Simulation of Efficiency and Competitive Effects of Horizontal Mergers in the Iron Ore Industry

Robert Lundmark & Linda Wårell
Luleå University of Technology
Department of Business Administration and Social Science
Division of Economics
971 87 Luleå
Sweden
Phone: +46920491941
Fax: +46920492035
E-mail: Robert.Lundmark@ltu.se, Linda.Warell@ltu.se

Abstract
The iron ore industry has experienced a continuous consolidation trend during the last years given an explosive activity of mergers and acquisitions. An evaluation of these mergers is important in order to establish the potential welfare effects on the iron ore industry. The purpose of the paper is to analyze the price effect from a horizontal merger, in particular the potential negative effect on consumer prices stemming from the increased consolidation on the market. This will be conducted using a simulation model based on PCAIDS, which uses the pre-merger situation in order to estimate the post-merger outcome. The model is applied to the merger between Rio Tinto and North Ltd, which was cleared by the European Commission, as well as the Australian authority, shortly after its announcement. The relevant market is defined, using shipments data. This will be followed by the simulation model, applied on the defined relevant market. Given that the merger has already taken place, this also provides an opportunity to evaluate the correctness of the methods applied to the actual outcome. These exercises will generate useful information to competition authorities regarding how valid certain formal methods of defining relevant markets, as well as simulating post-merger prices and quantities, are to evaluate the welfare effects from mergers in the iron ore industry. The results suggest that the predicted price increases from the merger are moderate and well in line with the price fluctuation that can be observed. The estimated increased market concentration indicates some concern for the competition authorities.

1 Introduction

The mining industry has experienced a continuous consolidation trend during the last years through a number of mergers and acquisitions (M&As). Between 1995 to 2002 the amount spent on mining M&As per year has averaged more than US$ 20 billion. In 2001 merger activities in the mining industry peaked with over US$ 40 billion spent on M&As that year. Compared to the total amount of M&A activity (in all industries) mergers in the mining industries have decreased from 1.8 percent in 1995 to 0.5 percent in 2000. However, since then this share has increased and in 2001 it reached almost 2 percent. Thus, one can therefore conclude that M&As still seems to be a highly important tool for managers in the mining industries to gain value for their companies (Ericsson, 2002). There are a number of characteristics in the mining industries that distinguish them from many other industries, such as very large investment costs, long term decisions, and risky initial exploration. These characteristics are certainly important factors behind the intense merger activities in the industry.

The iron ore industry provides a good example of an industry with a high M&A activity during the last years. Examples of large iron ore M&As during recent years are CVRD-Ferteco (2001), BHP-Billiton (2001), CVRD-Caemi (2001), Rio Tinto-North Ltd (2000), North Ltd-Iron Ore Co of Canada (1997), Cleveland Cliffs Inc-Silver Bay Mine (1994) (Ericsson, 2002). The iron ore industry is characterized by a geographical distribution of ore reserves, and the mine ownership is increasingly concentrated. For example, seaborne trade is dominated by Australian and Brazilian producers, each with 36 percent and 31 percent market shares respectively in 1997. There are also significant barriers to entry for new firms to enter the industry, given the large capital investments needed to start up production (SBC, 1998). It is therefore interesting and important to investigate whether or not the development leading to increased consolidation on the market has had a negative effect on consumer prices[1]. A thorough investigation and evaluation of an iron ore merger is therefore motivated in order to establish the price effects on the market.

---

[1] Note that the consumers of iron ore primarily are the steel companies, given that iron ore is an important input factor in steel production. Thus, the consumer is *not* defined as the end consumer who buys the finished product in this paper.

The purpose of the paper is to analyze the price effects from a merger in the iron ore industry. The focus will be on the potential negative effects on consumer prices stemming from the increased consolidation in the market. This will be conducted using a simulation model, which uses the pre-merger situation in order to estimate the post-merger outcome.

Merger simulation models attempts to estimate the effect that a merger will have on market prices by combining estimates of elasticities of demand with an economic model of how firms interact. One of the main reasons for using a simulation model is that it requires. The PCAIDS model requires just two inputs in order to generate a prediction of the effect of a horizontal merger. Using a simulation model allows us to directly estimate the total price effects from the merger, and evaluate the merger from a new perspective. Applying the simulation model on a past case also invites to compare the actual outcome to the simulated outcome, and thus the opportunity to evaluate the reliability of the chosen method and its assumptions. The outcome of merger analysis is often highly affected by the initial step to define the relevant market. This since a narrow market definition will most likely lead to more competitive effects form the merged firm, than a broader market definition. This study aims at conducting a thorough definition of the relevant market, both in terms of product and geographic space.

The paper proceeds with a background of the chosen merger and the European Commission's decision in the case. The next section presents the iron ore industry and an analysis of the shipments data including a definition of the relevant market. The following section presents the simulation method. Further, the results and conclusions are presented.

2 Background to the Merger Case

This study has chosen to focus on the merger between Rio Tinto and North Ltd, which took place in 2000. The merger united two of the top four participants in the iron ore industry (see Table 1), and thus increased the concentration in the market in a substantial way. The two merged firm's main operations are also located in the same country, Australia, which might increase the concentration too much in that particular area (SCB, 1998). Another reason for the chosen merger is that Rio Tinto is one of the two firms in the Australian market that negotiates the prices (the other firm is BHP). The price process in the iron ore industry is characterized by yearly negotiations between the largest iron ore suppliers and the largest iron ore importers (steel mills) in the two dominating regions, Brazil-Europe, and Australia-Japan. In the Brazil-Europe market it is CVRD who is the dominating price negotiating iron ore supplier. The price is set for a year, and guides the prices for the rest of the trade on the market (UNCTAD, 2003). Thus, regarding a competition study it is of most interest to evaluate mergers that have a ‘real’ impact on prices in the iron ore industry. The following sections in this chapter will presents the Commission’s decision regarding relevant market and competitive effects regarding the merger between Rio Tinto and North Ltd. This will provide a basis for the following investigations, since the results will be compared to the Commission’s.

Table 1: Iron Ore Operation Summary (1997)

	Country	Production (Mt)	Shipments (Mt)	Sales ($m)
BHP	Australia	64	64	1420
Rio Tinto	Australia	58	62	1562
North Ltd	Australia	33	32	465
CVRD	Brazil	121	107	2001
Samitri	Brazil	14	14	194
Iscor	South Africa	24	16	306

Source: SBC, 1998.

2.1 The Commission’s Decision in the Merger Case

On June 30, 2000, Rio Tinto Investments Two Pty Ltd[2] informed the European Competition Commission of their plan to pursue a public bid for all outstanding shares of North Ltd, giving the Rio Tinto group the sole control of North Ltd. The Rio Tinto group (henceforth called Rio Tinto) consists of two companies, Rio Tinto plc based in London UK and Rio Tinto Ltd based in Melbourne Australia. The firms headquarter is based in London, UK, but its mining operations[3] are spread all over the world. North Ltd is

[2] A subsidiary company, controlled to 100 % by, the Rio Tinto group.

[3] Rio Tinto produces and trades both metals and minerals, e.g. iron ore, copper, gold, uranium and zinc.

primarily a mining company with headquarters in Melbourne Australia.[4] Given this, Rio Tinto had to get clearance for the merger both from the Australian Securities and Investments Commission and the European Competition Commission. (Case No Comp/M. 2062, 2000).

2.1.1 The Commission's Definition of Relevant Market

Regarding the definition of relevant product markets the European Competition Commission (henceforth the Commission) has defined separate markets for copper, gold, uranium and zinc in previous cases[5] and will keep those definitions. When it comes to iron ore, which is the main interest in this study, Rio Tinto suggests that there is a single relevant product market, i.e., there is no distinction between the three different types of ores, fines, pellets and lump. However, the Commission was informed by a number of interested parties that fines, pellets and lump iron ore should be considered as separate product markets. According to these parties the substitution possibilities between the three different ores are limited, since the switching between e.g. pellets and fines can significantly affect the efficiency of the steel mills. There is also limited substitution possibilities from a supply perspective given that not all mines can produce lumps, and also since the production of pellets requires a palletizing plant, which involves a large capital investment (Case No Comp/M. 2062, 2000).

There is also a concern regarding that the relevant market for the European Union should only include seaborne quantities, i.e. the volumes exported by ship. This since it is only seaborne iron ore that normally is available for the European importers. In addition, most of the remaining production (e.g. in Russia and China) are primarily for domestic usage and do thus constitute a separate market. However, the Commission states that for the purpose of the decision regarding whether or not to allow Rio Tinto and North Ltd to merge, the Commission does not find it necessary either to establish separate product markets for pellets, fines and lump, or whether to only consider seaborne trade, the notified merger proposal "will not lead to the creation or strengthening of a dominant position" (Case No Comp/M. 2062, 2000; page 3).

---

[4] Its main production and trade is within iron ore, but it also operates in other metals and minerals such as copper, gold, forestry, zinc and uranium.

[5] Cases No. IV/M.470 – Gencor/Shell, and IV/M.660 – CRA/RTZ.

Regarding the definition of the relevant geographic market the Commission acknowledges that metals and minerals are commonly traded commodities on a global basis, and thus the relevant geographic market should be considered as world wide. This is supported by the fact that European consumption of iron ore constitutes of 90 percent imports. Also, the prices in the two main importing areas, Europe and Japan, follow each other, and the major producers in Australia and Latin America export their iron ore to steel mills both in Europe and Asia (Case No Comp/M. 2062, 2000).

2.1.2 The Commissions Assessment of Competition Effects

To assess whether or not the new company would be in a dominant position the Commission calculates the market shares in the different markets. Regarding copper, gold, uranium and zinc the market shares for the new merged company would range between 3.6 percent (zinc) to 12 percent (uranium). The concentration on these markets would though not be of any competition concern according to the Commission. Regarding iron ore (which operation is the main motive for Rio Tinto to acquire North Ltd) there is in 2000 more than 75 producers of iron ore world-wide, all with a market share of less than 15 percent. The Commission finds that the world-wide iron ore market share of the merged firm would be about 9 percent (calculated from the estimated world-wide supplies) and would thus not be of any competition concern (Case No Comp/M. 2062, 2000).

The Commission also considers concentration levels for the separate markets for pellets, fines and lump, only considering seaborne supplies. Regarding pellets there is no horizontal overlap in Rio Tinto and North Ltd's production and a merger would thus not lead to a dominant position in that market. For fines and lump the Commission finds that the market shares of the merged firm, based on seaborne supplies, would be approximately 25 percent to 30 percent for both products. Considering that other firms in the industry have similar shares, the Commission concludes that there would still be a significant degree of competition on the markets for seaborne fine ore and seaborne lump ore.[6] The Commission also notes that there presently is excess capacity for iron ore production, and thus the merged firm could not be able to raise prices profitably for its

[6] CVRD has market shares of approximately 20-30% for seaborne fines, and 15-20% for seaborne lump. BHP has market shares in the range of 15-20% for seaborne fines, and 15-25% for seaborne lump.

fines or lump supplies. The increased concentration on the markets would thus not lead to a dominant position for the merged firm (Case No Comp/M. 2062, 2000).

2.1.3 Motivation for Conducting this Research

Why is it interesting to investigate a merger that has already been cleared by a competition authority? The Commission defines the relevant market as a global market, but is this really the case? The conclusion is based on that the major producers in Australia and Latin America export their ore to steel mills both in Europe and Asia, and that the prices in these regions seems to follow each other closely. But is that sufficient information to define the relevant market? Also, regarding the concentration levels, the Commission finds that they are too low to have any impact on the prices, even if they separate the iron ore into the three main categories. However, given the recent developments in the iron ore industry, as well as certain characteristics of the market (see Section 1), we believe that this merger case is of interest to study from a competitive view.

We will start by conducting a thorough investigation of the definition of relevant market, using shipments data, which will be compared to the outcome from the Commission's investigation. This will be followed by a simulation model, applied on the defined relevant market, where the pre-merger prices and production levels will estimate the post-merger effects on prices and production. Given that the merger has already taken place, this also provides an opportunity to evaluate the correctness of the methods applied to the actual outcome. These exercises will also generate useful information to competition authorities regarding how valid certain formal methods of defining relevant markets, as well as simulating post-merger prices and quantities, are to evaluate the welfare effects from mergers in the iron ore industry.

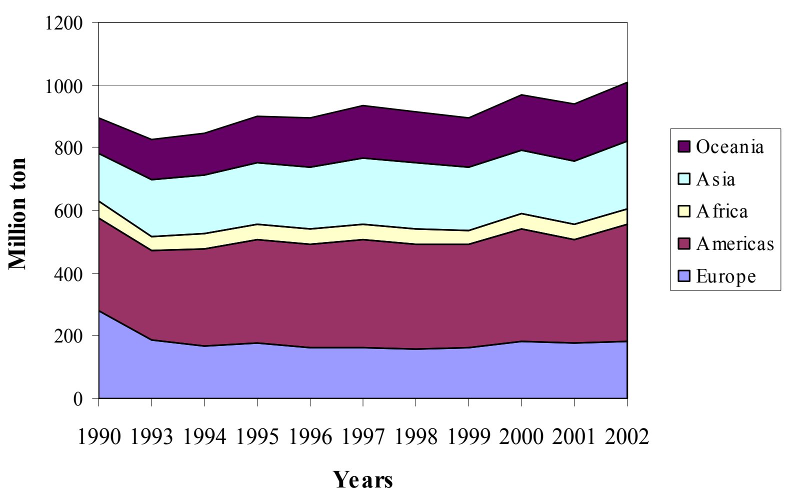
3 The Iron Ore Market and Definition of the Relevant Market

Before an analysis of the relevant market we will present the development of the iron ore industry. The presentation will be focused on 1999, since this is the year the year before the merger between Rio Tinto and North Ltd was realized. This is thus the year at which the Commission based their analysis on, and which will be the year at which we will conduct our further investigations on.

3.1 The Iron Ore Market

The world production of iron ore has increased steadily since the beginning of the 1990s and in 2002 world production exceeded 1000 Mt, an increase by 7.5 percent compared to the year before. Figure 1 shows world production of iron ore between 1990 until 2002, presented for each world region. By large, the iron ore production has followed the global economic trend, and since 1990 the increase in iron ore production has been about 12 percent. The largest growth stems from the Australian production, which has increased by about 65 percent during the same period. Other developed market economies production has though fallen by a third during this period. In 1999, which is the year of interest in this study, the world production of iron ore was 894.6 Million ton (Mt), a decrease by 2.3 percent compared to the year before (UNCTAD, 2003).

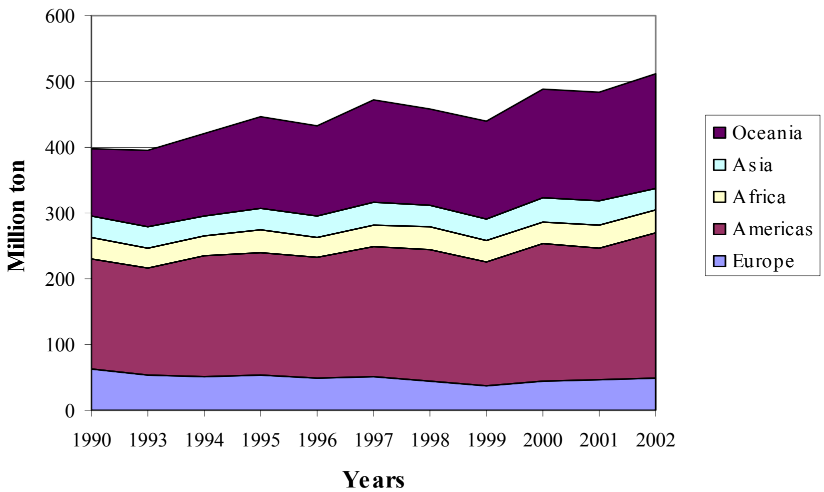
Figure 1: World Production of Iron Ore by World Region



Regarding iron ore trade we can also see an increasing trend since the beginning of the 1990s, and in 2002 exports hit a new record high at 512.4 Mt. Figure 2 shows world iron ore exports presented for each major world region. Total iron ore exports have grown more than 30 percent since 1990, showing a substantially larger increase in traded iron ore compared to iron ore production. The two dominating exporting countries in the world is Australia and Brazil, whose share is 34.3 percent and 33.2 percent respectively.

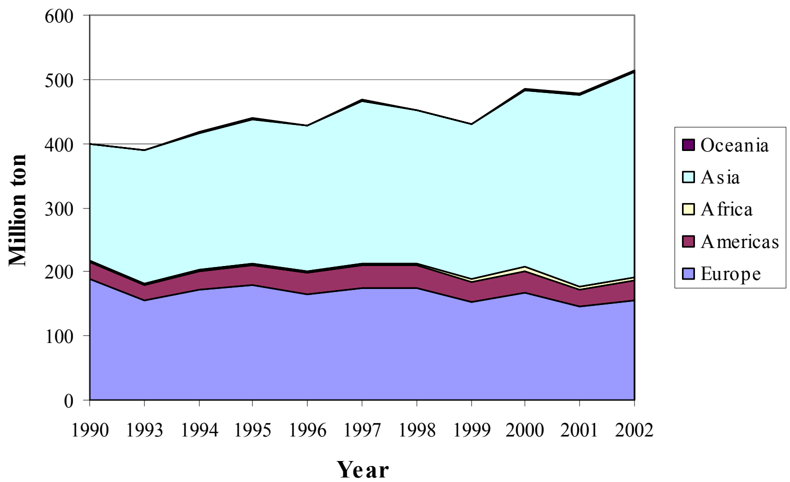
The third largest exporter in the world is India with an export of 6.1 percent, followed by Canada 5 percent and South Africa 4.7 percent. In 1999 the total world exports were 438.7 Mt, which was a decline by 4.2 percent from the year before. Regarding dominating regions, it was as well Australia and Brazil, whose share was 33.3 percent and 32.0 percent respectively this year (UNCTAD, 2003).

Figure 2: World Exports by World Region



Total iron ore imports in 2002 added up to 513.5 Mt, has also shown a corresponding strong growth since the 1990s. The world's largest importer is Japan whose share of all imports in 2002 was 25.1 percent, followed by China whose import has grown remarkably the last years reaching 21.7 percent of all imports in 2002. Korea is the fourth largest importer with a share of 8.4 percent, and total imports to Asia amounts to a remarkably 62.4 percent. The total European imports are 30.2 percent, where Germany is the largest importer with a share of 8.6 percent of total world imports of iron ore. The pattern of world imports of iron ore have changed substantially since 1990, when Europe was the dominating importing region with 47 percent of world imports. Japan was still the dominating importing country, but China's import was only 3.5 percent in 1990. Since then European imports has fallen by almost a third, and at the same time the imports to China and Korea has risen sharply making Asia the dominating importing region in 2002. In 1999, total iron ore imports were 431.2 Mt and in this year the pattern of imports were roughly the same as in 2002 (UNCTAD, 2003).

Figure 3: World imports by world region

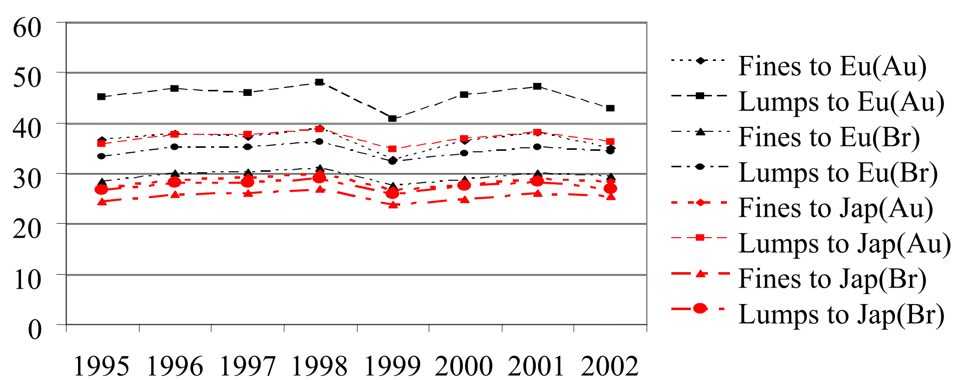


The iron ore prices are negotiated yearly between the large iron ore producers in Australia and Brazil, and the steel mills in Japan and Europe respectively. On May 29, 2002, CVRD concluded its iron ore and pellet price negotiations with Thyssen Krupp Stahl. The prices landed at 29.31 US cents/dmtu for fines, and at 47.36 US cents/dmtu for pellets. This meant a decline in the prices compared to 2001, 2.4 percent for Carajas fines and 5.47 percent for pellets. These prices set a reference for other CVRD customers. The first agreement on the Australian market was reached two days later between BHP Billiton and Nippon and Kawasaki Steel. These prices landed at 28.20 US cents/dmtu for Mt Newman fines, which is a decrease by 2.4 percent from the year before, and 36.13 US cents/dmtu for Mt Newman lump, which represents a decline by 5 percent from previous year. We can thus see that the prices in the two regions seem to have a strong effect on each other (UNCTAD, 2003).

In 1999 the corresponding prices from CVRD was 27.59 US cents/dmtu for fines, and at 46.46 US cents/dmtu for pellets. This meant a decline in the prices compared to 1998, 11 percent for Carajas fines and 13.3 percent for pellets. The Australian prices from BHP Billiton (Mt Newman) and Rio Tinto (Hamersley) in 1999 was 26.63 US cents/dmtu for fines, and 34.83 US cents/dmtu for lump. Also these prices had declined from the previous year, with 11 percent and 10.2 percent respectively for fines and lump (UNCTAD, 2003). Starting in 2000 the Brazilian producer CVRD has assumed price-leadership, and since 2001 it has concluded the first agreement. However, between 1988 and 2000 the price-leadership was held for ten times by either BHP Billiton or Rio Tinto (the two dominating Australian producers) in negotiations with steel producers.

Table 5 shows the price development for the major iron ore producers in Australia and Brazil since 1995, separated for lumps and fines, and also to which region the iron ore is directed, Japan or Europe (UNCTAD, 2003). The table shows that the price level for lumps from Australia are higher than for the other products, and also that the prices to Europe are significantly higher than the prices to Japan. We can also see that the prices follow each other very closely each year.

Figure 4: Iron Ore Prices to Europe and Japan in US cents per 1% Fe per ton



Source: UNCTAD 2003.

3.2 Defining the Relevant Geographic Market Using Shipments Data

There are a number of different ways to define a relevant geographic market. The tests that are most common to use for defining an economic market are based on either price series or shipments data. In this paper we have chosen to define the relevant market on the basis of shipments data. The motivation for this choice is primarily that prices in iron ore are negotiated yearly, and performing correlation tests or cointegration tests on yearly negotiated prices does not provide a good picture of the responses to the market demand and supply unless you have very long time series. As well, it can be difficult to identify a correct price from a producer given that they often charge different prices to different consumers (e.g. Brazilian producers charge different prices to European and Asian consumers). The shipment tests avoids the problems that can arise when using prices in market definition given that this test relies on quantity data, where it is assumed that the product flows will capture all of the fundamental demand and supply shifts that affect prices. Given the simplicity, as well as consistency with economic theory, this test have become on of the most widely used empirical methods for defining relevant geographic markets.

The EH method is based on shipments data, and its underlying assumption is that regions that trade significantly with each other belong to the same economic market. The EH method builds on two related tests suggested by Elzinga and Hogarty (1973). The tests formally calculate the interregional shipments between different areas in order to decide whether they belong to the same geographic market. The tests are; the little in from the outside (LIFO) test, and the little out from the inside (LOFI) test. The LIFO test relates to the demand side of the market, and asks whether total consumption in an identified area is also produced within the area. The LOFI test relates to the supply side of the market, and identifies the smallest geographic area needed to include almost all shipments from the defined market area. This implies that a relevant geographic market area will include all areas that either exports or imports significant amounts of the product under investigation.

The tests are only based on quantity data, and it is assumed that all necessary information about the product, such as prices and elasticities, is reflected in demand and supply behavior. It is though important to know where the shipment comes from (origin), and to where the product is transported to (destination). When the necessary data have been collected, Elzinga and Hogarty (1973) propose the following procedure. Start with a market, in the case of iron ore it could be the Brazilian market.[7] Estimate whether 90 percent (or 75 percent) of total consumption in Brazil comes from domestic production.[8] If this is the case, the LIFO test is met, and the analyst can move on to the next test. If the

---

[7] The procedure of selecting a starting point (which in this article is a country) is somewhat arbitrary. However, the authors propose using informed judgment such as either starting in a large producing area, or a large consuming area.

[8] The percentages are also arbitrarily chosen. Elzinga and Hogarty (1973) suggest that a 'strong' market implies that 90 percent of the shipments are within the market, and that a 'weak' market suggests that at least 75 percent of the shipments are within the specified market.

LIFO test is not met, add the country that is the largest exporter to the area and repeat the procedure. This continues until 90 percent (or 75 percent) of all shipments are within the defined market area. The LOFI test concludes that if at least 90 percent (or 75 percent) of the shipments from Brazil are to consumers within the area (in this case Brazil) the country constitutes an economic market area.[9] If this is not the case, add the country that most of Brazil's export is directed to and repeat the procedure. Continue until the LOFI test is met, i.e. when 90 percent (or 75 percent) of shipments are within the defined area (Elzinga and Hogarty, 1973).

According to Elzinga and Hogarty (1973) it is essential that both the LOFI and the LIFO tests are met since an exclusive reliance on, for instance, the demand side would likely define a market too narrowly. Fundamental economic theory assumes that if sales in one area affect the prices in all areas where the product is sold they belong to the same economic market. The EH method has been widely used by competition authorities in merger analysis, especially in the United States, due to the importance of geographic market definition for products where areas of production and consumption are separated. The EH method makes economic sense and is simple to apply, and has thus become valuable in practice.

However, some critique has been directed to this methodology. Capps et al. (2001) discuss the so called silent majority fallacy of the EH criteria. This fallacy concerns the potential error in relying on shipments data when there are significant differences in demand behavior within and outside the defined market area. The authors argue that markets sometimes are defined too broadly when some exports are directed out of the area. If this export does not follow the same demand pattern as that within the defined area, it is likely that they belong to different economic markets. The authors use hospital mergers as an example to show that even if some patients travel for hospital care, most patients do not, and thus the relevant market is not as broad as is often stressed.[10]

Werden (1981) identifies two situations where the method will lead to fundamental errors regarding what represents a relevant market. *First*, in a situation where there are no

[9] In the case of Brazil it is likely to assume that the LIFO test will be met, but not the LOFI test given that Brazil is one of the largest exporters of iron ore in the world.
[10] Capps et al. (2001) do however acknowledge that the silent majority fallacy is of more concern when the products under investigation are highly differentiated, regarding both location and other dimensions.

shipments between two areas, the EH test would conclude that the areas belong to separate markets. However, if the cross-elasticity of demand is high, it is not likely that the exporters in the different areas would be able to set prices independently. When this is the case, the areas do in fact belong to the same economic market. The *second* situation arises when a shipment test neglects to define a relevant market area within the defined area. Thus, the test could define the market too broadly, and thus not be able to detect anticompetitive behavior within the region. Werden notes that this problem would be avoided if the cross-elasticity of demand was known by the analyst. However, Werden recognizes that regardless of the shortcomings of shipments tests they are still helpful. Shipment tests are valuable since they provide an understanding of the product flow patterns, something which is an important part of the process of delineating the relevant market. Werden emphasizes, though, that shipments data need to be supplemented with some notion of cross-elasticity of demand in order to correctly delineate the relevant market.

3.3 Results from the EH tests

Annual data for production, consumption, import and export, for 1999 have been collected from *Iron Ore Statistics 2002*, published by the United Nations Conference on Trade and Development (UNCTAD). The test will be performed for 1999, since the merger between Rio Tinto and North Ltd took place in 2000. In the case of iron ore it seems applicable to start with the dominant exporting and importing countries when estimating the hypothetical market areas. The chosen starting points are Brazil and Australia (two large exporters) and Japan and Germany (two large importers). The reason for conducting the analysis using different starting countries is that it will illustrate if similar patterns of market integration appear regardless of the choice of starting point.

The results from performing the LIFO and LOFI tests for Australia, Brazil, Japan and Germany in 1999 are presented in Table 2. Not very surprisingly we find that the main exporting and importing countries in the iron ore market will not fulfil the EH criteria's. Regarding Australia and Brazil, it is obvious that the LOFI test is not fulfilled, since it does not reach the thresholds of either 90 percent or 75 percent. For the large importers, Japan and Germany, the opposite results arise, i.e. that the LIFO test is not fulfilled. Given this all four market areas need to be expanded in order to fulfil the EH test criteria's. In the case of Australia and Brazil we will add the country towards where the largest export is directed to, and in the case of Japan and Germany the country who is the largest exporter will be added to the defined market area.

Table 2: LIFO and LOFI test results in Mt and percentage

	Exporters		Importers	
	Australia	**Brazil**	**Japan**	**Germany**
Consumption	8	48.5	120.1	39.2
Production	153	188.7	0.1	0.1
Export	146.2	140.2	0	0
LIFO	0.85	1	0.0008	0.0026
LOFI	0.0444	0.257	1	1

Table 3 presents the results from extending the market area for Australia. The largest amount of export from Australia is directed to Japan, adding this area raises the LOFI percentage from 4.4 percent to almost 50 percent. Note that in order to calculate the LIFO and LOFI criteria's it is necessary to adjust the ratios for the amount that is exported within the market area, i.e. export from Australia to Japan is no longer part of export outside of the defined market area. The results from adding Japan to the market area shows that the LOFI test is still lower than the LIFO test, and therefore the following area to be included is China who is the second largest importer of Australian iron ore. The results from this transaction indicates that the LOFI test is fulfilled for the 75 percent level, but since the LIFO test is not fulfilled, this indicates that more countries exporting to Japan and China (and Australia) need to be included. The second largest exporter is Brazil, and when adding this country the LIFO test is fulfilled, but not the LOFI test indicating that the market area now exports significant amounts outside the relevant market area. The country that the now defined market area exports the most to is Korea, and when adding that country the LOFI rises from 66.7 percent to 73.8 percent. The next country to be added to the defined market area is Germany. The result now shows that the EH test is fulfilled at the 75 percent level.

Table 3: The Relevant Market for Australia in Mt and percentage

	Australia	Australia & Japan	A & J & China	and… Brazil	and… Korea	and… Germany
Consumption	8	128.1	294.9	343.4	378.9	418.1
Production	153	153.1	264.6	453.3	453.3	453.4
Export	146.2	146.2	146.2	286.4	286.4	286.4
X within	0	68.135	95.675	135.381	167.615	189.773
LIFO	0.85	0.5858	0.7259	0.8803	0.8829	0.8533
LOFI	0.0444	0.4901	0.8091	0.6668	0.7380	0.7869

In order to fulfil the EH test at the 90 percent level more countries have to be added. The result from this, as well as the result from the EH test for the other areas, are presented in Table 4. In the table each country added to the market area, Australia, Brazil, Japan and Germany, are presented in the order they were added on the horizontal axis. Also, the corresponding LIFO and LOFI rates are shown for the growing market areas. As we can see the countries needed to fulfil the shipments test at a 90 percent level are, France, Taiwan, Italy, India, UK, South Africa, and Belgium. The results for the four different starting areas differ only at the initial stages. All of this indicates that the two dominating exporting areas (Australia and Brazil) are not regional in scope, i.e. both areas are included in the defined market area despite the obvious presence of transport differences to the main importing countries.

Table 4: The EH test results at 90 percent

Austr:	***Japan***	***China***	***Brazil***	***Korea***	***Germ***	***France***	***Taiwan***	***Italy***	***India***	***UK***	***SA***	***Belg***
LIFO	58.6	72.6	88.0	88.3	85.3	84.1	84.0	83.4	89.9	88.7	92.3	91.7
LOFI	49.0	80.9	66.7	73.8	78.7	81.3	83.7	86.0	87.1	88.8	88.9	90.2
Brazil:	***Japan***	***Germ***	***Austr***	***China***	***Korea***	***France***	***Taiwan***	***Italy***	***India***	***UK***	***SA***	***Belg***
LIFO	43.5	44.7	79.1	84.8	85.3	84.1	84.0	83.4	89.9	88.7	92.3	91.7
LOFI	38.8	49.1	49.9	71.6	78.7	81.3	83.7	86.0	87.1	88.8	88.9	90.2
Japan:	***Austr***	***China***	***Brazil***	***Korea***	***Germ***	***France***	***Taiwan***	***Italy***	***India***	***UK***	***SA***	***Belg***
LIFO	58.9	72.6	88.0	88.3	85.3	84.1	84.0	83.4	89.9	88.7	92.3	91.7
LOFI	49.0	80.9	66.7	73.8	78.7	81.3	83.7	86.0	87.1	88.8	88.9	90.2
Germ:	***Brazil***	***Japan***	***Austr***	***China***	***Korea***	***France***	***Taiwan***	***Italy***	***India***	***UK***	***SA***	***Belg***
LIFO	77.5	44.7	79.1	84.8	85.3	84.1	84.0	83.4	89.9	88.7	92.3	91.7
LOFI	36.0	49.1	49.9	71.6	78.7	81.3	83.7	86.0	87.1	88.8	88.9	90.2

However, we can also see that rather few countries need to be added to the relevant market area to incorporate 75 percent of all shipments of iron ore. As well, when adding only 7 more countries 90 percent of the world shipments of iron ore is accounted for. This shows that a few countries dominate the shipments of iron ore in the world. Four exporting countries, Australia, Brazil, India, and South Africa, is included, and nine importing countries. This results point towards the fact that the iron ore market is not regional in scope, rather it shows that there is a world market for traded iron ore given that producers and consumers in many different world regions are added to the defined relevant market above. This definition is in line with the Commission who finds that the relevant geographic market should be considered as world wide, given that iron ore are commonly traded on a global basis. Their definition is supported by the fact that European consumption of iron ore constitutes of 90 percent imports. Also, the prices in the two main importing areas, Europe and Japan, follow each other, and the major producers in Australia and Latin America export their iron ore to steel mills both in Europe and Asia.

The following simulation analysis will be conducted on the above defined market area, i.e. producers (mines) that are located in above countries will be analyzed in order to evaluate the efficiency effects of the proposed merger. The reason for this is primarily that roughly 90 percent of the world trading countries will be incorporated for, even though the number of mines will be limited compared to a simulation when all mines in the world would be included for. It is our strong conviction that this defined market all relevant mines necessary to simulate the situation on the market after a merger have taken place.

4 Evaluating the Effects of the Merger Using Simulation Models

The basic approach in merger simulation studies is straightforward. Pre-merger price and quantities are usually easy to observe, and it may be possible to find some empirical evidence on price elasticities. Using this information, a numerical model is calibrated so that its solution equals the observed prices and quantities. This is the pre-merger equilibrium. A proposed merger would, if permitted by the enforcement agencies, imply that firms reconsider their price – or quantity – setting. Such a future situation is at present hypothetical, but the numerical model can be used to simulate the post-merger situation. After the simulation study has provided information about the possible price increase following a merger, the post-merger situation can be compared to the pre-merger situation.[11]

4.1 A Nested, Almost Ideal Demand System, with Proportionality calibration (PCAIDS)

Briefly, PCAIDS is an approximation to the Almost Ideal Demand System (AIDS) that is widely used in applied microeconomics (Deaton and Muellbauer, 1980). PCAIDS relies on a generalized principle of proportionality to reduce greatly the number of free parameters in the demand model: a price increase form a single mine results in diversion of lost sales to the other mines in proportion to their current market shares. In its most basic form, i.e. with all mines in a single nest, PCAIDS can be fully specified with two parameters: a single firm specific price elasticity of demand and the price elasticity of demand for the industry as a whole. If the market is well characterized by proportionality, this specification will yield a close approximation to the elasticities from the unrestricted AIDS. When the actual demand pattern deviates from "strict" proportionality, the approximation can be improved by adding nests to generalize the analysis.

Properly measured elasticities hold out the prospect of more accurate model calibration compared to conventional econometric modelling of pre-merger own and cross-price elasticities. The econometric approach is not well suited for many mergers because of a lack of adequate data even when strong assumptions are made about market structure to reduce the large number of parameters to be estimated. Even with relatively large datasets, the empirical results can be problematic, with wrong signs, implausible magnitudes, and low statistical reliability for the estimated coefficients.

[11] There may arise situations were the simulation procedure is not as straightforward as described. Mathiesen and Sorgaard (2000) point out two such situations. *First*, if the merger is conducted on beliefs about future competition conditions, the present situation is irrelevant for calibration purposes. *Second*, as the model is presented, it is implicitly assumed that the firms are single-goods producers and does not account for the possibility of multi-goods producing firms.

4.2 Merger simulation with PCAIDS

Merger simulation models for differentiated products typically assume that prices in the market can be analyzed using Bertrand assumptions. According to this theory, the first-order conditions (FOC) for profit maximization by each firm can be specified in terms of market shares, and price elasticities. The market is assumed to be in Bertrand equilibrium both pre- and post-merger.

There are n firms pre-merger. The ith firm controls n_i mines and there is a total of N mines operating in the relevant market. A matrix expression for all of the FOCs for profit maximization is given by

[1] $$\mathbf{s} + \mathrm{diag}(\mathbf{E_1}, \mathbf{E_2}, \ldots, \mathbf{E_n})\mathbf{S}\boldsymbol{\mu}$$

In equation [1], $\mathbf{s} = (s_1, s_2, \ldots, s_N)'$ is the vector of market shares (in terms of revenue) and $\mathbf{S} = \mathrm{diag}(\mathbf{s})$. The corresponding vector of mine margins is $\boldsymbol{\mu} = (\mu_1, \mu_2, \ldots, \mu_N)'$. For the ith firm, $\mathbf{E_i}$ is an n_i by n_i matrix of transposed price elasticities with element (k, j) equal to ε_{jk}. In the pre-merger equilibrium, the mine margins $\boldsymbol{\mu}$ are given by,

[2] $$\boldsymbol{\mu} = -\mathbf{S}^{-1}\mathrm{diag}(\mathbf{E_1}, \mathbf{E_2}, \ldots, \mathbf{E_n})^{-1}\mathbf{s}$$

Assume that the merger involves firms 1 and 2. The merged firm is characterized by an augmented elasticity matrix $\mathbf{E}^*$ for the $n_1 + n_2$ mines it is now operating. The FOCs for the post-merger market are

[3] $$\mathbf{s} + \mathrm{diag}(\mathbf{E}^*, \mathbf{E_3}, \ldots, \mathbf{E_n})\mathbf{S}\boldsymbol{\mu} = 0$$

where all variables are understood to be taken at their post-transaction values. Merger simulation consists of finding the post-merger prices that yield margins, shares, and elasticities that solve equation [3].

The solution to equation [3] depends on the functional form of the underlying demand model and a supply model that determines how total cost responds to incremental changes in post-merger output. The demand side can be modelled using a variety of specifications; the literature includes examples of linear, constant elasticity, and variants of logit and AIDS systems. The supply side is generally treated as a step-function for which incremental cost does not vary with output. The step allows for possible merger-specific efficiencies, which are analyzed by changing the level of post-merger incremental costs (keeping the assumption that the new level of incremental cost does not vary with output).

In PCAIDS each s_i is a linear function of the natural logarithms of all of the mines in the relevant market. Letting **p** be the vector of prices, the model can be written as **s** = **a** + **B**ln(**p**), where **a** is a vector of constants and **B** is a matrix of coefficients (that are assumed to be invariant to price changes). Unlike AIDS, PCAIDS does not include an aggregate expenditure term in the share equations. To proceed, differentiate each share equation totally to obtain:

[4] $$d\mathbf{s} = \mathbf{B}(d\mathbf{p}/\mathbf{p})$$

Equation [4] describes a simple relationship between the change in each mines market share (d**s**) and the unilateral effects (d**p**/**p**). The elements b_{ij} of **B** act as weights to determine the amount of share lost or gained due to unilateral effects. Moreover, as is apparent from equation [4], knowledge of the a_i terms is unnecessary. The post-merger shares for use in equation [3] are given by $\mathbf{s}^{post}=\mathbf{s}^{pre}+d\mathbf{s}$. Hence, PCAIDS is a particularly convenient demand model for merger simulation.

The post-merger own and cross-price elasticities for each mine in the market will, in general, also depend on the vector d**p**/**p** of unilateral effects. It can be shown that in PCAIDS the own-price elasticity for the *i*th mine and the cross-price elasticity of the *i*th mine with respect to the price of the *j*th are respectively (Epstein and Rubinfeld, 2002):

[5] $$\varepsilon_{ii} = -1 + \frac{b_{ii}}{s_i} + s_i\left(\varepsilon + 1\right)$$

[6] $$\varepsilon_{ij} = \frac{b_{ij}}{s_i} + s_j\left(\varepsilon + 1\right)$$

Here ε is the price elasticity of demand for the market as a whole, which is typically assumed to remain unchanged post-merger. Using the $\mathbf{s}^{\text{post}}$ vector in equations [5] and [6] yields the post-merger elasticities.

Finally, the solution to equation [3] requires updated mine profit margins. Algebraically, it can be seen that for each mine, $\mu_i^{\text{post}} = 1 - \left(1 - \mu_i^{\text{pre}}\right) / \exp\left(\mathrm{d}p_i / p_i\right)$. This relationship is independent of the demand model. This structure is sufficient to solve the post-merger FOCs entirely in terms of the predicted unilateral effects $\mathrm{d}\mathbf{p}/\mathbf{p}$.

The problem remains of finding appropriate values for the b_{ij}. PCAIDS assumes that the share lost as a result of a price increase is allocated to the other firms in the relevant market in proportion to their respective shares. In effect, the market shares define probabilities of making incremental sales for each of the competitors. We also impose homogeneity on the demand model in equation [4], i.e., $\sum b_{ik} = 0$ $\forall$k (since shares must sum to 100 percent, the model also satisfies an adding-up constraint $\sum b_{ki} = 0$ $\forall$k by definition). Homogeneity with the proportionality assumption implies symmetry of **B**, thereby satisfying Slutsky symmetry.

We allow a more general analysis of elasticity by grouping mines in nests. Proportionality governs diversion within a nest, where mines are relatively close substitutes. Mines are poorer substitutes across nests than indicated by proportionality, implying variation in the cross-price elasticities. While $\varepsilon_{ik} = \varepsilon_{jk}$ for mines in the same nest, the cross-price elasticities are (relatively) lower across nests, i.e., $\varepsilon_{mk} < \varepsilon_{ik}$ for brands *m* and *i* in different nests.

We use nesting parameters to adjust diversion away from proportionality. Share diverted to a mine in a different nest is adjusted in the following sense: the odds ratio is equal to the odds ratio under proportionality, multiplied by a nesting parameter, which lies in the interval [0,1]. For mines within a nest, the nesting parameter equals 1. The result is that mines within a nest are closer substitutes than mines outside the nest. Proportionality for all mines can be thought of as a model with a single nest. PCAIDS with multiple nests allows a more flexible pattern of cross elasticities, as the model is no longer fully constrained by the proportionality assumption.

Assume that there are w nests, $2 \leq w \leq N$, with each mine assigned to a nest. There are $w(w-1)/2$ distinct nesting parameters, denoted ω_i, arranged in a symmetric w by w matrix. In the case of three nests the matrix takes the form

[7] $$\mathbf{\Omega} = \begin{pmatrix} 100\% & \omega_1 & \omega_2 \\ \omega_1 & 100\% & \omega_3 \\ \omega_2 & \omega_3 & 100\% \end{pmatrix}$$

We generalize the determination of **B** with nests as follows. Each element of **B** can be written as $b_{ik} = \theta_{ik} b_{kk}$, where the θ's are known, but the diagonal elements b_{kk} are unknown. Impose adding-up and homogeneity. The constraints imply a system of N-1 independent equations in the N unknown diagonal elements. Without loss of generality, order the system so that b_{11} corresponds to the first mine with a known elasticity. We normalize with respect to that mine and define a vector $\boldsymbol{\beta}$ with N-1 elements equal to $b_{jj}/b_{11} = \beta_j$, $j > 1$. The equation system is then non-singular and can be written as

[10] $$\begin{pmatrix} \theta_{12} & \theta_{13} & \cdots & \theta_{1N} \\ 1 & \theta_{23} & \cdots & \theta_{1N} \\ \vdots & \vdots & \vdots & \vdots \\ \theta_{N-1,2} & \cdots & 1 & \theta_{N-1,N} \end{pmatrix} \begin{pmatrix} \beta_2 \\ \vdots \\ \beta_N \end{pmatrix} = \begin{pmatrix} -1 \\ -\theta_{21} \\ \vdots \\ -\theta_{N-1,1} \end{pmatrix}$$

Equation [10] can be inverted to solve for the $\boldsymbol{\beta}$ vector. **B** can therefore be specified entirely in terms of b_{11} and the θ's. With known ε_{11} and ε, calibration is completed by using equation [5] to solve for the value for b_{11}.

The θ's are known functions of the market shares and the nesting parameters. In general it can be shown that:

[11] $$\theta_{ik} = -s_i \frac{\Omega(\Im(k), \Im(i))}{\sum_{m \neq k} s_m \Omega(\Im(k), \Im(m))}, i \neq k$$

With strict proportionality (i.e., a single nest that contains all of the mines), the nesting parameter equals 100 percent and equation [11] reduces to $\theta_{ik} = -s_i/(1-s_k)$.

The matrix B of PCAIDS coefficients is symmetric both under strict proportionality and with nests. Since equation [10] has a unique solution, any feasible solution is also unique. The symmetric solution for **B** is that $b_{j1} = \theta_{j1}b_{11} = b_{1j} = \theta_{1j}b_{jj}$, implying $\beta_j = \theta j1/\theta_{1j}$. From equation [11] it follows that

[12] $$\beta_j = \frac{s_j}{s_1}\frac{\sum_{m\neq j} s_m \Omega(\Im(j),\Im(m))}{\sum_{m\neq 1} s_m \Omega(\Im(1),\Im(m))}$$

and from before, $b_{jj} = \beta_j b_{11}$. Equations [11] and [12] imply that

[13] $$b_{ij} = -\frac{s_i s_j}{s_1}\frac{\Omega(\Im(i),\Im(j))}{\sum_{k=2}^{N} s_k \Omega(\Im(k),\Im(1))} b_{11}$$

for $i \neq j$. Symmetry of **B** follows directly. It can be shown that the b_{ij} from equation [13] satisfy adding-up and homogeneity. They therefore comprise the unique solution to equation [10].

4.3 Model input and results

The two parameters needed to fully simulate the merger are an estimate of the iron ore industry demand elasticity and an individual mine demand elasticity. Given these two parameters the model calibrates the remaining own-price and cross-price elasticities, from which expected price changes can be derived.

At the calibration stage, an industry demand elasticity of $\varepsilon = 0.18$ (in absolute value) is used as an estimation of the elasticity of demand facing all iron ore producers. We interpret this elasticity value as the short-run elasticity for iron ore demand and it is consistent with the implied range of short-run demand elasticity values for iron ore demand reported by Chang (1994) and Heller (1997).

The Robe River mine was arbitrary chosen in the specification of a single mine specific price elasticity of demand. The Robe River demand elasticity was calculated as the ratio between the industry demand elasticity and Robe Rivers market share (in absolute value)

[14] $$\varepsilon_{11} = \frac{\varepsilon}{s_{11}} = 2.5 .$$

This is a good approximation since a high market share would indicate some degree of market power and hence make the mine less price sensitive. A low market share implies that the mine has a more elastic demand and is thus more sensitive to price changes.

If a mine increases its price it will, in various degrees, lose market share to its competitors. The distribution of the lost market share to competitors is assumed to be proportional to the competitors' market shares weighted by a nesting parameters matrix. The weights are based on an attempt to capture country specific characteristics of the iron ore and are presented in Table 5.

Table 5: Nesting Parameters Matrix

	A	B	I	S
A	100%			
B	95%	100%		
I	90%	85%	100%	
S	85%	85%	90%	100%

Note: A=Australia, B=Brazil, I=India and S=South Africa.

The data, i.e., markets shares, is compiled from the Raw Materials Data, which is a unique database on minerals and metals worldwide produced by the Raw Materials Group (RMG). The database includes information on ownership and production for each mine in the iron ore industry, which is relevant in order to perform the simulation process.

In order to reduce the number of included mines that operates in the relevant market and hence make the simulation tractable all firms with a production of less than 5 mt per year is included in the categories "Other Brazil" and "Other India" depending on location. In addition, all firms with a total production of 3 mt or less are deleted from the sample as well as all mines with a production less than of 2 mt per year. This reduces the number of included firms to 12 and the number of included mines to 48. Since the Shipment test indicates a worldwide market for iron ore the preferred approach would have been to include all iron ore mines in the world. However, this is not plausible. We have, therefore, and in addition to the production delimitation, limited the market definition to only include mines in countries that are included in the 90 percent Shipment test.

Table 6 presents the simulations results. The new company (newco) operates all merged mines and can, on average, increase its price with 5.1 percent, whilst the market weighted average price increase is 1.6 percent.

Although the predicted price increase generally decreases with the elasticities, monotonicity with respect to model inputs is not an unchanged property of the PCAIDS model. Predicted price increases for the non-merging companies illustrate the point. With an estimated industry elasticity of 0.18 (absolute value), the non-merging parties increase their prices with more when, for example, the mine specific price elasticity of demand is 2.5 than when it is 5. What drives the non-merging firms to change their prices at all is the increase in the merging parties' prices. In other words, since the non-merging parties are always reacting to the merging parties, theirs are only second order reactions. Moreover, the merging parties increase prices more when the mine specific price elasticity of demand is 2.5 than when the elasticity is 5. Based on these premises it might be expected that the non-merging companies increases their prices in direct relationship with the merging parties. Missing, however, from this intuition is the strength of the relationship between the merging parties' prices and the non-merging parties' quantities. That is, the magnitude of the non-merging parties' cross-price elasticities of demand with respect the merging parties prices. With an industry elasticity of 0.18, when own-price elasticity is relatively low (in absolute value) formal assumptions underlying the PCAIDS calibration imply low cross-price elasticities. But with increased own-price elasticities the cross-price elasticities increase manifold and greatly enhance the non-merging parties' responsiveness to a change in the merging parties' prices.

We also observe that the magnitude of the industry elasticity matters only when own-price elasticities are relatively low. As own-price elasticities approach infinity, the magnitude of price increase approaches zero regardless of industry elasticity.

The pre-merger Herfindahl-Hirschman Index (HHI) is 1240 and the post-merger HHI increase with 192 indicating an increased market concentration.

Table 6: Simulation results

Firm	Mine	Shares Pre	Shares Post	Price Change	Nest
NewCo					
	Robe River	7.2%	6.6%	6.9%	A
	Hamersley	10.7%	10.3%	4.1%	A
	Channar Mine	2.4%	2.3%	4.1%	A
	Corumba	0.2%	0.2%	3.9%	B
	Malangtoli	0.1%	0.1%	4.1%	I
Arbed					
	Samitri	3.4%	3.4%	0.6%	B
BHP					
	Yandi	4.5%	4.6%	0.8%	A
	Mt Newman	4.5%	4.6%	0.8%	A
	Germano	2.7%	2.7%	0.7%	B
	Goldsworthy	1.5%	1.5%	0.8%	A
	Jimblebar	1.2%	1.2%	0.8%	A
	Whyalla	0.6%	0.6%	0.8%	A
Caemi					
	Pico	2.6%	2.6%	0.7%	B
	Mutuca	1.8%	1.8%	0.7%	B
	Aguas Claras	1.2%	1.2%	0.7%	B
	Tamandua	0.6%	0.6%	0.7%	B
	Capitao Domato	0.5%	0.5%	0.7%	B
CSN					
	Casa De Pedra	2.4%	2.4%	0.6%	B
CVRD					
	Minas Gerais	10.9%	11.0%	0.8%	B
	Carajas	10.7%	10.8%	0.8%	B
	Capanema	1.2%	1.2%	0.8%	B
	Urucum	0.1%	0.1%	0.8%	B
Iscor					
	Sishem	4.9%	5.0%	0.6%	S
	Thabazimbi	0.7%	0.7%	0.6%	S
Other Brazil					
	Itaminas	1.3%	1.3%	0.6%	B
	Socoimex	1.1%	1.1%	0.6%	B
	Mannesmann	0.4%	0.4%	0.6%	B
Other India					
	Sesa Goa	1.1%	1.1%	0.7%	I
	Noamundi	1.0%	1.0%	0.7%	I
	Dempo Mining	0.7%	0.7%	0.7%	I
	Joda East	0.5%	0.5%	0.7%	I
	Chowgule	0.4%	0.4%	0.7%	I
	Velguem Surla	0.3%	0.3%	0.7%	I
	Mineira Nacional	0.3%	0.3%	0.7%	I
	Other	1.3%	1.3%	0.7%	I
State of India					
	NMDC	3.2%	3.2%	0.7%	I
	Kudremukh	1.4%	1.4%	0.7%	I
	Dalli	1.4%	1.4%	0.7%	I
	Megahahatuburu	0.9%	0.9%	0.7%	I
	Rajahara	0.9%	0.9%	0.7%	I
	Kiriburu	0.8%	0.8%	0.7%	I
	Gua	0.7%	0.7%	0.7%	I
	Bolani	0.5%	0.5%	0.7%	I
	Barsua	0.3%	0.3%	0.7%	I
	Kalta	0.2%	0.2%	0.7%	I
	Manoharpur	0.1%	0.1%	0.7%	I
Thyssenkrupp					
	Fabrica	3.8%	3.9%	0.7%	B
	Feijao	1.0%	1.0%	0.7%	B

5 Conclusions

The purpose of the paper is to analyze the price effects from a merger in the iron ore industry. Shipment tests (Elzinga-Hogarthy test) suggest that the relevant market for iron ore is not local or regional in scope, rather it is worldwide. The 90 percent shipment test includes all major producing countries with significant net export of iron ore.

Estimated price changes are in line with observed price changes. The observed mine price change in 2000 were higher for the Australian mines compared to the rest of the world. Taken together with the similar simulation results this indicates a good approximation by the simulation model.

The new merged company can, as an effect from increasing market share, increase their average price by 5.1 percent while all companies operating in the relevant market only increase their average price by 1.6 percent as a consequence from the merger. The difference in price changes between the merged mines and the remaining are striking. On average the non-merging mines increase their price by a moderate 0.7 percent due to spill over effects.

The predicted, or estimated, price changes are sensitive to own-price elasticities of demand. The value of the demand elasticity depends, in turn, on the time allowed between a change in price and the resulting change in quantity demanded. If the competition authorities adopts a relatively long-term view then it would be logical to consider relatively higher values of elasticities then used in this paper.

The price increase the merged firms can exercise indicates that it has obtained a larger degree of market power. Moreover, the market concentration, as measured by the Herfindahl-Hirschman Index (HHI), suggests a 15 percent increase in the market concentration. While the HHI is not a comprehensive measure of market concentration and market power it is widely accepted and commonly used. The U.S. Merger Guidelines states that, with per-merger HHI in the range between 1,000 and 1,800 points is of concern if the HHI increase is above 100 points. The simulation results therefore suggest that some caution regarding the competitive effects is warranted.

References

Capps, C.S., D. Dranove, S. Greenstein, and M. Satterthwaite (2001). *The Silent Majority Fallacy of the Elzinga-Hogarty Criteria: A Critique and New Approach to Analyzing Hospital Mergers.* Working Paper 8216, National Bureau of Economic Research, Cambridge, Massachusetts.

Case No. IV/M.470 – Gencor/Shell (1994). *Regulation (EEC) No 4064/89 Merger Procedure, Article 6(1)(b) Non-Opposition.* Office for Official Publications of the European Communities, Date: 29/08/1994.

Case No. IV/M.660 – CRA/RTZ (1995). *Regulation (EEC) No 4064/89 Merger Procedure, Article 6(1)(b) Non-Opposition.* Office for Official Publications of the European Communities, Date: 07/12/1995.

Case No. Comp/M.2062 – Rio Tinto/North (2000). *Regulation (EEC) No 4064/89 Merger Procedure, Article 6(1)(b) Non-Opposition*. Office for Official Publications of the European Communities, Date: 01/08/2000.

Chang, H-S. (1994), Estimating Japanese import shares of iron ore. *Resources Policy*, 20(2):87-93.

Crooke, P., L. Froeb, S. Tschantz and G. Werden. (1997). *Properties of Computed Post Merger Equilibria*. Draft: Vanderbilt University, Nashville, Tennesse.

Deaton, A., and J. Muellbauer. (1980). An almost ideal demand system. *American Economic Review*, 70:312-326.

Elzinga, K.G., and T.F. Hogarty (1973). The Problem of Geographic Market Delineation in Antimerger Suits. In *Antitrust Bulletin*, Vol. 18, pp. 45-81.

Epstein, R., and D. Rubinfeld. (2002). Merger simulation: A simplified approach with new applications. *Antitrust Law Journal*, 18:883-919.

Epstein, R., and D. Rubenfeld. (2004). Merger simulation with brand-level margin data: Extending PCAIDS with nests. *Advances in Economic Analysis & Policy*, 4(1):1-26.

Ericsson, M. (2002). Are Mergers and Acquisitions Really Working for the Mining Industry? In *LME Week supplement,* 2002.

Ericsson, M. (2002). The Iron Ore Industry at the Forefront of Global Mining Consolidation. In *Journal of Mines, Metals and Fuels,* 2002.

Farrell, J., and C. Shapiro. (1990). Horizontal Mergers: An Equilibrium Analysis. In *American Economic Review*, 80, 107-127.

Froeb, L., and G. Werden. (1996). Simulating the Effects of Mergers among Non-Cooperative Oligopolists. In *Computational Economics and Finance: Modeling and Analysis with Mathematica,* ed. H. Varian. New York: Springer-Verlag.

Hellmer, S. (1997). *Competitive strength in iron ore production*. Luleå University of Technology, Doctoral Thesis 1997:03.

Kirk, W. (2002). Mining Annual Review 2002: Iron Ore. In *The Mining Journal*, 2002.

Mathiesen, L., and L. Sorgard. (2000). *Simulating the Effects of an Acquisition in the Ferry Market*. Working Paper, Norwegian School of Economics and Business Administration, Department of Economics.

Röller, L-H., J. Stennek and F. Verboven. (2000). *Efficiency Gains from Mergers*. Working Paper no.543. The Research Institute of Industrial Economics.

Raw Materials Group (2002). *Raw Materials Data.* Database produced by: Raw Materials Group, Stockholm, Sweden, www.rmg.se.

SBC Warburg Dillon Read (1998). *Global Iron Ore Review – A Commodity for the Long Haul.* Issued by Swiss Bank Corporation.

UNCTAD. (2003). *The Iron Ore Market 2002-2004.* Trust Fund Project on Iron Ore Information, Geneva.