

# **TIME SERIES ECONOMETRICS IN A POST-ACQUISITION ANTITRUST ANALYSIS: CAUSALITY, EXPLANATORY POWER AND STRUCTURAL BREAK IN BRAZILIAN IRON ORE MARKET**

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## **ABSTRACT**

In Brazil, mergers and acquisitions are usually analyzed by the Antitrust Authorities ex post, following a SCP framework close to the Merger Guidelines applied in the USA. However, this framework was unable to address a set of acquisitions of four mining companies by the newly privatized national champion CVRD. The present article reports an econometric exercise undertaken by the Brazilian Ministry of Justice to reinforce the definition of the relevant geographic market and to test for a structural break in the price series. Though international prices Granger-caused domestic prices in Brazil, they explain less than a third of the variance. A price surge on the acquired miners' series was above the export price not long after the acquisitions and a structural break could not be rejected.

## **1. INTRODUCTION**

In February 2005 the leading Brazilian mining corporation CVRD (Companhia Vale do Rio Doce) announced the first overseas contract of iron ore supply in Asia for that year was closed with Nippon Steel Corporation, obtaining an unprecedented record of 71,5% price raise as compared to the previous year. Two weeks later, the same CVRD reached a similar agreement with Arcelor for the European market.

In the overseas iron ore market, the first contract sets up the basis price for all transactions throughout the year. The numbers of buyers and sellers with market power in the European and Asian markets are quite minute, thus producing a repeated bargaining game in a bilateral oligopolistic set. Even though CVRD have had most of the times been the company which closed the first deal of the year in the last fifteen years, their bargaining position was pretty much enhanced by a series of acquisitions – starting in 2000 - of rival Brazilian mining

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companies (Socoimex, Samitri, Ferteco and Caemi/MBR), which gave CVRD a 34% share in the overseas market and enabled the company to reap the fruits of the demand boom led by China starting in 2002.

In addition to this series of acquisitions, CVRD's market power was reinforced by a right of first refusal settled in 2000 with the steel company CSN (Companhia Siderúrgica Nacional). This agreement established a right of first refusal given to CVRD on all iron ore produced from CSN's gigantic mine Casa de Pedra in excess of CSN's own consumption. In other words, if CSN agreed to sell any quantity of Casa da Pedra's iron ore in excess of its own consumption to a third-party buyer, the same commercial conditions should be extended to CVRD who could exercise its right of preference and replace the third party in the contract.

The enhancement of CVRD's market power was facilitated by Brazilian Antitrust Law, which allowed at that time that mergers were carried out before the Antitrust Authorities analyzed the competition issues of the deal. Under the Brazilian competition legislation, merging parties can submit the operation for antitrust assessment after the deal's conclusion, and, if it is the case, Antitrust Authorities can order modifications or divestitures regardless of the elapsed time after the transaction.<sup>1</sup> In fact, only in August 10, 2005 the Antitrust Tribunal (CADE) issued a decision on the matter, approving the operations in block with two orders:

- 1) Annulment of the right of first refusal. This would create a significant competitor to CVRD in Southeastern Brazilian market, with a capacity in excess of total demand; and
- 2) Consolidation of CVRD's stakes in MRS, a major railway carrier of iron ore controlled by CVRD along with CSN, Usiminas and Gerdau (three major Brazilian steel producers), into a single one. The shares belonged previously to Caemi/MBR and Ferteco, the largest mining companies acquired by CVRD. This remedy would prevent CVRD from exercising veto power and would warrant some balance among partners with diverging goals.

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<sup>1</sup> On September 1, 2005 a new Bill was sent to the Congress that would reform the Brazilian Law 8884 (enacted in 1994), instituting among other things the requirement of previous approval for mergers and acquisitions.

Alternatively, CVRD could simply divest Ferteco. This mining company had two major advantages:

- a. It owned the only pellet plant (Fabrica) near the domestic consumers Gerdau, Usiminas and Acesita.
- b. Fabrica's mine and pellet plant have access to the two major railways, MRS and EFVM.

The present paper endeavors to describe the main features of the Operations and to act as a showcase of the advantages of a post-merger analysis, to be balanced against the well-known risks of irreversibility of Mergers and Acquisitions (M&A).<sup>2</sup>

The article has three sections besides this introduction. The next section summarizes the main elements of the Operations and describes the economic analysis performed by the Antitrust Divisions of the Brazilian Ministries of Finance and Justice, based on the Brazilian Horizontal Merger Guidelines. The third section introduces the econometric framework adopted by the authors during the case in order to address more precisely the claims of the merging parties. The estimations performed and their interpretation are reported in the fourth section. The econometric exercise was only possible thanks to the long time elapsed since the first two acquisitions (and since CVRD's own privatization as well). The last section amasses the conclusions.

## **2. MAIN ELEMENTS OF THE ACQUISITIONS**

CVRD was established in 1942 by the Brazilian Government and was privatized in 1997. At that time the company was already the largest iron ore supplier in Brazil and the largest in overseas exports value. The privatization faced a tough opposition from unions, which delayed the auction for several weeks. The acquirer was a consortium led by Vicunha, a traditional textile

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<sup>2</sup>In fact, as of the closure of this article, CVRD was to appeal to a judicial court in order to suspend the deadline for the divestitures and overrule CADE's decisions on procedural grounds, as Brazilian Law rules out a revision of the judgment of merit. Another paramount case in CADE's history, a chocolate company acquisition by Nestlé, judged in April 2004, even though was suspended by CADE as long as the approval had not been issued, and even though it was completely reprovved by the Tribunal members, was appealed in a judicial court and it still remained there as of the closure date of this article.

industry that had won the first big privatization auction in the early 1990s, of the leading steelwork CSN.

When the privatization was approved by CADE, the Brazilian Antitrust Tribunal, in 2000, CSN and CVRD were ordered to eliminate cross-ownership. CVRD withdrew from the steel business, but two clauses of the cross-divestiture contract ruled that CSN (who owned an important iron ore mine, Casa de Pedra) was to grant a right of first refusal to CVRD when selling iron ore in excess of its own consumption, and that CVRD had to offer preference to CSN as partner in case of any greenfield investment in an own steel mill. The so-called Casa de Pedra Agreement prevented CSN from competing aggressively with CVRD in iron ore supply, because any client who got interested in having CSN as potential alternative supplier would be neglected in favor of CVRD if the latter matched their offer's conditions.

**FIGURE 1**  
**LOCATION OF THE MINES, RAILWAYS AND PORTS INVOLVED IN THE RELEVANT MARKETS OF THE CASE**



Source: CSN.

CVRD retained after privatization not only the mining assets, but, what is most valuable for the business, the exporting ports and the whole set of railways connecting its mines in the States of Minas Gerais (EFVM) and Pará (EFC) to those ports. Figure 1 enables the reader to locate the broad sets of mines, the railways and the ports involved in the case.

CVRD started the series of acquisitions in focus in 2000, when the company purchased in sequence the small family-owned mining company Socoimex, which owned a small mine named Gongo Soco, and the third largest Brazilian iron ore supplier, Samitri.

To justify the first acquisition, CVRD claimed that Socoimex lacked the technical and financial ability to explore economically and with the due environmental safety the almost depleted mine. At that time the mine of Gongo Soco had only pellet feed left, and CVRD itself owned the only pellet plant within a distance sufficiently short to make the exploration viable.

Samitri, the second mining company acquired, was owned at that time by a steel mill in Minas Gerais, which the Belgian-Luxemburgan steel giant Arcelor owned an important stake at. It is worth noting that Samitri had filed a complaint in the Brazilian Antitrust System against CVRD in 1999, claiming that EFVM's iron ore freight rates from their mines to the port squeezed their profits. This complaint was dropped upon the time of the acquisition.

Samitri had its own port in Ponta de Ubu, approximately 75 km to the South of CVRD's port in Tubarão, and an ore-pipe from Mariana, in Minas Gerais, to the port, carrying exclusively pellet feed. In Ponta de Ubu, a joint venture company named Samarco, owned by Samitri and the Australian mining giant BHP (51% Samitri, 49% BHP), operated a pellet plant, whose whole output has always been exported, with minor exceptions. CVRD's seven pellet plants in Tubarão, five of them owned in joint-venture with Spanish, Korean, Italian and Japanese steel corporations, were also meant for exporting, a residual share being supplied to the local steelworks, which seldom used pellets to feed their furnaces.

While the Brazilian Antitrust System (BAS) was still analyzing the first two acquisitions, two more of them were announced in 2001. The first one involved Ferteco, a mining company totally owned by the German corporation

ThyssenKrupp. Along with the two iron ore mines, Ferteco owned the only pellet plant next to a mine (Fábrica) and far from the shore. The same mine was also the only one in Brazil able to access two railways: besides EFVM, Fábrica had access to a much younger railway named MRS. This railway had been privatized in 1996 and was owned jointly by Ferteco, by another mining company named MBR, and by three national steelwork groups: Gerdau, CSN and Cosipa-Usiminas. On top of having the mines, the pellet plant and the stake at MBR, Ferteco had its own port in Sepetiba, near Rio de Janeiro.

The last acquisitions involved Caemi, a large mining corporation which explored kaolin, bauxite, and iron ore. MBR, the subsidiary of Caemi which operated the iron ore business<sup>3</sup>, was the second largest Brazilian supplier and exporter and also owned a port in Sepetiba's complex named Ilha Guaíba, as well as a stake at MRS. This acquisition was more ingenious: though BHP made a better offer for the majority stake owned by the Frering family, the minority shareholder Mitsui, a major Japanese steelwork, exercised its preference right and acquired the whole control, but immediately transferred 50% of it to CVRD. The parts claimed that CVRD would "enjoy greater synergies", but one might wonder whether Mitsui did not want to prevent a greater dependence of iron ore supplier from the Australian companies, who enjoyed a dominant position in the Pacific Basin trade.

## **2.1. THE STANDARD-CONDUCT-PERFORMANCE (MERGER GUIDELINES STYLE) ANALYSIS**

Mergers and Acquisitions in Brazil are submitted to the Secretariat of Economic Law (SDE, after its Portuguese acronym), a division of the Ministry of Justice, who sends the cases to the Secretariat of Economic Monitoring (SEAE), in the Ministry of Finance. After the latter's analysis, the ordinary, unimportant cases usually deserve very little further inquiry by SDE and are sent to CADE. These three bodies make up the Brazilian Antitrust System (BAS). Other than the

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<sup>3</sup> Caemi also owned an iron ore operation in Canada, named QCM (Quebec Cartier Mining), which had to be divested to comply with the restrictions imposed by the European Community's Competition authorities in 2001. The bauxite and kaolin markets did not raise concerns for the Brazilian Antitrust System. Therefore, henceforth Caemi and MBR are to be understood as interchangeable for the purposes of the matter.

CADE's President, Commissioners and Attorney, no other member of the BAS has a fixed term or has to have their name submitted to the Senate when appointed.

Since 2002 a simplified procedure (sort of an early termination system) reduced even further the elapsed time of analysis. Polemic matters such as CVRD's four acquisitions in a row, however, stand among the very few which required further detailed investigation, when SDE disagreed substantially with the findings of SEAE or too long a time had elapsed and the market conditions had evolved much differently from what SEAE had assessed or expected. To make things worse, the Antitrust legislation in effect to the present does not prevent merging parties from carrying out the M&A before CADE has its say.<sup>4</sup>

In the last two years SDE and SEAE improved their division of tasks such that more and more the economic analysis of M&A was assigned to SEAE, whereas SDE increasingly dedicated resources to the collection of direct evidence of anticompetitive behavior, in collaboration with public prosecutors and the police.

The economic analysis performed by SEAE in these four matters followed strictly the Structure-Conduct-Performance (SCP) paradigm contained in the Brazilian Horizontal Merger Guidelines (BHMG), issued jointly by SDE and SEAE in 2001. Even though the cumulative effect of the four mergers was accounted for, each of the mergers was assessed in a separate report.

For each merger, a behavioral remedy and a structural remedy were proposed by SEAE as alternatives to each other. The structural remedies can be summarized as follows:

1. Socoimex: no remedy (unrestricted approval), as the only asset was a single mine at the end of its lifetime.

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<sup>4</sup>It is worth noting, however, that cautionary measures are at hand of the Brazilian Antitrust Authorities. CADE may grant SDE a preliminary injunction or negotiate an agreement with the merging parties suspending the merger or acquisition until that court reaches a final decision on the case. In recent years, such agreements (named APRO, i.e., Agreements for Preserving the Reversibility of the Operation) were adopted in industries as diverse as agricultural machinery, chocolates and supermarkets, where SDE or SEAE perceived immediately a worrying increase of market concentration. However, neither of the instruments was applied to the present cases, what certainly reinforced the delay in the analysis.

2. Samitri: divestiture of the mines of Conta-História and Fábrica Nova (Samitri) along with the mines of Timbopeba and Capanema (CVRD). These mines were claimed to have synergies in pairs.
3. Ferteco: non-approval;
4. MBR: divestiture of the mine of Jangada.

The divestitures should be bundled in a single package, in order to guarantee that the firm who acquired it had enough scale to compete in equal footing with CVRD, and would have access to railway and port so as to be able to export their output.

The behavioral remedy was always the same: once the European overseas price were announced, CVRD should convene with its domestic clients the same price, minus the freight from the local port (Tubarão or Sepetiba) to Rotterdam, minus the freight from the mine to the local port, plus the freight from the mine to the domestic client. CADE was to enforce this arrangement.

This remedy was thought of as a true-believer response to CVRD's claim that the domestic price should follow the international price, as SEAE never really put this claim to the test. But, as we will see below, this remedy would be useless. On the one hand, if CVRD's claim were true, the remedy would not be necessary. On the other hand, as SDE checked later, this pegging behavior only arose after the acquisitions.

It was clear therefore that CVRD acquired market power, or reduced or removed logistic bottlenecks, or both. By removing bottlenecks, it increased the opportunity cost for the mines to supply domestic clients during international market booms. By acquiring domestic market power, the international market price would become for the first time the only binding constraint to its exercise. But there is an important point to remark: the binding constraint would not be the FOB-port **minus** mine-port freight **plus** mine-mill, but rather the Fob-port **plus** port-mill freight; the difference between the latter and the former is positive and is greater, the farther from the port the mill is located. The difference can even skyrocket to infinity if CVRD, by controlling all ports and railways, takes all sorts of measures, non-verifiable by ANTT – the regulatory agency in charge of land transportation – to delay or impede the transportation of iron ore inland.

So the behavioral remedy would be insufficient, even though it contained clauses ordering CVRD to separate freights from ore prices, simply because any compromise between CVRD and CADE would be incomplete in that CVRD could always find a bypass to it, non-verifiable both to CADE and ANTT (informational asymmetry between regulator and regulated firm).

Indeed quite a few complaints were voiced against CVRD since its privatization, either to SDE or to ANTT, alleging that the giant miner disfavored third-party clients as compared to its own freights. To worsen things, EFVM was not privatized as a separate company from CVRD (because of tax incentives), no formal franchise contract was signed between the Government and CVRD at the time of privatization, and the accounting separation was insufficient to prevent CVRD from discriminating prices and other conditions between itself and the other clients. This narrowed tremendously ANTT's scope of action.

But the worst of all is that complaining companies would never file a formal written complaint out of fear of retaliation, and when they dared to do so, always in a few hours after CVRD became aware of it the agencies would receive some new communication from the complainants in which they recanted from the accusations.

Both types of remedy proposed by SEAE resulted from its analysis following the BHMG. Further investigation performed by SDE is also commented along:

#### **2.1.1. DELIMITATION OF THE RELEVANT MARKET**

Three relevant product markets were defined by SEAE: (i) lump ore; (ii) sinter feed ore; (iii) pellet feed ore. Sinter feed is a fine ore transformed into sinter in an industrial process that, at least in Brazil, always takes place within the steel mill's facilities<sup>5</sup>. Pellet feed ore is aggregated into pellets typically in dedicated plants owned (entirely or in joint ventures) by the mining companies themselves, located either near a mine or a port, as one could see from the locations of the pellet plants involved in the acquisitions under analysis. Lump

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<sup>5</sup> It was demonstrated that sinter is a very fragile agglomerate and very easily broken into pieces during long journeys.

ore is ordinarily fed directly to the furnaces, mixed with sinter, but it has become very scarce and it has increasingly been replaced by pellets and sinters themselves.<sup>6</sup> At any rate, substitution among the different types of ore consumed in a steelwork is rather limited once the plants are built. CVRD objected to this delimitation, claiming that the three types were quite substitutable for each other, and that their prices moved together.

Three other relevant product markets were defined to be analyzed in full depth: (iv) railway transportation; (v) ports; (vi) steel products. The last one was defined due to the fact that CVRD owned a stake at the controlling block of CST at that time, as well as a stake at Usiminas (but allegedly not in the controlling block), and through Usiminas, also in Cosipa.

In its analysis, SDE substituted pellets for pellet feed as one of the relevant product markets, as the pellet plants are all owned by the mining companies themselves and pellet feed is traded solely between these integrated companies and small miners. Only pellets are sold to steelworks (in domestic or export markets).

As regards the geographic market definition, there are two major iron ore sites in Brazil: Carajás (Northern System), located in the State of Pará – explored exclusively by CVRD and for export), and the Iron Square in the State of Minas Gerais (Southern System), where all the acquired firms operated. From the Iron Square, MRS and EFVM were the only railways leading to ports ready to load iron ore for export (MRS to Ilha Guaíba and Sepetiba<sup>7</sup>; EFVM to Tubarão and Praia Mole). Almost all steel mills in Brazil are located along these two corridors. Along MRS, one can reach Açominas (Gerdau), CSN and Cosipa; along EFVM, the plants of Acesita and CST (Arcelor), Açominas and Usiminas.

CVRD claimed that the iron ore price was formed in the international market and that the domestic market price was simply the FOB export price at the port, minus the freight from mine to port, plus the freight from mine to mill.

The main element to rebut this claim was that the Brazilian ports were not equipped to unload iron ore from ships, only to load them. This element was

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<sup>6</sup> Pellets are mainly used by the mini-mills, but increasingly by blast furnace mills and pig iron producers as well.

<sup>7</sup> The ports of Sepetiba and Ilha Guaíba are neighbors (both are part of the greater Sepetiba's complex) and they share some storing facilities.

reinforced by the finding that even from the Northern System no iron ore was ever brought to the clients into the Southern System, except in very isolated cases (see below).

Still these elements were not strong enough. First, the productive capacity in the Southern System exceeded greatly the demand therein. CVRD and the acquired firms were able to supply individually the whole demand of the region. It would take a serious transportation restriction or temporary interruption of some major mine to render some individual mining company unable to fulfill a previously contracted shipment, and in the case of CVRD, require the mining company to resort to a mine so far away from the domestic consumer. From the statements and testimonies collected in the proceedings, including the studies provided by the merging parties themselves<sup>8</sup>, it was quite clear that due to the great importance of logistic costs in determining the final prices, and to the abundance, low cost and high quality<sup>9</sup> of the Brazilian iron ore, this ore became so competitive that some kind of buffer was created, isolating the domestic market price from the overseas prices.

A second puzzling element was that, not only when the rare “imports” of iron ore from the Northern System did take place, but also when the transportation directly through MRS to Cosipa presented technical problems and required the ore to be shipped from Sepetiba by vessel, Cosipa’s port facilities were actually able to unload it. In yet another isolated case, Cosipa bought a shipment from Samarco and had it transported by vessel. This cast some doubt on SEAE’s argument that ports were inadequate for unloading.

Nonetheless, the relevant geographic markets were eventually defined by SEAE as being the area along EFVM for the first two acquisitions and the whole Southern System (Brazilian Southeastern Region) in the last two, because the iron ore appeared to be supplied to clients only through the two railways, and it happened that Ferteco had access to both of them. SDE revised the geographic definition of the first two acquisitions because Gerdau’s plant Açominas, a major consumer, had access to both railways, and because Usiminas, even though not

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<sup>8</sup> Two reports by private consultants hired by CVRD highlighted the importance of logistic costs as a great competitive advantage of Brazilian production, amounting to a very large share (confidential) of the total cost.

<sup>9</sup> Brazilian iron ore is one of the purest in the world: between 60% and 67% of iron content, whereas the Chinese ore, for instance, is around 32%.

having access to MRS, used to purchase iron ore from MBR's mines located at that railway. The ore was (inefficiently) transported by trucks.

The econometric exercises performed by SDE reinforced the rejection of the geographic delimitation proposed by CVRD. As we will see below, although export prices helped to explain the behavior of domestic price series, their explanatory power was quite limited (except for CVRD, whose prices moved quite closely together).

It is worth mentioning that only lump ore and sinter feed's geographic markets were defined by SEAE to be the corridor along EFVM for the first two acquisitions (Socoimex and Samitri) and the whole Southeastern Region for the last two acquisitions (Ferteco and MBR). The market for pellet feed was defined in all four matters as comprising the Southeastern Region, since Fabrica's pellet plant has access to both EFVM and MRS, and Cosipa could buy pellets from Tubarao and Ponta de Ubu by sea transportation.

### 2.1.2. ABILITY TO EXERCISE MARKET POWER

Using the relevant markets as defined above for the three types of ore, concentration rates obtained were quite worrisome, as one can see from Tables 1 to 3.

**TABLE 1**  
**Brazilian Lump Ore Market Shares (Southern System)**

Mining Co.	1998	1999	2000	2001	2002	2003
CVRD	<b>29.27</b>	<b>25.34</b>	<b>27.48</b>	35.62	30.98	29.00
Ferteco	14.20	19.47	12.35	8.26	14.20	15.72
MBR	7.65	5.20	7.78	13.65	13.15	15.51
Samitri	10.82	9.42	<b>11.34</b>	7.99	9.30	9.66
Socoimex	8.25	6.13	<b>6.57</b>	9.21	9.25	3.46
<b>Subtotal</b>	<b>70.19</b>	<b>65.57</b>	<b>65.52</b>	<b>74.73</b>	<b>76.88</b>	<b>73.36</b>
CSN	4.11	6.73	9.19	7.78	10.78	10.54
CFM	2.45	3.39	2.91	2.60	3.48	7.80
Brumafer	0.00	0.00	2.01	5.05	4.43	3.65
Rio Verde	2.77	2.04	0.08	1.64	1.51	1.87
Extrativa	0.00	0.00	0.00	0.00	1.36	1.85
Itaminas	18.31	20.29	19.28	7.33	1.55	0.93
Herculano	0.98	1.04	1.01	0.87	0.00	0.00
Mannesmann	1.18	0.94	0.00	0.00	0.00	0.00
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

**TABLE 2**  
**Brazilian Sinter Feed Market Shares (Southern System)**

<b>Mineradora</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>
CVRD	<b>63.78</b>	<b>42.45</b>	<b>44.72</b>	46.25	43.52	41.50
MBR	1.83	10.12	5.65	7.85	7.80	10.18
Ferteco	4.74	8.27	9.02	3.96	5.93	8.24
Samitri	2.95	3.23	<b>3.87</b>	3.58	5.99	5.81
Socoimex	7.66	8.71	<b>11.78</b>	13.71	9.19	3.40
<b>Subtotal</b>	<b>80.96</b>	<b>72.78</b>	<b>75.05</b>	<b>75.35</b>	<b>72.43</b>	<b>69.13</b>
CSN	8.35	14.34	13.90	13.42	16.78	18.78
Itaminas	7.85	9.34	7.20	7.35	6.17	6.44
Rio Verde	1.87	2.11	1.09	1.04	0.81	2.16
Others*	0.97	1.44	2.76	2.86	3.83	3.50
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

(\*) J. Mendes, Herculano, Integral, AVG, Brumafer and Mannesmann

**TABLE 3**  
**Brazilian Pellet Market Shares (Southern System)**

<b>Mineradora</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>
<b>CVRD</b>	100.00	100.00	93.57	98.03	72.89	66.67
<b>Ferteco</b>	0.00	0.00	6.43	1.97	24.83	29.95
<b>Samarco</b>	0.00	0.00	0.00	0.00	2.28	3.37
<b>Total</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>	<b>100.00</b>

To these concentration rates, one should add the monopoly of ports equipped to unload iron ore for export, as well as the ownership of EFVM and a dominant stake at MRS. Indeed, according to the call for tenders of the privatization of this railway, a clause ruled that no partner should own more than 20% of the controlling block, and the Shareholders' Agreement ruled that two partners could jointly veto any proposal in the Board of Directors. Now, Ferteco was fully incorporated into CVRD, but MBR was not, so in fact CVRD counted in the Board as two partners, with a total stake of 44.6% of the controlling block, resulting in practice that it was virtually able to control completely both MRS and EFVM.

These virtual monopolies, along with the stakes in CST and Usiminas, entitled CVRD to exercise any sort of vertical foreclosure that it dared to think of, except the fixing of the basis freight rate, which is controlled by ANTT.

### **2.1.3. PROBABILITY TO EXERCISE MARKET POWER**

Concerning the defined markets for iron ore, rivalry from remaining competitors would be almost none, due to the lack of financial and technical capacity, unless CVRD's right of first refusal on CSN's iron ore was removed. Entry would also face three major obstacles, according to SEAE. First, the parties of the acquisitions owned mining authorizations for 63% of the measured reserves located in the Southern System. Second, the cost of investment in a new mine (greenfield) was not to be ignored: around 100 million dollars; an entirely new pellet plant should cost 200 million dollars. Third, any greenfield investment would require access to the railways owned not only by CVRD but also by CSN, the greatest producers.<sup>10</sup> Imports were also out of question, for the reasons pointed out in the delimitation of the relevant geographic market.

In response to SEAE, CVRD claimed that it could not exercise such market power on the following grounds: (i) it held stakes at three steelworks, so it would not be worth raising them its prices<sup>11</sup>; (ii) another group of steelworks (though overlapping with the previous one) was partially owned by major overseas customers from Europe and Asia, and had long term contracts with CVRD; (iii) pig iron producers and other steelworks had their own captive mines and/or alternative suppliers, some of them with long term contracts, and some of them even consuming scrap metal.

Indeed claim (ii) made perfect sense. Claim (iii) is obviously fallacious, because removing competitors is supposed to change the conditions affecting the decisions of the clients on the renewal of contracts and on complementary purchases. Moreover, the group that consumes scrap metal (Gerdau) is also a major domestic purchaser of iron ore. In addition, the pig iron producers themselves, manifested at SDE accusing CVRD's railway EFVM and port in

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<sup>10</sup> An investment in a new railway was estimated to cost one million dollars per kilometer, besides all the red tape to pass the project in the government agencies, including ANTT.

<sup>11</sup> Such a claim is obviously misleading, as the shareholder prefers one dollar in her own pockets than in a purse to be shared with other partners, unless a tax planning advises otherwise.

Tubarão of unjustified delays in their export shipments<sup>12</sup>. Claim (i) is clearly misleading, after all a shareholder prefers one dollar in her own pockets than in a purse to be shared with other partners, unless a tax planning advises otherwise.

But a not so obvious fallacy was the power of the alleged long term contracts in the domestic market. In fact, SDE requested copies for analysis of the long term contracts, mentioned repeatedly by CVRD in its defense as dating back to fifty years. It turned out that only CVRD itself had contracts in effect before the acquisitions, whereas MBR and Ferteco signed contracts only in May/June 2003, one month after the first overseas contract of that year and with a higher raise. This was a strong evidence that steelworks such as Gerdau-Açominas and Usiminas only signed contracts with CVRD long after the acquisitions, when they realized the extinction of sort of a domestic spot market that existed earlier.<sup>13</sup> So the main point was the removal of competitors, what obviously affects the whole market.<sup>14</sup>

But this discussion was surmounted by the collection of evidence on what really had occurred as from the acquisitions. This possibility is an odd outcome of the ex post analysis of acquisitions contained in the Brazilian Antitrust Law. In particular, SDE inquired whether the acquisitions had been followed by any structural break of the price series. The results are reported in the next section.

#### **2.1.4. EFFICIENCY GAINS**

CVRD claimed that the acquisitions resulted in efficiency gains, which could be grouped into three categories:

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<sup>12</sup> According to the pig iron producers' union, 85% of their consumption came from CVRD and MBR. Data collected by SDE demonstrated that not only these two firms, but also small followers such as Herculano, raised substantially their prices to those clients in 2003.

<sup>13</sup> This suspicion was reinforced by anecdotal comments by CVRD that these clients bought from many suppliers because they were "stubborn" to mix their own ore, instead of having CVRD do this job "much more efficiently". It is worth noting that Gerdau announced the acquisition of rights to explore mines near Socoimex's field, thus signaling a hedging concern of theirs.

<sup>14</sup> CVRD's attorneys dared even to assert that, "as the acquired firms were market followers, they posed no threat to CVRD's leadership, so the acquisitions would not alter its previous leadership"(!!).

- i) Synergies (scope and/or scale economies) between pairs of mines, including rational use of equipments;
- ii) Synergies with CVRD's logistics;
- iii) Transfer of technology for better use of the mineral resources, allowing for the deferment of new greenfield investments.
- iv) Reduction or elimination of CVRD's supply deficit.
- v) Overhead economies in commercial, administrative, R&D and other activities.

In fact, category (i) referred to pairs of neighboring mines, where one of them was still to have production started and the other had nearly exhausted its natural resources. A simple transfer of (mobile) equipments or a better use of the existing ore reserves (both of them mentioned by CVRD) would obviously not derive specifically from the Operation, but the reutilization of fixed facilities (such as dams for residues) could well be argued as a social efficiency.

Category (ii) referred to the optimization of delivery and of blending of the different iron ores by CVRD for the steelworks, allegedly saving in freights and aggregating know how or quality to the product. Again it was an advantage of the post-acquisition analysis to be able to survey the steelworks and find that the evidence in support of this claim, after three years had gone by, was feeble, to say the least. Most important, no evidence was found to demonstrate that these efficiency gains were transferred to iron ore buyers.

Efficiency gains of category (iii) are certainly not drawn from the acquisitions, as a plain good consultancy would be able to replicate them. Deferment of investments should be accounted for only to the extent that the mines put back to operation save costs in comparison to the mine deferred. Category (iv) is clearly a private benefit. Category (v) included economies in fixed costs and pecuniary transfers (enhancement of buyer power). In fact, in spite of all the complaints by Brazilian lawyers against the Authorities' customary disregard of submitted efficiencies, submissions filed demonstrate the firms' and their attorneys' widespread misunderstanding of what is a social efficiency gain

derived specifically from the merger or acquisition, and they keep on submitting studies by private consultants without filtering them.<sup>15</sup>

### **3. THE NEED OF AN ECONOMETRIC STUDY**

Clearly the four acquisitions were not harmless to Brazilian market, in view of all complaints brought by customers, users of EFVM, and partners in MRS. But would a divestiture of mines really be required as a remedy? Would a behavioral remedy not be enough?

To educate their decision, SDE members raised two questions to be addressed:

- a. How truthful is CVRD's claim that domestic prices are simply given by the international market? Is that claim confirmed by the behavior of prices?
- b. Would SDE be able to pinpoint any structural break in the price series that could be ascribed to any of the acquisitions?

Studies on market power using structural models make up the core of the New Empirical Industrial Organization (see Bresnahan, 1989). A residual demand analysis of the iron ore market, or even a complete demand and supply model of the market would therefore be the first guess of a NEIO analyst.

Yet an attempt to estimate a residual demand curve was not successful in this case. Prices ruled by yearly contracts (even for a small number of important steelworks in Brazilian market) – quite often signed after part of the shipments had already been delivered – pose a severe difficulty for modeling either a residual demand or a complete model with monthly data, and the time span required for yearly data would be unfeasible for the purposes of the investigation.

A reduced form estimation was then a natural choice. The richness of price data enabled the analyst to address both issues listed above. Next we will discuss briefly the econometric tools at hand for the estimations.

#### **3.1. ECONOMETRIC FRAMEWORK**

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<sup>15</sup> It is worth mentioning that Brazilian law and jurisprudence make clear that consumers should not be worse off due to a merger or acquisition, so damages to consumers should be at least canceled out by efficiency gains through prices or any quality dimension.

If it is true that competition enforcement is a very young practice in Brazil, it is also true that the use of quantitative economic analysis in the cases is still crawling. Even a structured economic analysis resembling the US Horizontal Merger Guidelines was only endorsed by CADE in 2001, although SDE and SEAE were adopting an adapted version of it since 1999.

Most of the times, the SCP style analysis has been able to keep out from the BAS more sophisticated quantitative techniques. On the other hand, such that framework is unable to address issues that arise in markets with accentuated differentiation or where prices are formed through complicated processes of bargaining (especially bilateral oligopolies and monopolies). In fact, in some situations, even a “simple” definition of the geographic or product relevant market has been an object of tight dispute between SDE or SEAE and the attorneys of the merging parties, or between the latter and their challenging competitors. Quite often in Brazil, attorneys have claimed that the industry in dispute is merely a follower of market conditions set abroad. That also happened in CVRD’s case, as mentioned in the previous section.

There come econometric techniques to shed some light on the obscure notion of the hypothetical monopoly test (HMT). In two occasions before CVRD economists hired by the merging parties produced reports supposed to demonstrate that the relevant markets are international. CVRD was the first matter in Brazil where the Antitrust Authority took the initiative to test econometrically the delimitation of the relevant market.

LECG (1999) list four econometric approaches for the HMT: (i) Cross-sectional price tests; (ii) Hedonic price analysis; (iii) Price correlation; (iv) Causality tests. The last one was applied by two separate groups of scholars in two important cases at CADE: a merger in the petrochemical industry, and an acquisition in the fertilizers industry. This was a start for our work, but soon causality proved insufficient to demonstrate convincingly that domestic prices pegged international prices as closely as CVRD claimed. Approach (iii) was clearly inadequate as well, in view of the unit roots of some series. That is why a cointegration analysis was pursued. The estimated Vector Error Correction Model also enabled the authors

to address the revealed exercise of market power, as we will be able to see in the next section.<sup>16</sup>

### **3.2. DATA COLLECTED**

SDE required from CVRD, its competitors and major clients, the submission of series of monthly quantities (in metric tons) of each of the three types of iron ore sold by all mining companies reported by SEAE and their respective paid prices in the domestic and export markets. The series were compiled and all of them were turned to FOB-mine values<sup>17</sup> and cross-checked. Average prices in US dollars<sup>18</sup> per mining company and per steelwork were constructed, and they covered the period from January 1998 to December 2003.

For the estimations, we used average prices per mining company, and excluded at once the interrupted series<sup>19</sup>, so as to attain as large a number of observations as possible. Thus, only price series from CVRD, CSN and Samitri (lump and sinter feed) and Itaminas (sinter feed only) were included. As domestic pellet consumption had also been quite irregular and the series presented too many loopholes, this incipient market also had to be put aside.

#### **3.2.1. DESCRIPTION OF VARIABLES**

The code of each variable is as follows:

E E E \_ T T M V

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<sup>16</sup> For more on time series techniques applied to the definition of relevant markets, see Haldrup (2003) and Forni (2002). A companion paper of ours will address in greater depth the issues involved in relevant market delimitation, with a more detailed description of the most important applications in the BAS. It is worth noting, however, that cross-sectional techniques were not possible in the present analysis, due to insufficient cross-section observations. Nor hedonic analysis could be pursued, because of lack of data on the iron ore quality, CVRD's main argument for cross-sectional price differentiation. The ironical aspect of this argument is that it goes against the allegations in favor of a single relevant product market.

<sup>17</sup> When CIF prices were quoted, freights collected from MRS and CVRD (EFVM) were used to obtain FOB values.

<sup>18</sup> Many prices were already denominated in USD, especially from CVRD. Others had to be converted through the official export exchange rate (monthly average).

<sup>19</sup> This comprises mining companies of interest, such as Ferteco and Socoimex, and small miners.

- where:

- EEE are the first three letters of the mining company (CSN, MBR, CVRD is CVR, Itaminas is ITA, Samitri is SAM);
- TT is the ore type, that can assume two forms: SF, for *Sinter Feed*, and GR, for lump ore;
- M is the geographical dimension of the market, assuming two forms: D for domestic and X for export;
- V is the variable: P for Price and Q for Quantity;

Cointegration tests intended to help delineate relevant markets typically involve only price series. However, Haldrup (2003) advises the Antitrust Analyst to control these series for other common factors. Therefore, the following demand shifters were collected, namely:

- TRANS\_OCE: Overseas Trade Volume for iron ore, in tons (Source: CVRD);<sup>20</sup>
- PIM\_ALL: Manufacturing Output Index (Source: IBGE, Monthly Survey of Physical Production -- PIM-PF, <http://www.ibge.gov.br/english>);
- PIM\_MET: Metal Manufacturing Output Index (Source: *ibidem*);
- PIM\_BCD: Durable Consumer Goods Industrial Output Index (Source: *ibidem*);
- PIM\_BK: Capital Goods Industrial Output Index (Source: *ibidem*);
- FBKF: Gross Formation of Fixed Capital – apparent consumption of machinery (Source: Institute of Applied Economic Research – IPEA).

The following cost shifters were added:

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<sup>20</sup> Other world demand proxies were experimented, namely the Total Imports by Industrialized Countries (IMOP\_IND) and the Total World Imports (IMP\_MUND), both in US billion dollars and collected from the IMF International Financial Statistics. The results obtained with them are not qualitatively different from the ones reported herein.

- EXCH\_EFF: Index of Real Effective Exchange Rate, that is, an index of average exchange rates between Brazilian currency (BRL) and a currency basket of Brazil's sixteen greatest trade partners, deflated by wholesale price index of each country (Source: IPEA).
- FUEL: Price of fuel, provided by the regulatory agency ANP (National Agency for Oil and Gas).

The initial letter L in each variable name indicates that logarithmic transformation was applied.

The relevant market test as it is prescribed by LECG (1999) and Haldrup (2003), would be a simple cointegration test on the price series. But controlling for demand and cost shifters raises the following question: what if the controlling factors are themselves endogenous? Should we not include explaining equations for them as well?

SDE's analysis only added exchange rate as cost shifter (even though one could claim that it enters as a demand shifter as well, because it affects the mining company's opportunity cost of selling the ore domestically). In addition, based on economic intuition, both the exchange rate and the set of demand shifters were included as endogenous<sup>21</sup>, and a number of orderings were experimented for the Choleski decomposition. The ordering of price series followed the criteria of market and output size, thus starting with the export prices and following with domestic prices of CVRD, CSN, MBR, Samitri and Itaminas (if applicable).

To render the estimations more robust, we presently add three new features:

1. We assume that the world demand proxy (overseas trade volume) is exogenous and add fuel prices as exogenous explaining variables;
2. We run a more parsimonious cointegration test, only on price series.
3. Having added the new exogenous variables, we run both a restricted model where domestic output level proxies are considered exogenous, and an unrestricted model where they are endogenous. Then we test for the exogeneity of domestic output (LR test version), and report other results only from the selected model and from the parsimonious model.

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<sup>21</sup> Endogeneity of the exchange rate is justifiable on the grounds that iron ore plus steel products is computed as one of the top five export groups of the Brazilian trade balance.

In sum, the following series (in the indicated orderings) were used for our estimations.

1) LUMP ORE MARKET:

- Price variables – LCVR\_GRXP; LCVR\_GRDP; LCSN\_GRDP; LMBR\_GRDP, LSAM\_GRDP;
- Exogenous variables – Constant, LTRANS\_OCE; LFUEL and two dummy variables: **BRK2003**, which equals zero before January-2003 and one thereafter; and **D98\_99**, equals zero before January-1999 and one thereafter.

2) SINTER-FEED MARKET :

- Price variables – LCVR\_SFXP; LCVR\_SFDP; LCSN\_SFDP; LMBR\_SFDP, LSAM\_SFDP; LITA\_SFDP;
- Exogenous variables – Constant, LTRANS\_OCE; LFUEL and the same dummy variables **BRK2003** and **D98\_99**.

### 3.2.2. SOME INSPECTION OF THE DATA

Graphs 1 and 2 depict the series of average prices (lump ore and sinter feed) charged by mining companies in the Southern System, from which we can observe that CVRD's own domestic prices peg very closely its export price (FOB Tubarao).<sup>22</sup> Yet the prices of the other mining companies in the domestic market follow a much more erratic pattern, moving quite distinctly from the export prices. This pattern casts serious doubts on CVRD's claim of parallel behavior, and the econometric procedures would be quite helpful in determining more precisely how important domestic factors were, as compared to foreign markets' influences.

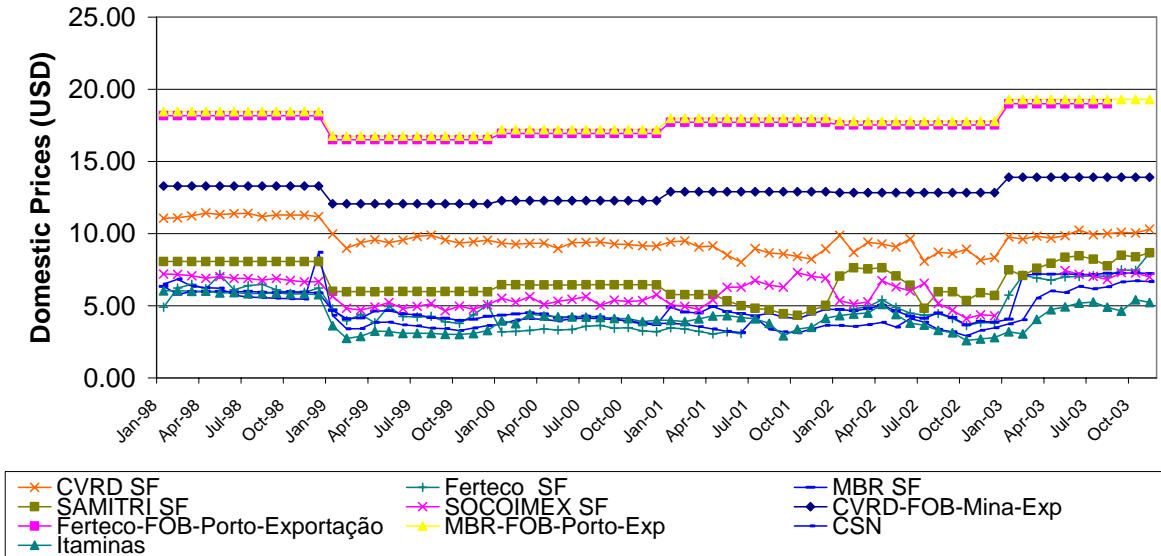
Moreover, a steep surge was recorded in the domestic price series of the acquired mining companies in early 2003, when the international market was booming, due to a significant increase of Chinese consumption. A structural break test was then called for.

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<sup>22</sup> Note that the behavior of the export prices from other miners is perfectly parallel to CVRD's. That is why these other series are not utilized in the regressions.



**Graph 2  
Sinter Feed Ore Prices**



### 3.3. ESTIMATIONS AND TESTS

#### 3.3.1. UNIT ROOT TEST

Before beginning our analysis, we had to check for stationarity of our time-series and to determine the order of integration for non-stationary variables. The most common tests are the Dickey- Fuller (DF) test or Augmented Dickey-Fuller (ADF) test, and KPSS – Kwiatkowski, Phillips, Schmidt and Shin (1992). There are several advantages in using both the ADF and KPSS tests. The ADF and similar unit root tests have the unit root as the null hypothesis, but lack power against trend stationary alternatives, so may give spurious unit root results. On the other hand, the KPSS test uses trend stationarity as the null hypothesis against the alternative of a unit root, so any lack of power will work in the opposite direction.<sup>23</sup>

Firstly, we have performed the methodology developed by Dickey and Pantula (1987) to test for multiple unit roots on the following variables: LCVR\_GRPX, LCVR\_GRPDP, LCSN\_GRPDP, LMBR\_GRPDP, LSAM\_GRPDP (Lump Ore market),

<sup>23</sup> Hence, as argued by Cheung and Chinn (1996, 1997), the two tests can be viewed as complementary rather than substitutes.

LCVR\_SFXP, LCVR\_SFDP, LCSN\_SFDP, LMBR\_SFDP, LSAM\_SFDP, LITA\_SFDP (Sinter Feed market), LTRANS\_OCE, LIMP\_MET, LIMP\_BCD, LEXCH\_EFF, LFUEL. Secondly, after discarding the hypothesis of multiple unit roots, the Augmented Dickey-Fuller test, or ADF<sup>24</sup> and the KPSS test<sup>25</sup> were applied on the levels of variables. For the ADF test the Schwartz criterion and the correlation analysis gave support to the lag selection. For greater robustness, the inclusion of a constant and/or of a trend was also tested, starting from the most complete model.

**TABLE 4**  
**UNIT ROOT TESTS**

VARIABLE	ADF test statistic - t	KPSS test statistic -LM
<i>LCVR_GRXP</i>	-2.038 (-3.475)	0.185 [0.146]
<i>LCVR_GRDP</i>	-1.568 (-2.903)	0.161 [0.146]
<i>LCSN_GRDP</i>	-2.418 (-2.903)	0.773 [0.463]
<i>LMBR_GRDP</i>	-1.842 (-2.903)	0.167 [0.146]
<i>LSAM_GRDP</i>	-2.325 (-2.902)	0.588 [0.463]
<i>LCVR_SFXP</i>	-1.123 (-2.903)	0.250 [0.146]
<i>LCVR_SFDP</i>	-2.460 (-2.903)	0.521 [0.463]
<i>LCSN_SFDP</i>	-0.419 (-1.945)	0.214 [0.146]
<i>LMBR_SFDP</i>	-1.646 (-2.903)	0.217 [0.146]
<i>LSAM_SFDP</i>	-1.831 (-2.903)	0.982 [0.463]
<i>LITA_SFDP</i>	-1.966 (-2.903)	0.498 [0.463]
<i>LTRANS_OCE</i>	-1.496 (-2.903)	0.963 [0.463]
<i>LPIM_MET</i>	-1.382 (-3.486)	0.812 [0.463]
<i>LPIM_BCD</i>	-1.014 (-2.910)	0.536 [0.463]
<i>LEXCH_EFF</i>	-0.059 (-1.945)	0.191 [0.146]
<i>LFUEL</i>	-2.253 (-3.474)	0.963 (0.463)

\* [ ] Asymptotic critical values at 5%: Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1);

\*\* ( ) Test critical values at 5% : \*MacKinnon (1996)

Note: For ADF,  $H_0$  = variable has unit root and for KPSS,  $H_0$  = variable is stationary.

<sup>24</sup> The lag order of the unit root was selected by using the Schwarz Criterion (SC) and by checking the residuals' correlogram.

<sup>25</sup> The ADF tests are very sensitive to outliers (Frances & Haldrup 1994, Cati, Garcia & Perron 1999). As these series had undergone some interventions, such as the break in early 2003, the KPSS test was also utilized, so the presence of outliers harms only the power of the test, but does not affect its size. This provided for more robustness of the test and reassured us of the order of integration I(1).

Both tests point out that all log variables are I(1). Thus the analysis may proceed to Johansen's cointegration analysis.

### **3.3.2. GRANGER CAUSALITY TEST**

Granger-causality tests are very sensitive to the choice of the lag length and to the methods employed in dealing with any non-stationarity of the time series. Therefore, before testing the Granger's causality, we tested for the number of lags used in the VAR-VEC<sup>26</sup>. From Akaike, Schwarz and Hannan-Quinn tests, it was found that only one lag is enough for modeling each of the two markets (lump ore and sinter feed).

The tests call for rejection of the hypothesis that the export price of CVRD (FOB-Tubarão) does not Granger cause domestic prices (except in the case of CVRD and CSN for Sinter Feed). In addition, we cannot reject the hypothesis that domestic prices do not Granger cause export prices. But is it enough support for the claim that domestic prices peg international ones? Next section proceeds to investigate the explanatory power of international prices.

### **3.3.3. COINTEGRATION ANALYSIS**

Cointegration tests in the VARs with the levels of variables were performed, using the methodology developed by Johansen (1991, 1995).

Five specifications were tested, namely:

- (1) the explained variable (level) does not have a deterministic trend and the cointegration equations do not have intercepts;
- (2) the explained variable (level) does not have a deterministic trend and the cointegration equations have intercepts;
- (3) the explained variable (level) has a linear trend, but the cointegration equations have only constants;

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<sup>26</sup> ARCH tests (LM tests) were also performed, and indicated that non-linearities could be sources of specification bias in a VAR-VEC model. These tests are also available upon request.

- (4) both the explained variable (level) and the cointegration equations have linear trends, and
- (5) the explained variable (level) has a quadratic trend and the cointegration equations have linear trends.

### 3.3.3.1. COINTEGRATION TESTS

To select deterministic components of the vector error correction model (VECM), the Akaike criterion was employed and indicated the existence of a linear trend in the cointegration vector for the Sinter Feed and Lump Ore markets<sup>27</sup>.

### 3.3.3.2. RANK OF THE COINTEGRATION MATRIX

The results of Johansen procedures – eigenvalue max and trace tests – recommend the choice of **two** cointegration vectors in the parsimonious model for and **four** vectors in the unrestricted model, both in the **Lump Ore** market, whereas in the **Sinter Feed** market the detected ranks were **three** and **four**, respectively.

1) Lump Ore Market:

1A – Parsimonious Model:

Unrestricted Cointegration Rank Test Trace and Maximum Eigenvalue
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<sup>27</sup> Test outputs available upon request.

Hypothesized Numero of CE(s)	Eigenvalue	Trace Statistic	5 % Critical Value
None *	0.885187	212.0010	76.97277
At most 1*	0.425530	62.65414	54.07904
At most 2	<b>0.210369</b>	<b>24.40690</b>	<b>35.19275</b>
At most 3	0.100562	8.109803	20.26184
At most 4	0.011482	0.796827	9.164546
<b>Trace test indicates 2 cointegration equations at the 5% level.</b>			
Hypothesized Numero of CE(s)	Eigenvalue	Max-Eigen Statistic	5 % Critical Value
None *	0.885187	149.3469	34.80587
At most 1*	0.425530	38.24724	28.58808
At most 2	<b>0.210369</b>	<b>16.29710</b>	<b>22.29962</b>
At most 3	0.100562	7.312976	15.89210
At most 4	0.011482	0.796827	9.164546
<b>Max-eigenvalue test indicates 2 cointegration equations at the 5% level.</b>			

1C – Unrestricted Model:

Unrestricted Cointegration Rank Test Trace and Maximum Eigenvalue			
Hypothesized Numero of CE(s)	Eigenvalue	Trace Statistic	5 % Critical Value
None *	0.910573	367.7372	169.5991
At most 1*	0.625035	201.1483	134.6780
At most 2*	0.557212	133.4646	103.8473
At most 3*	0.414681	77.25279	76.97277
At most 4	<b>0.262670</b>	<b>40.29653</b>	<b>54.07904</b>
<b>Trace test indicates 4 cointegration equations at the 5% level.</b>			
Hypothesized Numero of CE(s)	Eigenvalue	Max-Eigen Statistic	5 % Critical Value
None *	0.910573	166.5889	53.18784
At most 1*	0.625035	67.68371	47.07897
At most 2*	0.557212	56.21179	40.95680
At most 3*	0.414681	36.95626	34.80587
At most 4	<b>0.262670</b>	<b>21.02565</b>	<b>28.58808</b>
<b>Max-eigenvalue test indicates 4 cointegration equations at the 5% level.</b>			

2) Sinter Feed Market:

2A – Parsimonious Model:

Unrestricted Cointegration Rank Test Trace and Maximum Eigenvalue			
Hypothesized Number of CE(s)	Eigenvalue	Trace Statistic	5 % Critical Value
None *	0.846112	223.4060	103.8473
At most 1*	0.432797	94.27024	76.97277
At most 2*	0.342398	55.14467	54.07904
At most 3	<b>0.157920</b>	<b>26.22297</b>	<b>35.19275</b>
At most 4	0.132285	14.36320	20.26184
<b>Trace test indicates 3 cointegration equations at the 5% level.</b>			
Hypothesized Number of CE(s)	Eigenvalue	Max-Eigen Statistic	5 % Critical Value
None *	0.846112	129.1358	40.95680
At most 1*	0.432797	39.12557	34.80587
At most 2*	0.342398	28.92170	28.58808
At most 3	<b>0.157920</b>	<b>11.85977</b>	<b>22.29962</b>
At most 4	0.132285	9.790534	15.89210
<b>Max-eigenvalue test indicates 3 cointegration equations at the 5% level.</b>			

2C – Unrestricted Model:

Unrestricted Cointegration Rank Test Trace and Maximum Eigenvalue			
Hypothesized Number of CE(s)	Eigenvalue	Trace Statistic	5 % Critical Value
None *	0.873055	399.7495	208.4374
At most 1*	0.681410	257.3332	169.5991
At most 2*	0.546071	178.4076	134.6780
At most 3*	0.474140	123.9105	103.8473
At most 4	<b>0.336472</b>	<b>75.56272</b>	<b>76.97277</b>
<b>Trace test indicates 4 cointegration equations at the 5% level.</b>			
Hypothesized Number of CE(s)	Eigenvalue	Max-Eigen Statistic	5 % Critical Value
None *	0.873055	142.4163	59.24000
At most 1*	0.681410	78.92556	53.18784
At most 2*	0.546071	54.49717	47.07897
At most 3*	0.474140	44.34774	40.95680
At most 4	<b>0.336472</b>	<b>28.30273</b>	<b>34.80587</b>
<b>Max-eigenvalue test indicates 4 cointegration equations at the 5% level.</b>			

### 3.3.3.3. ESTIMATIONS

As mentioned in section 3.2.1, three models were run in each product market:

- A. Price Variables and Constant only (*parsimonious model*)
- B. Price Variables, Exogenous Variables; LEXCH\_EFF; LPIM\_BCD; LPIM\_MET as exogenous (*restricted model*);
- C. Price Variables, Exogenous Variables; LEXCH\_EFF; LPIM\_BCD; LPIM\_MET as endogenous (*unrestricted model*);

The exogeneity test by Sims (1980) belongs to the Likelihood Ratio family and was performed to select between models B and C. The results are the following:

1) Sinter Feed Market:

LR statistic = 289.70

2) Lump Ore Market:

LR statistic = = 294.3313

As the 1% critical value for a  $X^2(12)$  is 32.9, we can very safely reject the joint hypothesis of exogeneity of LEXCH\_EFF, LPIM\_BCD and LPIM\_MET, thus selecting the unrestricted model C instead of model B.

### 3.3.4. VARIANCE DECOMPOSITION

Tables 5 and 6 below display the variance decompositions of CVRD and MBR, our target companies, obtained from the unrestricted model. It is known that the ordering of the endogenous variables affects this decomposition, so we adopted the following ordering: LPIM\_BCD, LPIM\_MET, LEXCH\_EFF, and Price Variables, as listed in Section 3.2.1.

**TABLE 5 – Lump Ore Market**

**Model A**

Variance Decomposition of LCVR_GRDP Period: 1 – 12 MONTHS					
Period	LCVR_G_RXP	LCVR_GRDP	LCSN_GRDP	LMBR_GRDP	LSAM_GRDP
1	6.826187	93.17381	0.000000	0.000000	0.000000
12	9.713943	65.72398	12.56993	0.057540	11.93461

Variance Decomposition of LMBR_GRDP Period: 1 – 12 MONTHS					
Period	LCVR_G_RXP	LCVR_GRDP	LCSN_GRDP	LMBR_GRDP	LSAM_GRDP
1	0.579235	5.902858	0.366959	93.15095	0.000000
12	7.079516	32.90852	33.61567	17.37123	9.025070

**Model C**

Variance Decomposition of LCVR_GRDP Period: 1 – 12 MONTHS								
Period	LPIM_MET	LPIM_BCD	LEXCH_EFF	LCVR_G_RXP	LCVR_GRDP	LCSN_GRDP	LMBR_GRDP	LSAM_GRDP
1	0.207246	0.061442	6.293478	8.953392	84.48444	0.000000	0.000000	0.000000
12	6.012512	2.144358	38.76011	5.968109	42.73757	2.305337	1.767945	0.304060

Variance Decomposition of LMBR_GRDP Period: 1 – 12 MONTHS								
Period	LPIM_MET	LPIM_BCD	LEXCH_EFF	LCVR_G_RXP	LCVR_GRDP	LCSN_GRDP	LMBR_GRDP	LSAM_GRDP
1	2.773200	1.844011	24.49673	0.003363	2.615412	0.009549	68.25773	0.000000
12	1.547259	1.224302	39.92544	4.775484	36.65159	7.932501	7.482646	0.460781

**TABLE 6 – Sinter Feed Market**

**Model A**

Variance Decomposition of LCVR_SFDP Period: 1 – 12 MONTHS						
Period	LCVR_SFXP	LCVR_SFDP	LCSN_SFDP	LMBR_SFDP	LSAM_SFDP	LITA_SFDP
1	0.719035	99.28096	0.000000	0.000000	0.000000	0.000000
12	15.24120	39.48329	19.69869	14.17535	7.313746	4.087731

Variance Decomposition of LMBR_SFDP Period: 1 – 12 months						
Period	LCVR_SFXP	LCVR_SFDP	LCSN_SFDP	LMBR_SFDP	LSAM_SFDP	LITA_SFDP
1	0.284608	2.546156	5.094626	92.07461	0.000000	0.000000
12	3.577345	10.51231	4.643757	42.89001	11.38488	26.99171

**Model C**

Variance Decomposition of LCVR_SFDP Period: 1 – 12 months									
Period	LPIM_MET	LPIM_BCD	LEXCH_EFF	LCVR_SFXP	LCVR_SFDP	LCSN_SFDP	LMBR_SFDP	LSAM_SFDP	LITA_SFDP
1	4.807178	1.897445	4.464791	7.759760	81.07083	0.000000	0.000000	0.000000	0.000000
12	2.693757	10.75842	41.99431	13.24208	21.91568	4.018362	2.945074	0.308869	2.123450

Variance Decomposition of LMBR_SFDP Period: 1 – 12 months									
Period	LPIM_MET	LPIM_BCD	LEXCH_EFF	LCVR_SFXP	LCVR_SFDP	LCSN_SFDP	LMBR_SFDP	LSAM_SFDP	LITA_SFDP
1	1.882205	4.309793	10.65970	2.809036	3.217801	0.334750	76.78672	0.000000	0.000000
12	3.905319	33.73448	4.879439	4.598191	2.808986	12.17605	16.90848	11.68035	9.308711

The tables display the variance decomposition into each endogenous variable. The rows of the tables report the range of variance percentage from one to twelve periods ahead after an innovation of one standard error in each of the explanatory variables.

What is worth highlighting in the tables is:

- i) Innovations in the own explained variable (because of its entering with a lag as explaining variable) is always the major source of explanatory power; it responds for up to 93% of the variance in the first period and retains at least 7% of the share in the twelfth period.
- ii) Own explanation is followed distantly by exchange rate. This is a strong manifestation of the fact that many domestic prices were denominated in Brazilian currency, so that the dependent variable in US dollars is closely affected by variations of the exchange rate.
- iii) CVRD being a price leader, its domestic prices are not significantly affected by prices of competitors, but rather by domestic level of activity. As a follower, MBR reacts more to CVRD prices, except in the unrestricted model for the sinter feed market.
- iv) The explanatory power of the export prices range from zero to fifteen percent, a disappointing performance in view of CVRD' insistent claims of international-market-driven price behavior in the domestic market.

### **3.3.5. TESTING FOR STRUCTURAL BREAKS**

As we mentioned in Section 3.2.2, January 2003 records very suspicious surges of the domestic prices, especially of MBR and Ferteco, far above the raise of the export price – alleged to set up the basis for any variation of domestic prices. On the other hand, at that time the exchange rate reversed a severe process of devaluation that preceded President Lula's term inauguration (though

the combination of export price raise and exchange valuation were unable to explain alone the domestic price surge).

**TABLE 7 - Structural Breaks**

**Lump Ore Market**

<b>Unrestricted Model</b>	<b>CVRD_GR</b>	<b>CSN_GR</b>	<b>MBR_GR</b>	<b>SAM_GR</b>
<b>BRK2003</b>	0.143216	0.328975	0.250272	0.249389
	<b>[ 5.96722]</b>	<b>[ 4.10989]</b>	<b>[ 5.55345]</b>	<b>[ 4.15383]</b>
<b>D98_99</b>	-0.084776	-0.377461	-0.135416	-0.315985
	<b>[-6.23101]</b>	<b>[-5.19351]</b>	<b>[-3.17403]</b>	<b>[-7.26280]</b>

**TABLE 8 - Structural Breaks**

**Sinter Feed Market**

<b>Unrestricted Model</b>	<b>CVRD_SF</b>	<b>CSN_SF</b>	<b>MBR_SF</b>	<b>SAM_SF</b>	<b>ITA_SF</b>
<b>BRK2003</b>	0.060559	0.513993	0.191415	0.310770	0.060559
	<b>[ 5.17580]</b>	<b>[ 8.22358]</b>	<b>[ 5.21714]</b>	<b>[ 8.30599]</b>	<b>[ 5.17580]</b>
<b>D98_99</b>	-0.147622	-0.403467	-0.144109	-0.184193	0.039164
	<b>[-5.90452]</b>	<b>[-4.83869]</b>	<b>[-3.06970]</b>	<b>[-2.94509]</b>	<b>[ 0.58215]</b>

Tables 7 and 8 report the coefficients and t-test statistics. From them, we can conclude the following:

- 1) A negative break in 1998-99 is not rejected for the levels of the domestic prices (except for Itaminas in the SF market)
- 2) BRK2003 was found significant and positive, pointing out a severe increase of the price level one and a half year after the last acquisition (the largest of them).

Further, in the past SDE estimations, a test for the significance of the sum of the two coefficients was performed and indicated that their balance was null or positive for all prices.

### **3.3.6. VARIATIONS ON THE SAME THEME**

In response to CVRD's counter-estimations, the authors performed several extensions or modifications of the models presented herein. These include:

- i) Treating exchange rate as exogenous;
- ii) Using prices of hot rolled coils negotiated in Antwerp as a sort of leading indicator<sup>28</sup> for demand from steelworks, instead of trade volumes, which ordinarily should be a very poor indicator of the agents' expectations;
- iii) Substituting a Laspeyres index for the average price;
- iv) Extending the price series back to 1995, what required removing variables not supplied by CVRD, such as CSN's and Itaminas' prices;
- v) Restricting the analysis to Forni's (2002) unit root test on the export/domestic log-price-ratio.

The first three modifications did not change qualitatively our conclusions. The last two are to be treated in a separate paper on relevant market delimitation issues.

## **4. CONCLUDING REMARKS**

The Brazilian government privatized in the early 1990s the whole flat steel industry, which benefited from public investment in the plants themselves and in the exploration and transportation of the competitive, high quality iron ore abundant in the country. In 1997 CVRD, a national champion of the metal mining industry, along with all logistic facilities, was also privatized. As long as they were "children of the same father", in the say of a CVRD director, prices and other contractual features were harmonically set up.

The move of the Brazilian State out from most of the productive activities was then accompanied of a greater emphasis on competition promotion and

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<sup>28</sup> CVRD explained that prices in the steel industry move much more frequently in response to changes in supply and demand conditions.

Antitrust action. And extremely necessary it proved. CVRD, by using the power of its vertical integration, its huge cash turnover and by choosing a deliberate strategy of concentrating its business in mining and logistics, moved aggressively to dominate the iron ore market by acquiring its main competitors. Prices collected by SDE showed clearly that pricing of iron ore in the domestic market changed completely some time after the acquisitions.

CVRD's strategy to defend the acquisitions aimed at convincing the Antitrust Authorities that the whole domestic market pegged closely the behavior of the international market. But how would the Antitrust Authorities be assured of such claim, if miners and steelworks had been living together as private companies for such a short period of time before the acquisitions under analysis?

The unfortunate feature of the Brazilian Antitrust Law that allows for post-acquisition notification ended up enabling the Antitrust analysts to gather a reasonably long number of observations to put that claim to the test. The present paper has pursued to provide a fair account of the strategy and execution of the econometric investigation undertaken by the authors therein. Granger causality tests and cointegration analysis were used to verify how truthful the claim for an international relevant market definition for iron ore was. On top of that, some structural break tests showed that a pronounced raise taking place in 2003 could not be explained by demand conditions, neither in the international nor in the domestic market, suggesting that CVRD was finally exercising its domestic market power one and a half year after the last set of acquisitions (the most important ones).

Still CVRD's increased market power was not exercised to its full: prices remained far below the opportunity cost of imports. Even more: prices remained tightly below or equal to CVRD's opportunity cost to export. In addition, CSN announced investments that would more than double its mining capacity, thus rendering dispensable any divestiture remedy regarding mines, except in case CVRD's right of first refusal to CSN's ore was maintained.

The study performed by the authors in the Antitrust Division of the Ministry of Justice (SDE) – and extended for the present exposition – was important, though, to signal that the domestic market was much more competitive before the acquisitions. In fact four conclusions of the study should be highlighted:

1. Indeed international prices “cause” (at least in Granger sense) domestic prices;

2. Nonetheless, international prices are not the only variable to explain the movements of domestic prices. Actually, in the immense majority of the cases analyzed, the variance of the international prices does not explain more than 30% of the total variance of each domestic price. In many cases (not reported here), the domestic prices of domestic competitors have greater explanation power.

3. Statistically significant structural breaks in the series of domestic prices were detected in January 2003, after controlling for several demand variables in the domestic and international markets.

4. The dollar price surge in the domestic market in 2003 more than compensated or, at least, canceled out the 1999 tumble that followed a major devaluation of the Brazilian currency.

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