analysis of the sector in terms of capacity utilization was not possible, as the data obtained on the production capacity of common flat steel per company are only available for 1999. As an alternative, we took the growth rate of the capacity for crude steel production as basis in order to apply the test proposed by Osborne and Pitchik.

[13] According to Paula (1998, p. 12), the installed capacity must be at least 2 million tons of crude steel; whereas the segment of common long rolled products and special rolled products have an intermediate capacity, between 150 thousand and 2 million tons, and 30 to 800 thousand tons, respectively.

Table 3 - Excess capacity in the production of crude steel, Brazil (1,000 t)

| YEARS | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|
| Production | 25,207 | 25,747 | 25,076 | 25,237 | 26,153 | 25,760 | 24,996 |
| Capacity | | | | | | | |
| Total | 28,000 | 28,200 | 28,300 | 29,550 | 30,450 | 30,757 | 30,728 |
| Growth rate(1) | - | 0.0071 | 0.0035 | 0.0442 | 0.0305 | 0.0101 | -0.0009 |
| Excess capacity | 2,793 | 2,453 | 3,224 | 4,313 | 4,297 | 4,997 | 5,732 |
| Excess capacity(%) | 10 | 8.7 | 11.4 | 14.6 | 14.1 | 16.3 | 18.7 |

Source: Anuário Estatístico (2000, p.8) and (1) own calculations.

### 3.2 Osborne and Pitchik test for the steel industry.

According to Howell et al. (1999, p. 36), excess capacity is a problem that has affected steel industries on a worldwide basis, but the reasons for its existence are not unanimous, ranging from a reduction in the demand up to the strategic aim of ruling out potential entrants. In the case of Brazil, Paula (1997, p. 50) states that there is some evidence that the segment of long steel uses idle capacity as a barrier to entry, since this can be a way of waging a price war against potential entrant companies[14].

Nevertheless, as described, maintaining the excess capacity can have another strategic reason: *making the threats of retaliation against cartel agreements credible.* Bearing this possibility in mind, in the case of the Brazilian steel industry, more specifically, the segment of common flat steel, the propositions resulting from Osborne

[14] In this paper, Paula refers to this evidence only once. The evidence is actually not shown and the source of such statement is not mentioned.

and Pitchik model were tested in order to check the existence of collusion between CSN, COSIPA and USIMINAS, from 1993 to 1999. The criterion for the selection of the time period was to try to include the maximum number of years according to the availability of information, combined with the period in which the companies were privatized.

The data used on the test were the following:

a) *estimated production capacity of common flat steel per companies*

As these data are only available for 1999, the growth rate of the capacity for crude steel production (Table 3) was used as approximation. The estimated data allowed obtaining information on the excess production capacity of flat steel per company[15];

b) *apparent consumption*

This corresponds to the internal sales plus the import of common flat steel as an indicator of domestic demand, obtained from Anuário Estatístico (1995 and 2000) published by the Brazilian Steel Institute (IBS);

[15]Excess capacity in collusive equilibrium is defined as the excess sum of the firms' capacities (in this case, production capacity of common flat steel) comparatively to the total sales (as an indicator of demand). However, the measurement of excess capacity for empirical purposes can be different. According to Khemani and Shapiro (s.d., p. 42), excess capacity occurs when the firm is underproductive (cannot achieve the target production). This occurs when the marginal costs are lower than the intermediate costs and it is possible to reduce the intermediate cost by producing more goods or services. Thus, the ideal measurement of excess capacity consists in observing how much the output level should increase in order to reduce the unit costs of production to a minimum. If this is not possible, we can follow the standard procedure suggested by Esposito and Esposito (1974, p. 190): in general, the estimated excess capacity that is normally used indicates the underused capacity. We used this method since no data on demand at the company level were available.

c) *gross profits of companies*[16]

In dollars (nominal values), obtained from Análise Setorial publications (Gazeta Mercantil, 1998) and Balanço Anual (1999 and 2000).

The firms and the two groups[17] (COSIPA/USIMINAS and CSN) were sorted out by size, assessed in terms of estimated production capacity of common flat steel. Therefore, when the firms are separately considered, they are sorted out in terms of estimated production capacity of common flat steel in such a way that USIMINAS is the larger company and COSIPA is the smaller one. When the firms are considered as a group, COSIPA/USIMINAS have a greater estimated production capacity than CSN. According to Table 4, we can affirm that none of the firms could independently meet the demand throughout the period. Thus, the firms would fit neither into case III nor into case IV. Since, conjointly, the firms could produce the monopoly output (because the combined capacity would sufficiently meet the demand), these firms would not fit into case I, but could be included in case II. These considerations are equally valid for the market observed in terms of groups. Table 4 shows that there is a significant estimated excess capacity of approximately 25% in the sector.

[16] To avoid using data with possibly negative financial results.

[17] The differentiation between firms and groups is important because the consideration of the group is more appropriate to companies' stockholding and also to the hypothesis that the choices of the firms are independent and simultaneous.

Table 4 - Estimated excess capacity (EEC) in the segment of common flat steel, Brazil - 1993–1999

| YEARS | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | Mean |
|---|---|---|---|---|---|---|---|---|
| Apparent consumption | 5,859 | 6,858 | 6,900 | 7,343 | 8,614 | 7,795 | 7,518 | 7,270 |
| Production | | | | | | | | |
| COSIPA | 2,463 | 2,723 | 2,654 | 2,796 | 2,582 | 2,424 | 2,320 | 2,566 |
| CSN | 3,894 | 3,981 | 3,984 | 4,159 | 4,530 | 4,146 | 4,197 | 4,127 |
| USIMINAS | 3,178 | 3,513 | 3,596 | 3,696 | 3,771 | 3,396 | 3,084 | 3,462 |
| Total | 9,535 | 10,217 | 10,234 | 10,651 | 10,883 | 9,966 | 9,601 | 10,155 |
| Capacity(1) | | | | | | | | |
| COSIPA | 2,688 | 2,707 | 2,717 | 2,837 | 2,923 | 2,953 | 2,950 | 2,825 |
| CSN | 4,192 | 4,222 | 4,237 | 4,424 | 4,558 | 4,604 | 4,600 | 4,405 |
| USIMINAS | 5,955 | 5,997 | 6,019 | 6,284 | 6,476 | 6,541 | 6,535 | 6,258 |
| Total | 12,835 | 12,926 | 12,972 | 13,545 | 13,958 | 14,098 | 14,085 | 13,488 |
| EEC(2) | | | | | | | | |
| COSIPA | 225 | -16 | 63 | 41 | 341 | 529 | 630 | 259 |
| CSN | 298 | 241 | 253 | 265 | 28 | 458 | 403 | 278 |
| USIMINAS | 2,777 | 2,484 | 2,423 | 2,588 | 2,705 | 3,145 | 3,451 | 2,796 |
| Total | 3,300 | 2,709 | 2,738 | 2,894 | 3,075 | 4,132 | 4,484 | 3,333 |
| EEC(3) | | | | | | | | |
| COSIPA | 8 | -1 | 2 | 1 | 12 | 18 | 21 | 9 |
| CSN | 7 | 6 | 6 | 6 | 1 | 10 | 9 | 6 |
| USIMINAS | 47 | 41 | 40 | 41 | 42 | 48 | 53 | 45 |
| Total | 26 | 21 | 21 | 21 | 22 | 29 | 32 | 25 |

Source: Anuário Estatístico (1995, 1999 and 2000, p.2/4) for total internal sales: *home pages*[18] of COSIPA, CSN and USIMINAS for capacity in 1999; and own calculations.

(1) Estimated between 1993 and 1998, in thousands of tons.

(2) In terms of production, in thousands of tons.

(3) In %.

[18] COSIPA, CSN and USIMINAS home pages are, respectively, http://www.cosipa.com.br, http://www.csn.com.br and http://www.usiminas.com.br. As stated herein, the estimated production capacity of common flat steel between 1993 and 1998 took for granted that its evolution kept the same pace as the production capacity of crude steel.

By using the data on excess capacity and production, it is possible to distinguish between individual excess capacity (firm/group) and the excess capacity of rivals (industry). According to Rosenbaum (1989, p. 233), the extension of the retaliation that an industry can impose on firm $i$ can be measured by $EC_R = \frac{\sum_{j \neq i} EC_{jt}}{\sum_{j=1}^{n} PROD_{jt}}$, where $EC_R$ is the relative excess capacity that the industry can impose on firm $i$, measured as the ratio between the sum of excess capacity of firms $j \neq i$ and the sum of industrial production. The worst retaliation that the industry can impose on firm $i$ depends on the extension of the relative excess capacity available for all firms that are different from $i$.

These calculations were made for the sector of common flat steel and the results in Table 5 show that both CSN and COSIPA have the same vulnerability in terms of retaliation that the industry could impose against possible breaches of agreement. However, the analysis in terms of groups indicates that COSIPA and USIMINAS together have the highest power of retaliation over CSN, as expected.

Tabel 5 - Intermediate retaliation (industry and firm/group) in the sector of common flat steel, Brazil, in thousands of tons - 1993–1999

| | absolute EEC | Production | Relative EEC |
|---|---|---|---|
| COSIPA | 259 | 2,566 | 0.3027 |
| CSN | 278 | 4,127 | 0.3008 |
| USIMINAS | 2,796 | 3,462 | 0.0529 |
| COSIPA/ USIMINAS | 3,055 | 6,028 | 0.0274 |
| Industry | 3,333 | 10,155 | - |

Source: Own calculations.

However, in terms of companies or groups, CSN was the firm with the highest profit. Table 6 shows that the intermediate profit of CSN between 1993 and 1999 reached approximately 53% of the joint profit, maintaining this superiority also in terms of group.

The data on profits per unit of capacity in Table 7 indicate that the smaller firm, COSIPA, did not have higher profit per unit of estimated capacity, as foreseen by the model of Osborne and Pitchik in case the companies colluded. When the sector is considered in terms of groups, COSIPA/USIMINAS (larger in terms of capacity) had a lower profit per unit of capacity than CSN. Therefore, whereas CSN obtained higher profit per unit of estimated capacity, a mean of 1.58 for the period, COSIPA/USIMINAS had a profit per unit of capacity equal to a mean of 0.68 between 1993 and 1999, which means that the profits were not proportional to the estimated capacities for the groups.

Table 6 - Profits and share per producer of common flat steel, Brazil - 1993–1999

| YEARS | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 | Mean |
|---|---|---|---|---|---|---|---|---|
| Joint profits[(1)] | 1,536,858 | 1,580,273 | 1,055,867 | 1,104,808 | 1,468,088 | 1,345,029 | 1,057,725 | 1,306,950 |
| COSIPA | 223,156 | 264,868 | 110,478 | 142,455 | 156,583 | 129,780 | 147,708 | 167,861 |
| CSN | 976,611 | 765,678 | 427,575 | 539,694 | 816,878 | 767,023 | 576,157 | 695,659 |
| USIMINAS | 337,091 | 549,727 | 517,814 | 422,659 | 494,627 | 448,226 | 333,860 | 443,429 |
| Share[(2)] | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| COSIPA | 14.52 | 16.76 | 10.46 | 12.89 | 10.67 | 9.65 | 13.96 | 12.84 |
| CSN | 63.55 | 48.45 | 40.50 | 48.85 | 55.64 | 57.03 | 54.47 | 53.23 |
| USIMINAS | 21.93 | 34.79 | 49.04 | 38.26 | 33.69 | 33.32 | 31.56 | 33.93 |

Source: Gazeta Mercantil (1998, p.65, 66 e 77) and Balanço Anual (1999, p. 248 and 2000, p.196[19]).

[(1)] Nominal, gross (value declared in the demonstration of results) and in thousands of dollars (Balanço Anual, 1999, p.146).

[(2)] In %.

[19] The 1999 data on profits are originally expressed in reais and were converted for standardization purposes by using the annual average exchange rate, as of December 1999.

By observing whether the third conclusion of Osborne and Pitchik test applies to the sector, that is, whether the profit per capacity of the smaller firm increases in relation to the profit per capacity of the larger one when the joint capacity increases in relation to the market demand. Tables 7 and 8 show that the joint capacity increased in relation to market demand only in 1998 and 1999, in practically constant values (1.809 and 1.874). However, the correspondent increase in the profit per capacity of the smaller firm (group) in relation to the larger firm (group) was not observed in the period.

Table 7 - Profit per estimated capacity (EC) and total estimated capacity (TEC) of the industry according to demand, Brazil - 1993–1999

| YEARS | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 | 1999 |
|---|---|---|---|---|---|---|---|
| Profit/EC[1] | | | | | | | |
| COSIPA/USIMINAS | 1.466 | 1.066 | 0.473 | 0.747 | 0.702 | 0.642 | 0.980 |
| CSN/COSIPA-USIMINAS | 3.597 | 1.937 | 1.405 | 1.969 | 2.586 | 2.736 | 2.452 |
| TEC/Demand[2] | 2.197 | 1.885 | 1.88 | 1.845 | 1.621 | 1.809 | 1.874 |

Source: Own Figures

[1] Of the smaller firm/group in relation to the larger firm/group and in thousands of dollars per $10^5$ tons.

[2] Apparent consumption, in $10^3$ tons.

Table 8 - Representation of the direction of profit variation per estimated capacity compared with capacity estimated by demand

| YEARS | 94–93 | 95–94 | 96–95 | 97–96 | 98–97 | 99–98 |
|---|---|---|---|---|---|---|
| Profit/Capacity | | | | | | |
| COSIPA/USIMINAS | − | − | + | − | − | + |
| CSN/COSIPA-USIMINAS | − | − | + | + | + | − |
| Total capacity/Demand | − | − | − | − | + | + |

Source: Own figures.

For test purposes, the previous result was considered with caution because the difficulty in observing the existence of the relation predicted by the authors may be attributed to the fact that the values of the ratio total capacity:demand are practically constant, due to the relatively stable tendency of the demand.

## 4. Final considerations.

The results indicate that there is excess estimated capacity in the industry of approximately 25%, on average, and that the smaller group (CSN) had higher profit per unit of capacity. Furthermore, if we admit that the relatively constant behavior of demand may have limited the confirmation of the third proposition of the test (ratio profit per capacity of the firms versus joint capacity per demand), there are at least two proofs that strategic choices of capacity were made in order to sustain a collusion.

At this point, it is necessary to make some observations that are complementary to the results cited herein. We previously underscored that the antitrust authorities usually attempt to check the presence of certain structural and behavioral conditions that could favor collusion. In the case of lawsuits against steel companies, factors such as high concentration of the sector and lack of periodical

changes in market shares and lack of competition with imported goods were the basis for the condemnation of the involved companies. In this sense, the model of Osborne and Pitchik influenced the inclusion of another important variable in the definition of the characteristics of the market of common flat steel – excess capacity – thus reinforcing the idea that the scenario for the existence of collusion was adequate.

In view of the argument that these characteristics alone do not guarantee the existence of collusion, a collusion test was applied in the sector, based on the premise that there is excess capacity when collusive results are sustained in a repeated noncooperative game. Although the propositions made by Osborne and Pitchik were not totally met, there was a relevant advance in obtaining evidence of collusion. At least, the test shows that it is possible to use a complementary path for the antitrust authorities in terms of identifying collusive results and not only the conduct and structure that favor collusion, no matter how scarce the information on the firms may be.

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