THE EVOLUTION OF THE IRON ORE PRICES AND THE IRON ORE PRODUCTION SINCE 1940[1]

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Abstract
The main purpose of this paper is to analyze the evolution of the iron ore international prices on the long run. In this sense, we analyze figures of iron ore ocean trade prices, figures of iron ore production and world exportations (ocean trade in iron ore), and the evolution of iron ore world reserves. To identify changes in the industry, we look at the main players' strategies such as investments, production, conventions of price, acquisitions and mergers. We also discuss the main reasons of the iron ore price increases as, for example, the evolution of world income and the evolution of iron ore demand, and the changing nature of the iron ore market structure (market concentration, prices conventions, barriers to entry and so on).
Key words: Iron ore prices; Iron ore production; Iron ore ocean trade market.

A EVOLUÇÃO DOS PREÇOS E DA PRODUÇÃO MUNDIAL DE MINÉRIO DE FERRO DESDE 1940

Resumo
O principal objetivo do trabalho é analisar o comportamento dos preços internacionais do minério de ferro a partir do pós-guerra. Nesse sentido, analisamos dados históricos de preços internacionais do minério de ferro, dados históricos anuais da produção, do consumo aparente e do nível de reservas mundiais. Analisamos ainda informações qualitativas sobre as principais empresas produtoras (investimentos, produção, convenções para a fixação de preços, fusões e aquisições), procurando identificar mudanças na estrutura da indústria. Discutimos em que medida as flutuações do preço internacional do minério de ferro são explicadas, de uma parte, pela evolução da renda mundial e pelo comportamento da demanda dos produtores de ferro primário (sobretudo ferro gusa), e, de outra parte, pelas mudanças estruturais do mercado mundial de minério de ferro (concentração, formação de preços, modalidades de contração, barreiras à entrada etc).
Palavras-chave: Mercado de minério de ferro; Produção de minério de ferro; Preços internacionais de minério de ferro.

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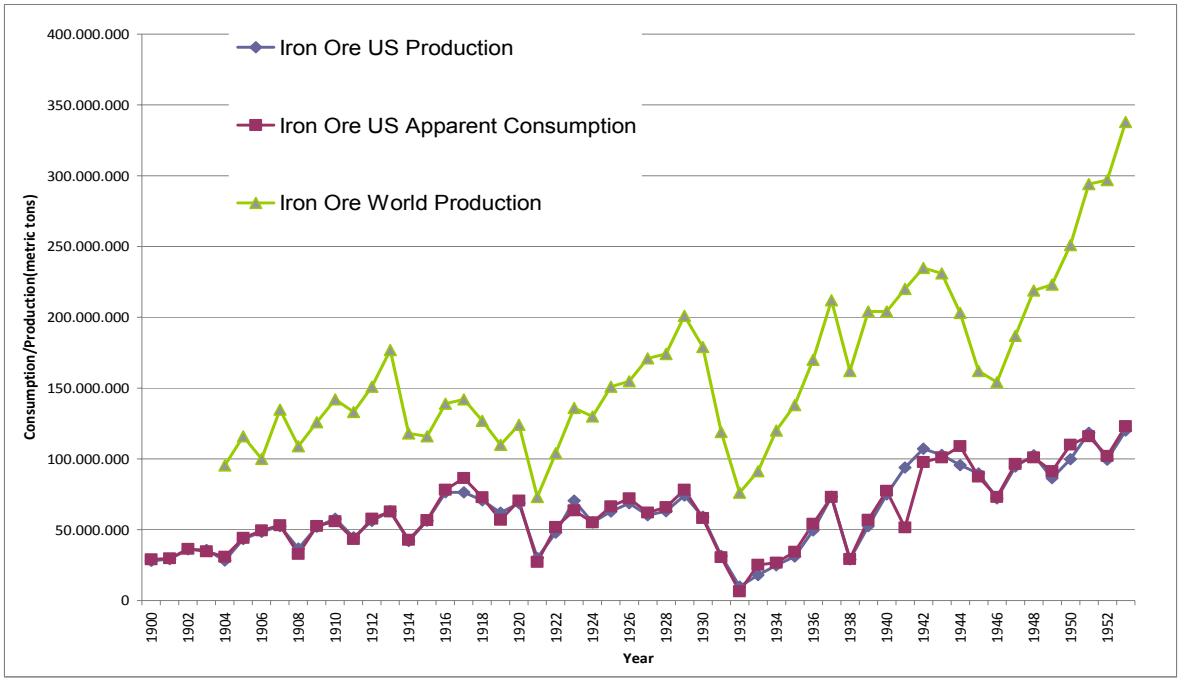
1 INTRODUCTION

In the last years, the increase of mineral commodities prices has been the centre of attention. In the spite of the recently spot prices and the long term contract prices explosion, before 2002 several ore prices there were almost frozen. For example, the iron ore composite price in the USA market had been so brought down since 1983, that, in the beginning of 21st century, it was at the Great Depression level. Perhaps, these later prices moved up above their historical average level in 2006, and, since 2008, they have increased up above their highest quotations in the 70's.
Why are the iron ore prices so high? Obviously, analysts put lights on the excess of demand and in the market concentration as the drivers of prices' rise. Are those reasons the main factors of the heavy increase of prices after the Second World War and in the seventies? Will a context of the demand slow down and a simultaneously rise of the supply, like a expansion of ore production and a reduction of market concentration of the iron ore supply in the next years (Greenfield Mine Explorations by Trading Companies and Iron and Steel Groups) change that cycle of increased prices?
Actually, we do not intend to fully answer these questions. Although, we think that we will learn with the past, if we intend to predict what will happen in the future.
The development of the iron ore international market is a recent event. In fact, in the first half of the twenty century, the United States was the major steel and pig iron producer and the other main steel producers were a small number of European countries (Germany, United Kingdom, France, Belgium-Luxembourg, Italy, Sweden), the USSR and the Japan.



Source: USBM, United States.

Figura 1. US and World Iron Ore Production, US Apparent Consumption – 1900- 1953.

At the beginning of the last century, the steel works in the North America and in the Western Europe (the Lake Superior region and the Lorraine French region, riches in iron ore deposits, and the industrial region centered in the valley of the Ruhr, rich in

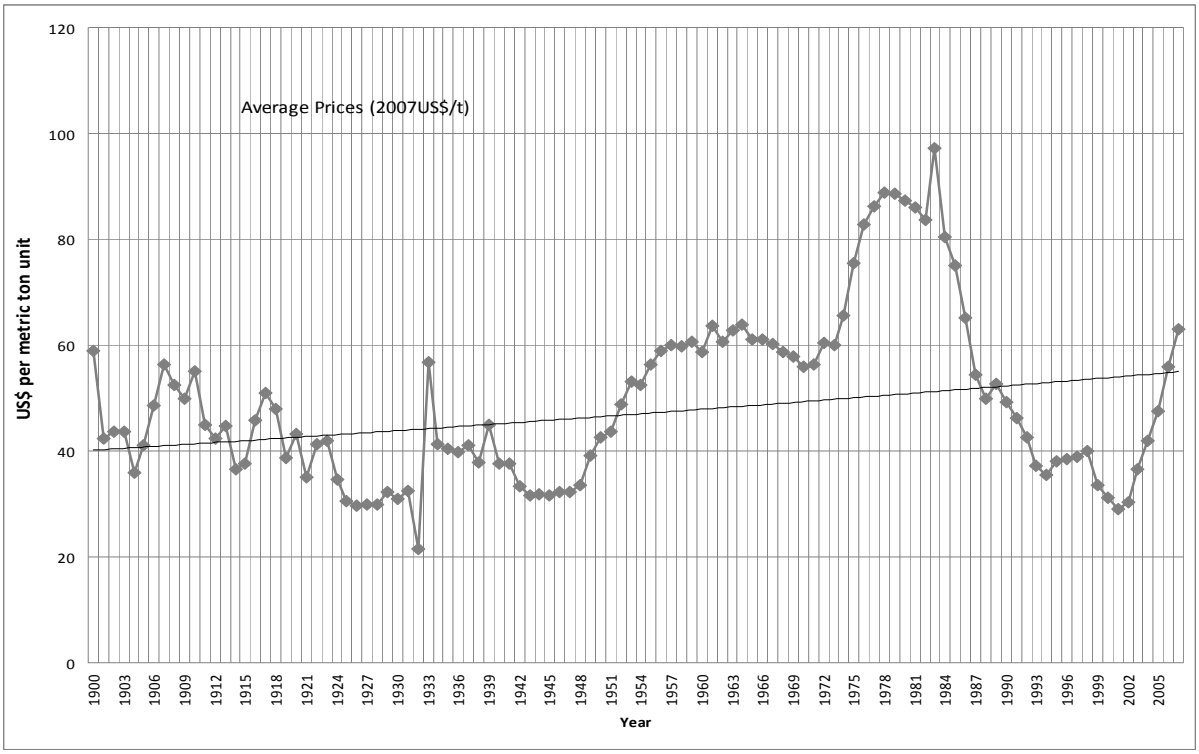
bituminous coal deposits, for example) were located near to ore resources and the regional market provided the iron ore supply. There were the exporter countries, mainly Sweden, more than 50% of the ocean trade in 1937, followed by Chile – a minor player[1], but, as the Figure 1 shows, in this period, the United States was almost self-sufficient in the iron ore supply.
Despite this picture, a speculative rise of ore price in the 1905-1910 period engaged western big companies in a course of iron ore reserves by acquisition of the mineral property rights and the building of Greenfield projects, financed by venture capital. On account of the World War I and, after, on the Great Depression, many of these projects didn't work. We can quote the well known case of Itabira Iron Ore Company in Brazil. This ambitious project (mine, steel works, railroad, port) was never started, on one hand, because of shut down of steel demand, and on the other hand, as a result of nationalist movement that placed the national control of the iron ore exploration in the center of the emergence of the iron and steel industry in the country, as a piece of an industrialization strategy.[2,3]
In the second section, we describe our methods. In the third section, the main results are presented. Roughly speaking, we draw a picture of the evolution of iron ore prices, production and world exportations, show some figures of the demand side (steel and pig iron production, and changes in the world income level) and of the market concentration. In the fourth section, the results are examined and, in the fifth section, some conclusions and some future work issues are presented. Acknowledgements and references will be presented in the sixth and seventh sections.

2 MATERIAL AND METHODS

In this paper, we discuss statistical figures extracted from several sources. Our main sources were the United States Bureau of Mines (US Geological Service), the Australian Government (Bureau of Mineral Resources Geology and Geophysics), and the Brazilian National Department of Mineral Production (DNPM), the International Iron and Steel Institute (IISI) and the main iron ore producers (CVRD, BHP Billiton and Rio Tinto). These sources were completed by gathering information from academic works. Sometimes, the figures are not directly comparable and we had to do a careful work to put them in a similar standard.
Our figure analysis is mainly a descriptive statistical analysis, which is completed by historical and qualitative analysis. We intend to make a more analytical analysis in a future work.

3 RESULTS

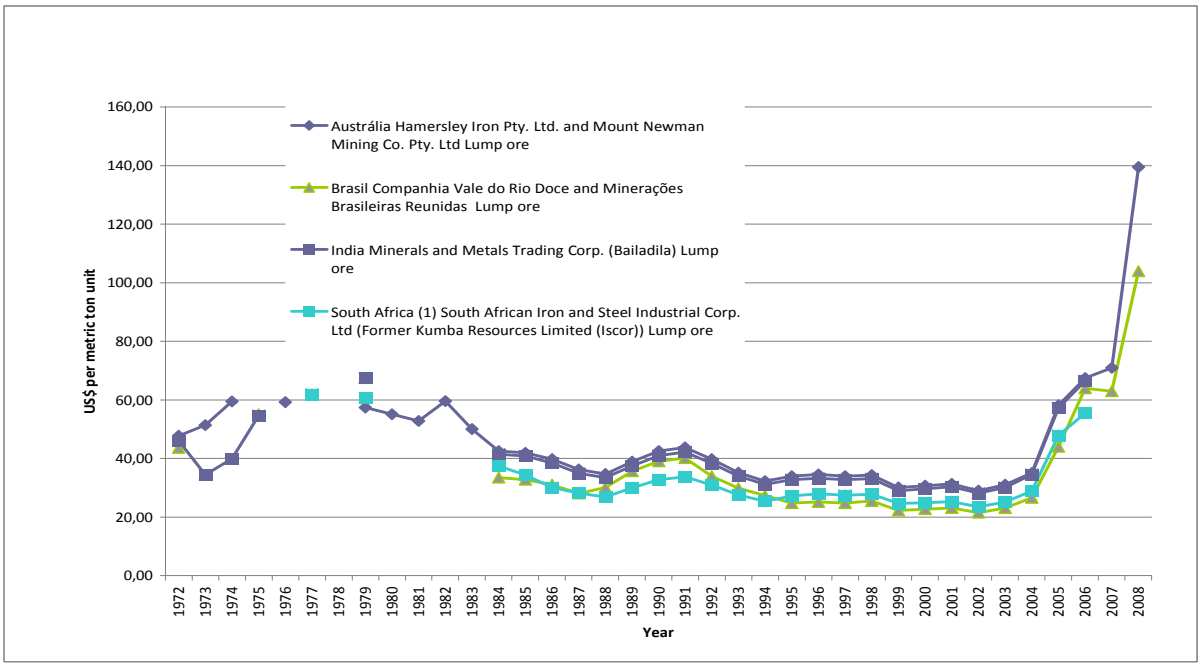
Figure 2 offers us an idea about the cyclic behavior of iron ore price over a long period of time. As already observed, there are three big cycles of high prices, which are, the early 20th century, the Golden Age (1947-1973) which reach its peak in the end of the 70's, and the recent rise of ore prices after 2002. Actually, this graph gives us an approximate idea of the phenomenon, because it is the US average price f.o.b. at mines, which does not reflect the price in the ocean iron ore trade market for several reasons: these are c.i.f. prices in the domestic market; some mines belong to steel companies (in sourcing strategies and added price); mining producers sometimes are sheltered by protection measures, etc.



Source: USBM, United States.

Figura 2. Average Iron Ore US Prices (fob at US Mines) – 1900 to 2007.

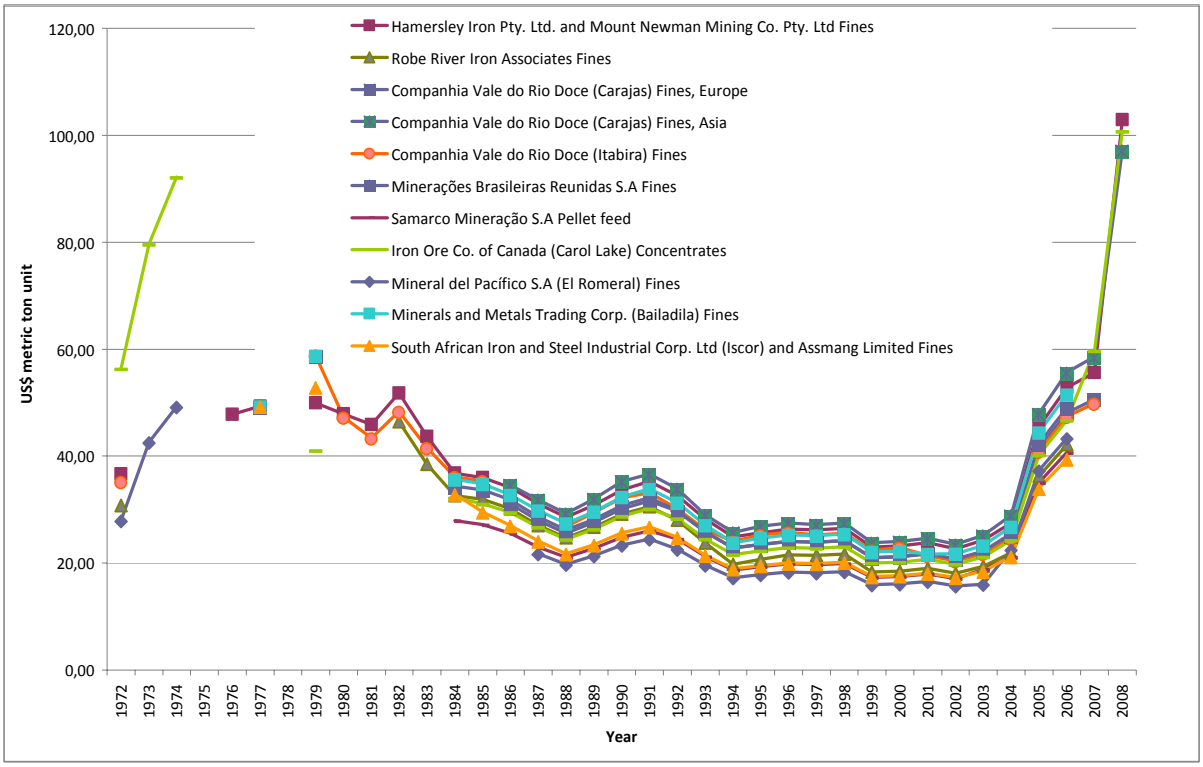
Therefore, it seems more appropriate to observe directly the international values. Those, on the other hand, present at least two inconveniences: first, it is difficult in the case of iron ore, to obtain a time series long enough; and, second, these are the price quotations, not the current prices.



Sources: Trust Fund Project on Iron Ore Information, The TEX Report, Iron Ore. Manual 2006. USBM. BMRGG-Australia. Companies. Financial Times. Steelonthenet.com. IMF.

Figura 3. The Japanese fob Contract Lump Ore Prices (Fiscal Year, US$/metric tons)-1972-2008

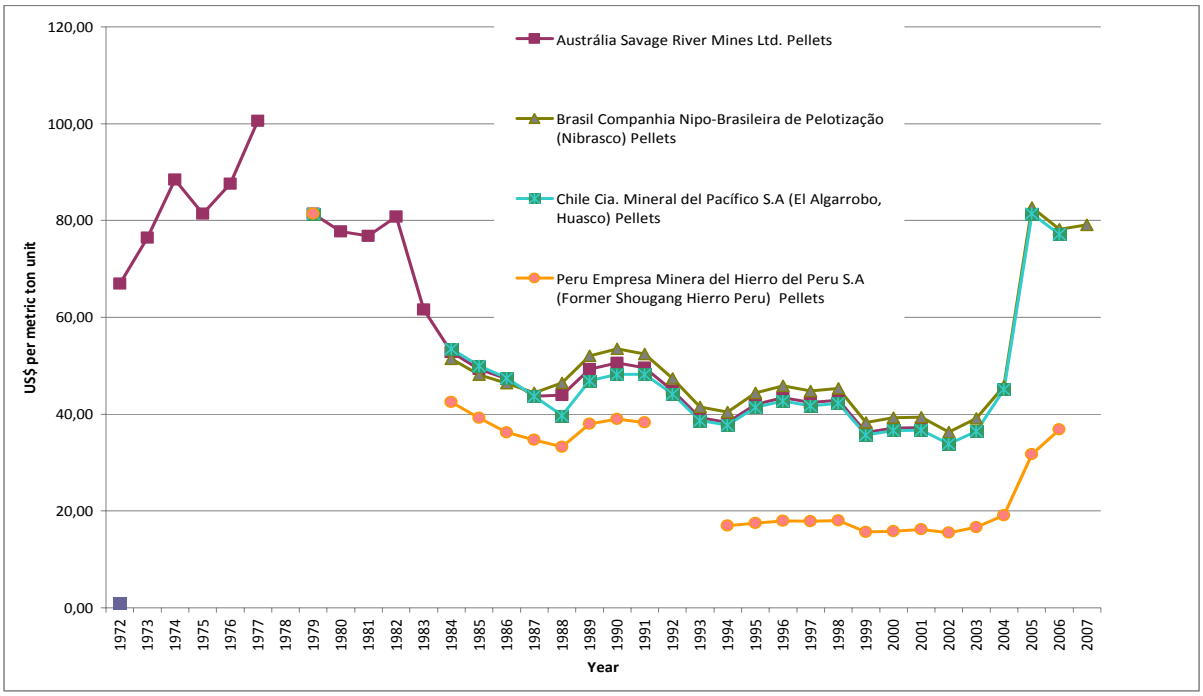
The first inconvenience can be partially solved, observing data like the ones from the USA, which allows us to visualize the tendency of prices. The second inconvenience is, generally, compensate by the process of price formation in the iron ore industry. This is well known, since the emergence of the ocean market after the World War II, an annual convention of price guides iron trade. Usually, before April, an important player (sometimes the greater) in the iron ore market negotiates a quoted price with an important steel producer, and the others suppliers follow the price as a norm. For example, in the 1978-1986 period,(4) the price was fixed by agreements between the BHP and the Japanese steel producers. Later, CVRD (Brazil) takes the place of BHP and, more recently, Chinese steel producers (especially Baoosteel Company) takes the place of the Japanese producers.



Sources: Trust Fund Project on Iron Ore Information, The TEX Report, Iron Ore. Manual 2006. USBM. BMRGG-Australia. Companies. Financial Times. Steelonthenet.com. IMF.

Figura 4. The Japanese fob Contract Fines Prices (Fiscal Year, US$/metric tons) -1972-2008

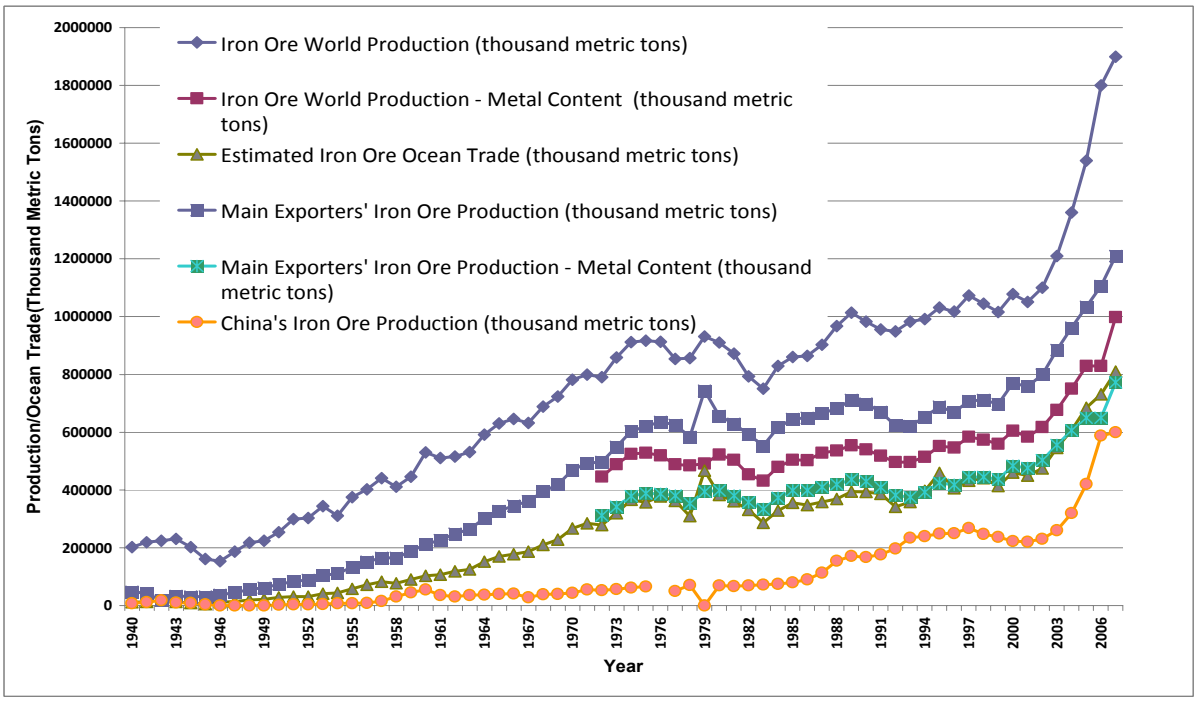
In the iron ore market, as usual, the trade of ores is organized by physical attributes of ore (the size of natural or processed ore particles and their iron content). The more frequent forms of iron are lump ore, fines and pellets. In the domestic trade iron content may vary from 30% to 67.5% of iron content, the range depends on the characteristics of country's reserves. In the foreign trade, for obvious reasons, just the high grade ones are traded. The figures 3, 4 and 5 display price figures for the lump ore, fine ores and pellets in the called 'Japanese Market' – today chiefly a 'Chinese Market'- from 1972 to 2007-2008. Here, these quoted contract prices, usually exhibit in cents of American dollars for 1% of iron content (long dry ton unit), are expressed in US$ for metric ton unit. It is interesting to say, after the speculative wave of the end of the 70's, followed by two decades of depressed prices (about 20-25 dollars for lump ores and fines, and 40 dollars for pellets), the 21st century meets an unprecedented rise of iron ore prices.



Sources: Trust Fund Project on Iron Ore Information, The TEX Report, Iron Ore. Manual 2006. USBM. BMRGG-Australia. Companies. Financial Times. Steelonthenet.com. IMF.

Figura 5. The Japanese fob Contract Pellets Prices (Fiscal Year, US$/metric tons) -1972-2007

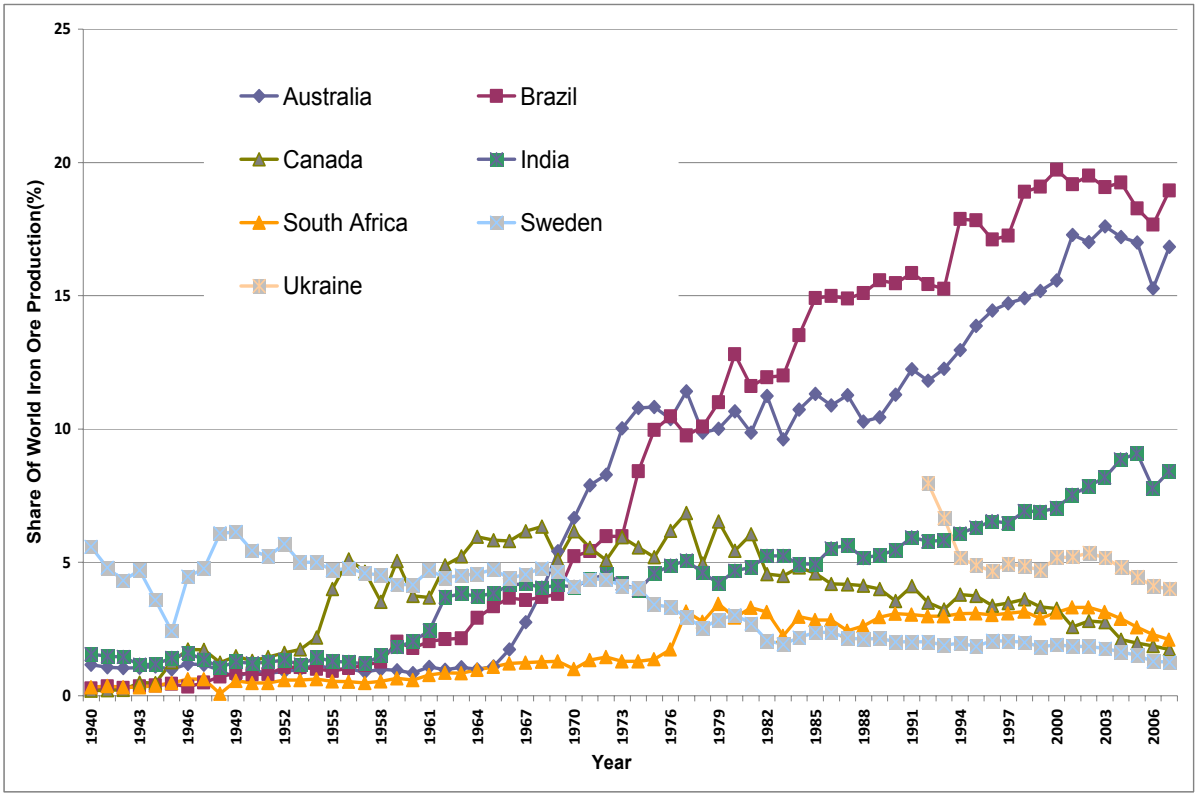
After two peaks in April 2005 and even in April 2008, the iron ore prices are at a level that had never been experienced since the beginning of the 20th century. In fact, the quotations as 100US$/ton for high grade fines is an unparalleled event, as the same 140US$/ton quoted for lump ores.



Source: USBM

Figura 6. Iron Ore World Production and Iron Ore Ocean Trade – 1940 – 2007

Figure 6 describes the emergence and the development of the iron ore ocean trade since the end of the World War II to present. For a long time stabilized at 400 million tons, today, foreign iron ore trade may be estimated at 800 million tons, almost a half of the world's iron ore production. In recent years, iron ore production has grown in China, notwithstanding the low iron content of its deposits (30% of ore on average) due to the fast and to the great increase in the Chinese production of pig iron and steel, and, in Australia and Brazil, known as the greatest exporters and also known for their greatest high grade iron ore reserves (Figure 7 and Table 1).



Source: USBM

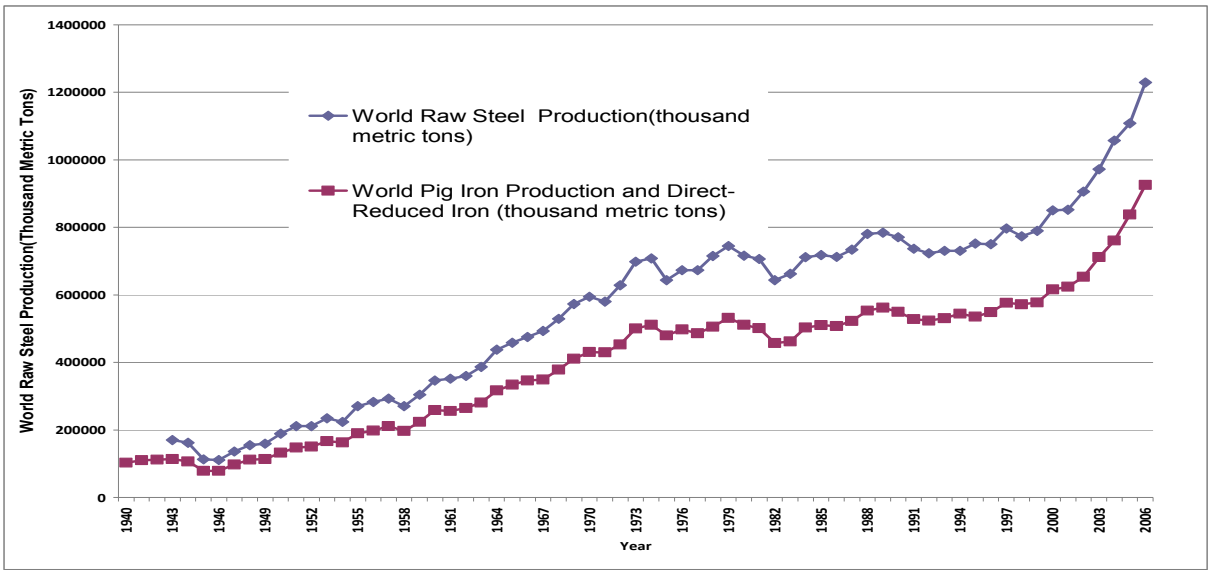
Figura 7. Iron Ore Production Shares of the Main Iron Ore Exporters – 1940 – 2007

On the one hand, the Australian-Brazilian global production share grew from 11.89% (1970) to 35.79% (2007). On the other hand, the Brazilian's reserves (the part of the reserve base which, actually, could be economically extracted at the present day) on crude ore are of 23 000 million metric tons and they are of 16 000 million metric tons on iron content, the greatest in the world by iron content criteria. Perhaps, Australia also has great reserves and India, which suddenly increased its share in the world production, has high grade deposits too. Early important exporters like Canada and Sweden have high grade ores (Figure 7 and Table 1).

Table 1- Iron Ore World Reserves of Crude Ore and of Iron Content– 1977, 1995, 2006.

Country	Crude ore (million metric tons)						Iron content (million metric tons)				
	Reserves		Reserves Base				Reserves		Reserves base		
	1995	2006	1977	1995	2006		1995	2006	1977	1995	2006
United States	16 000	6 900	17 273	25 000	15 000		3 800	2 100	4 409	6 000	4 600
Australia	16 000	15 000	17 781	28 000	40 000		10 000	8 900	13 007	18 000	25 000
Brazil	11 000	23 000	27 230	17 000	61 000		6 500	16 000	19 841	10 000	41 000
Canada	12 000	1 700	36 578	26 000	3 900		4 600	1 100	13 228	10 000	2 500
China	9 000	21 000	6 096	9 000	46 000		3 500	7 000	3 307	3 500	15 000
France	2 200		4 064	2 200			900		1 984	900	
India	5 400	6 600	9 145	12 000	9 800		3 300	4 200	6 834	6 300	6 200
Liberia	900		1 422	1 600			500		772	800	
Sweden	3 000	3 500	3 353	4 600	7 800		1 600	2 200	2 425	2 400	5 000
Russia (Former U.S.S.R.)	64 000	25 000	110 547	78 000	56 000		24 000	14 000	34 171	29 000	31 000
Venezuela		4 000	3 251		6 000			2 400	1 874		3 600
Mauritania	400	700		700	1 500		200	400		300	1 000
South Africa	4 000	1 000		9 300	2 300		2 500	650		5 900	1 500
Iran		1 800			2 500			1 000			1 500
Kazakhstan		8 300			19 000			3 300			7 400
Mexico		700			1 500			400			900
Ukraine		30 000			68 000			9 000			20 000
Others	7 400	11 000	22 048	16 000	30 000		2 300	6 200	11 243	6 300	17 000
World Total	150 000	160 000	258 790	230 000	370 000		65 000	79 000	113 096	100 000	180 000

Source: USBM



Source: USBM

Figura 8. World Pig Iron and World Raw Steel Production – 1940 – 2007

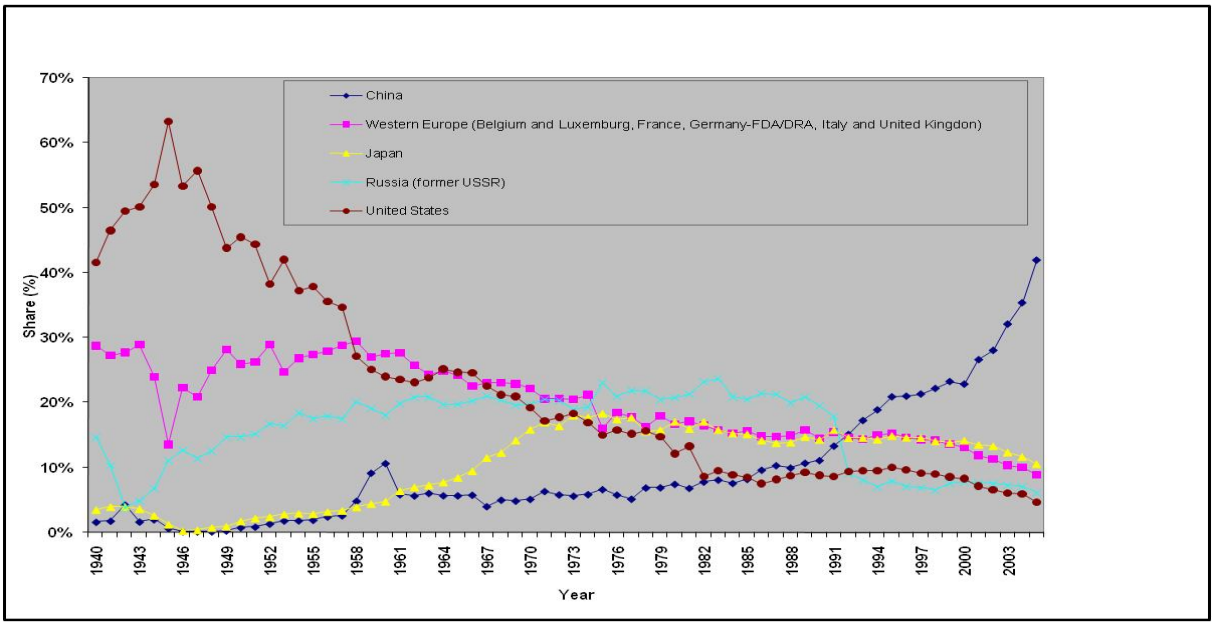
Certainly, the 'China phenomenon' explains the high expansion rate of the steel and pig iron production, which increased almost 50% between 2001 and 2006 (Figure 8). Roughly speaking, China is for the world's iron and steel production today as the United States were in the Golden Age (Figure 9). However, it is not much more of the same. Chinese average annual increase rates of iron and steel production is faster than the American ones in the past. Additionally, the Chinese GDP average annual increase rate (about 10%) over 1981-2006 period is exceptional and the Chinese Per Capita GDP is very low - in spite of its significant improvement in the last years (Table 2). In this sense, we also realize that a country's hegemony in the iron and

steel production does not let us ignore that the iron and steel production was much more concentrated in the past than it is today (Table 2).

Table 2- Selected Countries Average Shares (Pig Iron and Raw Steel Production), Selected Countries Average Annual Increase Rates (Pig Iron and Raw Steel Production, and GDP) and Selected Countries Per Capita GDP – 1949-2006 (selected years).

Countries by GDP	Average Share of Raw Steel Production (%)						Average Share of Pig Iron Production (%)				
	1949-1971	1970-1980	1981-1985	1986-2001	2002-2006		1949-1971	1970-1980	1981-1985	1986-2001	2001-2006
1st -20th	94,44%	89,84%	82,82%	77,34%	81,72%		92,81%	90,32%	83,79%	78,61%	84,11%
21th - 40th	5,29%	7,69%	13,29%	9,83%	8,26%		6,96%	7,31%	12,67%	8,80%	6,34%
41th +	0,28%	2,47%	3,88%	12,83%	10,02%		0,23%	2,37%	3,54%	12,59%	9,55%
Countries by GDP	Average Increase Rate of Raw Steel Production (%) times World Share						Average Increase Rate of Pig Iron Production (%) times World Share				
	1949-1971	1970-1980	1981-1985	1986-2001	2002-2006		1949-1971	1970-1980	1981-1985	1986-2001	2001-2006
1st -20th	5,59%	1,40%	0,02%	1,53%	7,05%		5,30%	1,16%	0,01%	1,62%	7,72%
21th - 40th	0,63%	0,48%	0,36%	-0,02%	0,59%		0,81%	0,42%	0,29%	-0,04%	0,21%
41th +	0,04%	0,14%	0,19%	-0,07%	0,34%		0,03%	0,08%	0,16%	-0,07%	0,29%
Total World	6,26%	2,02%	0,58%	1,45%	7,98%		6,13%	1,66%	0,45%	1,51%	8,22%
Countries	Average Share of Raw Steel Production (%)						Average Share of Pig Iron Production (%)				
	1949-1971	1970-1980	1981-1985	1986-2001	2002-2006		1949-1971	1970-1980	1981-1985	1986-2001	2001-2006
United States	30,85%	17,74%	12,11%	11,82%	9,12%		29,68%	16,22%	9,96%	8,65%	5,49%
Japan	7,31%	20,50%	14,80%	13,35%	10,70%		6,62%	16,95%	16,10%	13,81%	11,08%
China	2,32%	3,89%	5,89%	11,79%	26,87%		4,28%	6,14%	7,84%	16,33%	32,89%
Countries	Average Annual Increase Rate of Raw Steel Production (%) times World Share						Average Annual Increase Rate of Pig Iron Production (%) times World Share				
	1949-1971	1970-1980	1981-1985	1986-2001	2002-2006		1949-1971	1970-1980	1981-1985	1986-2001	2001-2006
United States	0,94%	-0,18%	-1,00%	0,16%	0,17%		0,79%	-0,33%	-1,03%	0,05%	-0,12%
Japan	1,02%	0,50%	0,14%	0,04%	0,21%		1,05%	0,38%	0,03%	0,05%	0,16%
China	0,30%	0,29%	0,41%	0,86%	5,78%		0,54%	0,31%	0,49%	1,25%	6,70%
Countries	Average Annual Increase Rate of GDP (%)						Average Income, Per capita GDP by Country (US$)				
	1949-1971	1971-1980	1981-1985	1986-2001	2002-2006		1949-1971	1970-1980	1981-1985	1986-2001	2002-2006
United States	NA	3,26%	3,23%	3,13%	2,93%		NA	28701	31049	37233	43334
Japan	NA	4,46%	3,09%	2,28%	1,90%		NA	17869	20925	43205	37404
China	NA	6,22%	10,72%	9,49%	10,02%		NA	661	622	825	1699

Source: IISI, USBM, United Nations.



Source: USBM

Figura 9. World Pig Iron Production, Shares by Main Producers – 1940 – 2007

4 DISCUSSION

After 1940, the two great cycles of price increase (1972-1977 and 2002 to the present) are usually associated with a rapid increase on iron ore demand. Actually, the picture is more complex. Although the demand side is very important, we can not overestimate this side of the problem.

In the 70's, USA and Western Europe increase rate fell suddenly and quickly, in spite of the growing of the Japanese economy, which keeps the leadership in the iron and steel industry. To understand prices behavior in this period, QUARESMA (1987)[5], as others authors, also discusses market concentration although he puts emphasis on the country production concentration then on companies' market share concentration. In a context of increased demand for iron, it is interesting to note: the rise of iron ore price in the 70's was driven by the contractor of a traditional exporter (Sweden), by timing to start up new plants (Mining Companies and in sourcing strategies of major European and Japanese Steel Producers in Brazil and Australia), and by a progressive process of concentration in the iron ore industry.[6,7] In the precedent period (1940-1970), there was a loss of concentration, which encouraged a true race to iron reserves in the 60's due to the economic grow. Today's three major players were created (Rio Tinto and BHP operations in Australia) or became a bigger player (CVRD) in this decade brought out by the discovery of greater and high grade reserves in Australia (Pilbara Region) and Brazil (Carajás Region). At the same time, new mining companies were established or the old ones started new projects in Australia (Robe River e Goldsworthy) and in Brazil (MBR, FERTECO, SAMITRI). On the one hand, the growth and the future leadership of Australian mines are intrinsic associated with long term arrangements with the Japanese iron and steel industry. On the other hand, the Brazilian iron ore industry development was due to State (CVRD) and in sourcing strategies of European (ARBED, Thyssen Group) and Japanese iron and steel industries.[8,9]

In spite of the stagnation of the industry, in the last two decades, the iron ore industry became more and more concentrated. The major players emerged through a process of successive mergers, acquisitions and joint-ventures. BHP moved to acquisitions of shares in Australia (Goldsworth) and Overseas (Waipipi, SAMARCO), Rio Tinto (former CRA) made the same (Rober River) and the State Owned CVRD consolidated its control under resources in Brazil. In the beginning of 21st this process was consolidated and, for example, CVRD was almost a monopolistic producer in Brazil, which controls MBR, FERTECO, SAMITRI, SAMARCO (50%); and BHP had increased its shares at Goldsworth and had merger with Billiton. On the other side, Rio Tinto had increased its shares at Robe River and also had bought the Iron Ore of Canada.[10-12]

It is hardly to dissociate the context of recent increased prices to the greater concentration of iron ore market, when the ocean trade market share of the three big players is estimated at around 75%.[13] At the same time, the demand side is not absent. However, our preliminary results indicated that, usually, the GDP rate is greater than the pig iron and raw steel rates and it has been true even in the Chinese experience since the 80's (see Table 2, above). Here, we do not develop income-elasticity for iron ore demand; it is interesting to note, QUARESMA (1987)[5] presented some income-elasticity estimations for the iron ore demand at around 0.9.

5 CONCLUSION

Finally, we summarize some conclusions. The first one is more obvious: the present iron ore prices rise is an unprecedented event. The second one: the high prices of ore usually happen in a context of increasing iron and steel industry dependence on the overseas trade. Perhaps it happens over a Chinese leadership in steel industry in a manner quite different from that which happened over the Japanese leadership in the iron and steel in the 70's. The third one: the two greater movements of price increase in the iron industry after the World War II were preceded by important market concentration.
For future research work we envisage some questions as follows. Will the iron ore industry present, in the next years, as in the beginning of 80's, an oversupply and will the prices shoot down because of the Greenfield Plants and the increased capacity in the Brownfield ones? Will an overcapacity be created by a cut in increase rate of world income? How much does income elasticity of iron ore demand vary on average income country level (Per Capita GDP)? What are the limits of the prices rise? Will the continuous rise of the iron ore price turn in a profit squeeze in the iron and steel industry?

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