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An Economic Model of the Iron Ore Trade

by

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Abstract

Iron ore is among the biggest, non-energy extractive industry in the world in terms of value, and the biggest in terms of the volumes of cargo it channels in international trade. Two key characteristics of the iron ore market are central to its study: firstly, there is only a small number of buyers and sellers; and secondly, there is a great degree of interdependence among buyers and sellers and both groups are aware of this interdependence. For buyers, security of supplies is crucial. For sellers, long-term commitment from importers is essential in order to maintain the long-run viability of mining projects. Since the 1960s, long-term contracts have been, and still are, the main vehicle used in international iron ore trade.

Under the light of the above peculiarities of the iron market, a non-competitive analytical framework is adopted. This thesis proposes an alternative profit maximising behaviour different to the solutions offered by oligopoly and bilateral monopoly theorists. In this case, the importer enters negotiations with complete knowledge of his own minimum acceptable price, a possible idea of his partner's maximum acceptable price and also an idea (which can be held with varying degrees of certainty) of what alternative suppliers may be able to offer. This will restrict the range of prices over which negotiations take place and will mitigate the bargaining power of the seller. A buyer is likely to act in a similar manner, knowing that the seller has alternative export outlets, but he can also use other bargaining tools to achieve a better deal. A quite common tool is the promise of long term commitment through the signing of contracts, acquisition of equity stakes in mines or provision of financing facilities.

The behaviour of the trading partners in such an oligopoly/oligopsony (or bilateral oligopoly) environment is also studied empirically with a relatively simple and tried econometric technique, borrowed from consumption and investment theory and applied for the first time for all top iron ore importers, who collectively have accounted for approximately 90% of world trade in the last 35 years. The model performs well in most cases and reveals: firstly, different results from previous research in the case of Japan; and secondly – and most importantly – substantial differences in the way Far East and West European importers behave.

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I. Background and Characteristics of the Iron Ore Industry

I.1 Introduction

Of all the non-fuel extractive industries in the world, iron ore is probably the biggest, in terms of volume, and among the most widely traded. In the last 20 years, iron ore production has fluctuated between 800 million and 1 billion tonnes (Bmt), with some 400 million tonnes (Mmt) channelled to international trade. With the exception of crude oil, the only other commodity generating such volumes of trade is coal. The iron ore trade provides employment to a large part of the world fleet of bulk carriers vessels, particularly vessels of the 'Capesize' class, with dead-weight capacities of over 100,000 tonnes. Despite the widespread movement of iron ore around the world, its study has not attracted a great degree of interest from academic sources. Most of the analytical and modelling work in the extractive industries has (understandably) concentrated on energy resources (particularly oil) and then on copper and other base metals, where the analysis focuses on the finished product rather the raw material.

Iron ore is of course the feedstock of the steel industry and has only negligible uses elsewhere. As such, it is driven by the steel industry which, in its turn, is driven by the general level of economic activity and industrial production. Steel production is a widely spread manufacturing industry, both in developed and developing countries. Among the biggest traditional producers are the United States, Japan, and a group of dominant West European producers. However, the 1980's have witnessed the spectacular growth of new market entrants, including South Korea, Taiwan and China, which assumed an important role alongside other developing producers such as Brazil and India. Despite this seemingly competitive structure of the iron ore industry, its true structure is somewhat more complicated. On the supply side there is only a handful of countries that generate the majority of exports. Likewise, on the demand side a similar degree of concentration also exists, with relatively few importing agencies negotiating on behalf of the steel manufacturers they represent.

It is evident that the perfectly competitive analytical framework is far from appropriate to analyse the economic structure and dynamics of the sector. Oligopoly economics seem appropriate, and are extensively reviewed in chapter II, in order to build a more suitable analytical framework. Traditional oligopoly theory, however, tends to be one-sided and focuses primarily on production, whilst assuming that oligopolists face the aggregate demand of 'many', 'powerless' consumers, who are essentially price takers. As a result, their attention focuses on the reactions of their competitors, not their clients. To overcome this shortcoming, it is necessary to adopt a more suitable market scenario, that of a bilateral monopoly. Although not entirely fit for the case of iron ore, this framework provides useful insights in the ways that mutually dependent and equally powerful economic agents behave when transacting with each other. The learning from this theory is then expanded to accommodate more than one such agents on both the demand and the supply sides.

As a result of the imperfect structure of the iron ore market and the degree of concentration on both demand and supply, procurement strategies have traditionally favoured long-term ties between producers (mines) and consumers (steel mills). In the 1950's and 1960's the strategy favoured by many steel mills in industrialised countries was to hold substantial equity stakes in mines both at home and abroad, in order to ensure a steady flow of supplies. Since the 1970's, when Japanese steel mills became a dominant purchasing force, long-term contractual arrangements have become the most common procurement strategy in the iron ore market. Chapter III focuses on the structure of such contracts and then focuses of the development of Japanese[1] long-term contracts between steel mills and mines in Australia, Brazil and India, which provide the majority of Japan's iron ore needs.

The central part of this thesis is contained in chapter IV, where an economic model of the iron ore industry is constructed on the basis of developing and improving the theoretical mechanisms suggested in literature. The second part of that chapter is dedicated to ascertaining the degree of interdependence between

[1] The choice of Japan was dictated by the amount of publicly available information on long-term contracts.

exporting and importing partners through the construction of a partial adjustment model looking at the allocation behaviour of the world's major importers during the period 1962 to 1996.

Finally, chapter V focuses on the interpretation of the results of the econometric tests and links them to the theoretical model put forward in chapter IV.

I.2 Economics of Mineral Resources

Iron ore is one of a number of metallic ores which are produced on a large scale around the world. Metalliferous ores and processed metals are known to have been traded since antiquity, but iron ore is a relatively recent entrant in the international trade scene.

Before focusing on the supply and demand characteristics of iron ore, however, I will take a look at the economics of non-fuel mineral resources, which will set the framework for the discussion of the iron market.

I.2.1 Supply Determinants

Like other minerals, metals are classified as exhaustible – or non-renewable – natural resources. The central concept behind the supply of mineral commodities is the determination of a feasible rate of extraction, which will neither deplete the resource too quickly nor leave it unexploited for too long. Let's start at the beginning, however.

I.2.1.1 Extraction

The first stage of mineral supply is the extraction of the metal-bearing ore. This depends on a number of factors, ranging from geological conditions to the market price of the commodity.

I.2.1.1.1 Geological Conditions

The geological formation of the mineral-bearing area determines the extent and quality of reserves. Large proved reserves are necessary for any mineral project to even begin, as the whole process takes a long time and is extremely capital intensive. In fact, long lead times – normally more than four years – are characteristic of mineral projects and the process of turning a mere suspicion of possible reserves into a fully fledged ore-producing unit consists of several consecutive phases[2]:

- exploration for economic concentration of the mineral;
- evaluation of mineralisation during exploration;
- discovery;
- evaluation and feasibility study of discovery;

- construction of the mine, which can be an open or an underground pit;
- mining of the ore;
- ore processing and refining;
- distribution of the ore to the final markets.

At the exploration stage the aim is to collect as much information as possible at the lowest possible cost. The techniques usually employed include aerial surveys and geochemical sampling, and these will provide a first indication of mineral concentration in an area. Once geological anomalies indicate possible mineralisation, more precise – and costlier – methods are used to determine the extent and quality of reserves.

These methods include more frequent sampling and a more detailed geological mapping. The precision of the mapping will be verified by drilling the prospect – a technique identical to wildcat drilling in oil exploration. When adequate samples have been tested and indicate, with a satisfactory degree of certainty, that the project has the required size and quality characteristics, it is registered as a discovery.

The next stage is to carry feasibility studies regarding the development of the project. This will include plans about the development of underground or open-pit mines, and the design of a proper transport network to transfer the ore from pit to

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[2] Trocki, L.K. (1990), op.cit.

consumption point. Another issue that is increasingly taken into account is the effect of the mining project on the flora and fauna of the area, so that landscaping is now an integral part of many new ventures.

Once all the studies are in place, and finance has been arranged, the project enters the developmental stage. This includes the purchase of capital equipment and the hiring of labour in order to construct the mine and put in place all the accompanying infrastructure. This stage might take 1-2 years to complete, assuming that there are no major natural obstacles to overcome.

The procedure does not end, however, with the extraction of the mineral. The raw material is usually processed before leaving the country of origin[3], and then has to be transported from the processing plant to the export terminal. From there distribution is usually the responsibility of the metal fabricator, but this can vary from case to case.

The above description is applicable for a project starting from scratch – a so-called *greenfield* project. Not all mining ventures are greenfield, however. In fact, they are classified into several categories:

- ancient mines, which have been mined for several centuries;

[3] Crushing is usually the minimum, while further processing might also take place, like pelletising in the case of iron ore.

- previously mined deposits, which were abandoned in the past, but are now redeveloped, perhaps with the introduction of new technology;
- expansions, which are attached to already existing mines;
- previously known mineralisations, which have been known in the past but have never been drilled or defined;
- previously known deposits, which have been drilled and defined, but were not previously mined because they were considered of inferior quality;
- greenfield discoveries, which are projects starting from scratch, as was discussed before;
- related discoveries, which are usually brought to light soon after major greenfield discoveries.[4]

I.2.1.1.2 Technology

Technology does, of course, play a great role in determining the rate of extraction and the degree to which probable reserves turn into proven reserves. In fact, technology might even make the difference in reaching the decision to develop a project. One particular area where technology plays a crucial role is transport. A typical example of this is found in the history of iron ore: exports of the raw commodity jumped in the 1950s and 1960s with the introduction of larger vessels which made economical the transportation of that relatively cheap commodity, over long distances.

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[4] Trocki, L.K. (1990), op.cit.

Improvements in mining technology are also important, especially when underground excavation is used. Technological advances, for example, changed the face of coal mining, from a labour-intensive to a capital-intensive production process. Technology is also the parameter that might make some – previously uneconomical – reserves worthwhile exploiting.

Metals can also be manufactured from recycled material. In fact, scrap may be an important source of *secondary* supply for some metals (e.g. aluminium), and may originate from the manufacturing process of crude metal or metal manufactures (*manufacturing* scrap), or from obsolete final products (*recycling* scrap), like aluminium from cans, and steel plate from car bodies and ships. Advances in technology affect the extent to which metal supply originates from primary or secondary sources. In the aluminium industry, for example, it is actually quite cost effective to recycle while, in the steel industry, technological advances in the electric arc furnace allow steel to be produced entirely from scrap material.

Technological advances may also alter the way production is organised in metal manufacturing, which affects in turn the way mineral supply responds to new manufacturing procedures. We will see in more detail how the advent of 'mini-mills' has affected the way the steel industry has restructured its supply contracts with mineral producers.[5]

I.2.1.1.3 Economic Conditions

Geological and technological conditions alone do not determine the decision to develop a mineral resource. Several economic parameters come into play, and these include capital and labour intensity, the cost of inputs, and the price of the extracted ore itself. The cost of capital and labour – the fixed and variable production inputs – together with the specific geological conditions, determine the final combination of these inputs and the shape of the production curve. Assuming that the producing firm has the objective of maximising its profits, production will expand until marginal cost equals marginal revenue from the sale of the commodity.

The main drawback of the analysis used before is that it is, by definition, static. When dynamic price determination is of importance, a number of additional considerations enter the model, such as the nature of long- and short-term supply of production inputs, and the way these inputs are phased into production.[6] As was discussed before, mineral production is a large scale process, which requires several years to set up, in order to run it at the minimum possible cost. As a result,

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[5] Note, however, that technological progress was not the only reason for change; economic conditions played an even more important role.

[6] For example, short term supply of labour tends to be more inelastic than long term supply. In the short term it is difficult for management to hire and fire as needed due to the strong objections that are likely to be raised by miners' unions. At the extreme, such inflexibilities can be

any decision to alter production fundamentals cannot be implemented immediately; a number of time lags intervene between the decision to change production and the actual change itself. Labys[7] lists three different types of lags:

> "...(1) an implementation lag [1-2 years], which is the time lag between a change in price and the reaction by decision makers; (2) a technological or developmental lag [1-4 years], which is the time required to place new mining capacity into full production; and (3) an exploration lag [≥ 4 years], which is the time between the decision to explore for new deposits and the utilisation of the deposits in production."

The existence of so many lags implies that the response of supply, to changes in prices, is rather slow. As a result, supply conditions remain fairly stable for long periods and simply absorb – rather than react to – demand changes. Hence, capital-intensive low-variable-cost mines prefer to continue operating under unfavourable prices, as long as operating costs are covered. Such a behaviour, for example, has been observed in the copper market, whereby copper producers prefer to hold inventories when prices are low, and ration supplies when prices are high, in order to sustain short-term price stability.

Despite any attempts for price stability, however, long-term price trends cannot be ignored. Supply will eventually have to adjust to any structural changes of demand. The problem, however, is that with total lead times of well over 6-8

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extended for many years, as evidenced by the long and painful experiences of West European coal mines, which had to be drastically downsized due to poor competitiveness years, the effect of new projects coming into production could be devastating to a market much different from what it was when the project began. One such example of a new mining project that was heavily criticised for its bad timing was the Carajas project, a massive iron ore development in the north of Brazil. Production from that project was added to international iron ore supply at a time when prices were under immense pressure. In fact, the market depression was so severe that several steel mills in West Europe and Japan had to cancel liftings of the ore which were specified in their contractual obligations with mines around the world.

Finally, supply decisions are very much affected by the economic objectives set by the mining company Profit maximisation is a central assumption in the classical supply model, but other objectives – like employment, foreign exchange earnings, etc. – may assume greater importance.

I.2.1.1.4 Resource Ownership and Concentration in Supply

Until know I have looked at considerations facing the individual producer of the metallic ore. It is often, however, that production and investment decisions are dictated by the structure of the industry, its participants, and the degree of concentration of supply. Mineral projects require substantial capital investments, which impose an entry barrier for new participants. The firms which are already in

[7] Labys, W.C. (1980), op.cit.

the market are few and large and their commitment is imposed by the level of exit costs. Similar considerations arise in the case of metal manufacturers, who also tend to be large in size and vertically integrated. With this kind of operational constraints it is not surprising that in most mineral and metal markets, power is concentrated in the hands of a few countries or companies.

In many cases governments – especially in developing countries – are largely involved in the development of mining projects, because they view them as an integral part of their economic development plans. In doing so, they tend to assume a majority stake in such projects, in order to retain control of the foreign exchange earning capacity of the mining operation.

Of course ownership concentration in the hands of a few companies only gives rise to oligopolistic – or in some extreme cases, in the past, even monopolistic – behaviour. The copper industry in the United States, for example, has been scrutinised for price-setting oligopolistic behaviour; their aluminium industry was monopolised by Alcoa at the beginning of the century, before the company was broken down – much like what happened to Standard Oil. Oligopolistic behaviour doesn't always imply collusion among suppliers; firms might be following the pricing decisions of one of the bigger firms (although not necessarily the biggest), which becomes the market leader. One such example is the case of U.S. Steel, the largest North American steel manufacturer, which often assumes a price-setting role, with the remaining steel manufacturers following suit.[8]

One should note, however, that the mere existence of just a few producing firms doesn't necessarily imply oligopolistic behaviour. Sometimes demand structure has a considerable bearing on suppliers' behaviour. In the market for iron ore, for instance, procurement of imports is often undertaken by private or government agencies representing a country's steel manufacturers; this effectively creates a monopsony in the particular country and, if imitated by other importing countries, an oligopsony on a global basis. The situation then becomes much less clear, but it certainly puts a lot more pressure on suppliers to behave competitively.

I.3 Iron Economics

Iron is the most widespread of all metals. It is used almost invariably in the form of steel, which is present in almost every aspect of our everyday life. The buildings we live and work in; the cars we drive; the electrical appliances we use; the drills to extract oil; the machines we construct to manufacture new goods – all are made of, or contain, steel because of its strength and flexibility. As Fish (1995) puts it:

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[8] This behaviour is also called *signalling*. See, for example, Martin, S. (1994; p. 157) where the case of U.S.Steel is described.

"Steel is a material essential for the modern world. The industrial revolution would not have been possible without the development of iron and steel."

Iron, however, is not a new metal; its use has been widespread for several thousand years.[9] It was the development of technology that could produce it cheaply and in large quantities which made it indispensable for the industrial revolution.

I.3.1 Physical Characteristics

Iron – or *ferrum* as it is known in Latin – is a magnetic, malleable, greyish white metallic element. In the periodic table of elements its symbol is *Fe;* it has a specific gravity of 7.86; it melts at 1,535°C; it boils at 2,750°C; and it loses its magnetic properties at about 790°C. The metal exists in three different forms: ordinary, or α-iron (alpha-iron); γ-iron (gamma-iron); and δ-iron (delta-iron). The internal arrangement of the atoms in the crystal structure of the molecule changes in the transition from one form to another. Iron is an allotropic element, i.e. each of its forms has different physical properties. Allotropy and the difference in the amount of carbon taken up by each of the forms play an important role in the formation, hardening, and tempering[10] of the steel.

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[9] The earliest specimen known today, a group of oxidised iron beads found in Egypt, dates from about 4000 BC.

[10] Tempering is the process of bringing steel to proper hardness and elasticity by heating after quenching.

Chemically, iron is an active metal. It combines with fluorine, chlorine, bromine, iodine, sulphur, phosphorus, carbon and silicon. It burns in oxygen to form ferrosoferic oxide – Fe_3O_4. When exposed to moist air, iron becomes corroded, forming a reddish-brown, flaky, hydrated ferric oxide, commonly known as rust.

Iron is one of the most abundant elements, estimated to make up about 4.6% of the earth's crust. It is very rare for metallic iron to appear in free form; instead, it is most frequently found in chemical compounds, i.e. ores. In general, grades of iron ore around the world range from 30% to 65% Fe. The principal ferrous ores are:

- hematite (Fe_3O_4), which is the most common and, in its pure form, contains 70% iron;
- magnetite (Fe_2O_3), which when pure contains about 72%;
- limonite ($HFeO_2$);
- ilmonite ($FeTiO_3$);
- siderite ($FeCO_3$), containing about 48% iron;
- pyrite (FeS_2), containing 47% iron; and
- taconite, containing 15-35% iron

The first four oxides are the most widely used iron ores. Pyrite – an iron sulphide – is the least common because of the difficulty in extracting the metal from the compound. Taconite is the ore with the most impurities, and has to be beneficiated and agglomerated before it can be used; some North American ores are taconites and this is where pelletisation has been heavily used. Beneficiation and agglomeration are going to be discussed in the following section.

Sometimes, iron ore deposits also contain valuable minerals of copper, titanium, phosphorus, vanadium, cobalt and, occasionally, even gold and silver. In the past, gold has been recovered from iron ore operations in Minas Gerais in Brazil; copper, cobalt, minor accounts of nickel, and unspecified amounts of gold and silver occur in the ore at Hierro, Peru.[11] Therefore, it is common for the ores to be processed before they leave their origin in order to recover any of the above metals.

I.3.2 Supply Determinants

Iron is a metal which can be found in almost every country around the world. The problem is that it may be found in quantities which are too small, or formations which are too impure, to exploit. In North America, taconite formations are found in the Mesabi range in the Lake Superior region. Most North American iron formations contain 30% or more total iron, 60-80% of which is economically recoverable.

Better quality iron formations are found in South America, especially Brazil. Brazilian *itabirites* are usually richer in iron content; the term was applied

[11] Bolis, J.L. and J.A. Bekkala (1987), op. cit., p. 9.

originally in Itabira, Brazil, to a high-grade massive specular hematite ore (66% Fe), and is now used to describe formations in which ore is present in thin layers of hematite, magnetite, or martite. Iron ore may also be present in river bed deposits, such as the Robe River deposit in Australia; or in manganiferous or titaniferous compounds, like the ores found in Canada, India and New Zealand. Before we look at individual countries, however, we need to discuss in more detail the production characteristics and initial processing of iron ore.

I.3.2.1 Iron Ore Processing

As we have seen, iron is abundant and can be found in a variety of compounds. However, not all ores can be used directly for the iron-making process. Plain, unconcentrated iron ore as it leaves the mine, is classified as *crude ore*. If this ore can be used with minimal crushing and screening, it is considered as *direct-shipping ore*. This is also frequently known as *lump ore* and refers to any relatively unbeneficiated product, with granules generally sized between 6 and 30mm.

Usually, however, most ores need to be *beneficiated*, i.e. processed until a considerable part of the *gangue*[12] has been removed and their iron content improves. Hematite and magnetite are concentrated by means of magnetic

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[12] Non-metallic part of the ore.

separators. Other ores, however, are concentrated by screening or flotation. In all cases, the products of the beneficiation process are called *concentrates*.

After beneficiation, the ore has the proper iron content, but may not be suitable yet for use in the blast furnace, because the size of the ore particles is too small.[13] At this stage, iron ore is usually known as *fines*, a term which refers mainly to the size of the ore granules, and is very important because it affects the usability of the ore in the blast furnace.

Most iron ores with a particle diameter of less than -inch must be agglomerated. *Agglomeration* is a process in which small particles are combined to produce larger, permanent masses. There are two principal types of agglomerates – sinter and pellets.

Sinter is produced by firing a mixture of fine ore, lime or limestone, and coke on a moving horizontal grate. The result is a rather brittle product, suitable for blast furnace feed, but sensitive to handling and transportation; this is the reason why almost all sintering facilities are located next to steel mills.

Pellets are the product of a process whereby very fine iron ore (pellet feed) is rolled into 'green'[14] pellets, using bentonite[15] as a binder, and then fired at 1,250-

[13] If the ore is too fine it cannot be fed in the blast furnace, because it 'chokes' it and results in lower recovery rates of pure iron at a higher cost.
[14] i.e. unfired.

1,350°C in a furnace to produce the final indurated product. Pellets are normally between 9-16mm, with less than 5% below 5mm; have excellent burning characteristics and, hence, are ideal for blast furnace feed; and are also resistant to handling and transportation, which is why pelletising plants are usually located near mines.

Pelletising normally yields products of at least 60% Fe content, with the average being 65% Fe. The process was originally used in the United States and Canada as a means of recovering more iron from the low-grade taconite ores that were available domestically. North America still possesses the largest pelletising capacity in the world, with some 90 million tons. In free-market economies, Brazil and Sweden have considerable facilities, while the former Soviet Union has a staggering 80 million tons of pelletising capacity in place.

I.3.2.2 Iron Ore Producers

The face of the iron ore industry has changed dramatically since the beginning of the 20th century. Until the 1950s most of the iron ore used in Europe was produced domestically – mainly in France, Sweden, Spain and Germany. As domestic reserves were depleted and post-war reconstruction multiplied the need for steel, iron ore had to be imported from abroad, often over long distances. In North America, the United States and Canada have traditionally been important

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[15] A type of clay.

producers of iron ore, but most of their output is consumed domestically, or channelled in intra-regional trade. South America rose to prominence after the 1950s, especially Brazil and Venezuela.

The former Soviet Union and China remain the world's largest producers, but only a very small fraction of their production finds its way in the international market. Because of the domestic absorption of Chinese production, Australia emerges as Asia's prime supplier of iron ore, followed by India – another very important producer and exporter of iron ore in the region.

African production is mainly channelled to the European market, with most of the deposits located in Western Africa and South Africa. But let us take a closer look at the most important suppliers of iron ore, around the world.

I.3.2.2.1 Western Europe

Today, Sweden is the only important West European producer, with France and Spain being distant second. Sweden's deposits are estimated in the range of 4.5 Bmt and are produced mainly in the northern part of the country. Some of these deposits are located above the Arctic Circle, and contain some of the world's most important high-grade iron ore; the ore bodies of the Kiruna district – Kirunavaara, Luossavaara, Malmberget, and Svappavaara – account for over 90% of Swedish exports. The rest of Swedish production originates in the Grangesberg area in central Sweden, with the principal mines about 150 km west of Stockholm.

The country's iron ore production and exports are dominated by Luossavaara-Kirunavaara AB (LKAB), a state-owned mining company, which was established in 1890. The company ships a number of ore grades with %Fe-content ranging from 61.8% for KDF's (Kiruna D Fines – high phosphoric), to 70.6% for MAF's (Malmberget A fines – low phosphoric). One important characteristic of Swedish mines is the fact that they are underground, as opposed to the open-pit mines in countries like Brazil and Australia, which are less costly to operate and, thus, more competitive in pricing their products.

The other important producers in Western Europe are France, Spain and Norway. France is a deficit region, which not only consumes all the iron ore produced domestically but also imports substantial quantities of it. Spain produces 3-4 million tons of iron ore per annum, most of which is handled by one company – Compa a Andaluza de Minas (CAM).

Norway has three companies producing iron ore: Nye Fosdalen Bergverk, with an underground mine in Fosdalen, at the northern head of Trondheimsfjord; Rana Gruber, with an open pit operation in Storforshei; and, the biggest of the three, Sydvaranger, with the 1.5 Mmt-per-year Bj rnevatn mine, at Kirkenes. Sydravanger is primarily state-owned, while Rana Gruber used to be part of Norsk Jernverk, the state-owned steel producer.

1.3.2.2.2 North America

Most of the available iron ore reserves in North America are located in the United States. Crude ore reserves are estimated in the region of 100 Bmt, but most resources are primarily low-grade, taconite-type ores, of the Lake Superior district, that have to be processed in order to be suitable for commercial purposes.

Apart from the Lake Superior region, other iron ore resources of the United States are widely distributed in several geographical regions, including Alaska and Hawaii. Several of the old mines are now out of action, however, and the main iron ore producing region is around Lake Superior, which includes the Mesabi, Cuyna, Vermillion and Fillmore ranges in Minnesota, the Black River Falls and Baraboo districts in Wisconsin, the Gogebic Range in Wisconsin and Michigan, and the Marquette and Menominee districts in Michigan.

There are several mining companies producing iron ore in the United States and Canada, some of which are: Cleveland-Cliffs, Cyprus Northshore Mining, M.A.Hanna, Hibbing Taconite, LTV Steel Mining, Oglebay Norton, Pea Ridge Iron Ore, and Tilden Mine. They produce a number of iron ore products, with sinter and pellets being the most common.

In Canada, production is dominated by the Iron Ore Company of Canada (IOC), a joint venture between Bethlehem Steel, Dofasco, Hanna Holding, Labrador Mining & Exploration, Mitsubishi Corp., and National Steel Corp. The other two producers are Quebec Cartier Mining (QCM) – owned by Dofasco, Mitsui and Caemi; and Wabush Mines – a joint venture between Finsider, Cleveland-Cliffs and several North American steel mills.

Production in the United States and Canada should be examined as one, since all of the iron ore output is used in the regional steel industry, especially in steel mills in the United States.

I.3.2.2.3 South America

Brazil has become Europe's most important supplier, with most of its production finding its way to German steel mills. Brazilian resources are estimated in the region of 40 Bmt, and are located primarily in two states – Minas Gerais (in the southern, more developed part of the country), and Para (in the northern, more remote and less developed Amazon region). In the south, the deposits are found mainly in the 'Quadrilatero Ferrifero'[16], while in the north they are found near the municipality of Maraba in the Carajas range. The mines in the Quadrilatero Ferrifero have provided most of Brazil's production and exports, while production from the Carajas project started only in the mid-1980s. However, the Carajas resources are of magnificent abundance and quality; some 18 Bmt are estimated to be in place; their grade is in the region of 66% Fe; and the project is designed to yield some 35 Mmt per annum, at full capacity.

[16] Iron-bearing quadrilateral.

Brazilian iron ore production is dominated by a massive company, with considerable interests in other metal and non-metal commodities: Companh a Vale do Rio Doce (CVRD), which has only recently been privatised. CVRD produces about 80% of the country's iron ore, with grades ranging from 61-67% Fe. A few other iron ore companies produce the rest of Brazil's output. Of these, the most important is Minera es Brasileiras Reunidas (MBR), which has most of its mines in the state of Minas Gerais. Other, smaller, companies include: Ferteco Minera o – a joint venture between Thyssen Stahl, Hoesch Stahl and Krupp Stahl of Germany; Hispanobras – a joint venture between CVRD and Ensidesa; Itabrasco – a joint venture between CVRD and the Italian Finsider; Nibrasco – a joint venture between CVRD and Nippon Steel; Samarco Minera o – a joint venture between SA Minera o da Trindade and BHP Minerals; Samitri-SA Minera o da Trindade – a company owned by C a Sider rgica Belgo-Mineira; and, finally, Minas de Serra Geral – a joint venture between CVRD, Kawasaki, Nomura, and five more Japanese minority holders.

Other Latin American producers include Venezuela, Chile, and Peru. Of these, Venezuela is the most important, with reserves estimated at 2 Bmt, and production about 20 Mmt per year. The entire production is handled by the state-owned CVG Ferrominera Orinoco, which operates four principal mines at Cerro Bol var, El Pao, San Isidro, and Los Barrancos. With the exception of El Pao, all other mines are in the 'Bol var Iron Quadrilateral', which is located in the valley of River Orinoco and its tributary Caroni.

In Chile, iron ore deposits are estimated at 900 million tons and are located mainly in a fault zone, 600 km long and 25 to 30 km wide, paralleling the Andes. Production is about 8 million tons and is handled by C a Minera del Pacifico (CMP) from its two mines – El Romeral and El Algarrobo. Peru's output is just over 3 million tons per annum, and is produced by the state-owned Hierro Peru at its Marcona mine.

I.3.2.2.4 Oceania

After China, the most important producer of iron ore in the Pacific Rim is Australia. Production is normally between 110 to 120 million tons, most of which is exported, with iron ore reserves estimated at about 33 billion tons. Most of the Australian output is exported to other Pacific Rim countries, particularly Japan, South Korea, Taiwan and China. About half of Australia's iron ore comes in the form of lumps, while the remaining is usually pelletised at destination, although a pelletising capacity of 4 million tons is in place. As Bolis and Bekkala (1987) note:

> "Australia is one of the lowest cost producers of iron ore in the world, making its operations very competitive on the world market. This is attributable to several factors –

large, high-grade deposits; high production; highly automated nature of the industry in both mining and shipping; and short distances from Japanese markets."

Most Australian deposits are located in Pilbara, WA, with a few mines in the state of South Australia and the island of Tasmania. A handful of mining companies control the iron ore industry in Australia, and are also involved in the mining of most other metallic ores. The largest of these companies is Broken Hill Proprietory (BHP) Minerals, which operates its own mines and also participates in joint ventures with other Australian producers and Japanese steel mills.

Hamersley Iron Proprietary is the second largest iron ore producer, and almost as influential as BHP in Australia's economy and politics. The company is wholly owned by CRA (Conzinc-Riotinto Associates), which started life after the merger of two British companies with interests in Australian mining. The company's mines are also located in the Pilbara region and include Mt. Tom Price, Paraburdoo, Channar, and Mt. Brockman. Savage River Mines is one of the few projects not located in Western Australia. It is owned outright by Cleveland-Cliffs and the mine is located in Tasmania.

The rest of the mining projects are joint ventures between domestic companies and, usually, Japanese sogo soshas. Mt. Goldsworthy Mining Associates is a joint venture of BHP, CI Minerals, and Mitsui and its mine is located in the northern part of Western Australia, near the place with the same name. Robe River Iron Associates is owned by Robe River Mining, Peko-Wallsend Operations, Mitsui, Cape Lambert Iron Ore Development Proprietory, and Pannawonica Iron Associates; it is also located in the Pilbara region. Mt. Newman is another joint venture between BHP, CI Minerals, and Mitsui-C.Itoh. Finally, there are a few more joint ventures, where the main shareholder is again BHP.

New Zealand is a relatively small producer of mainly titanomagnetite (just over 2 Mmt p.a.), but about half of this production is exported, primarily to Japan. The project is located in Waipipi, on the North Island of New Zealand and is handled primarily by BHP.

I.3.2.2.5 Asia

Asian output is dominated by two main producers – China and India. However, while the latter exports over 60% of its production to the world market, the former uses its entire production to satisfy domestic needs.

India produces well over 50m tons of crude ore per annum, which come from a number of private and state-owned companies. The National Mineral Development Corporation (NMDC) has mines in Bailadila (470 km from the port of Visakhapatnam), and in Donimalai (in the Bellary-Hospet region, 500 km from Madras). NMDC's entire production is handled by the state-owned Minerals & Metals Trading Corporation of India (MMTC), and it is sold mainly to the Japanese market.

Apart form MMTC, there is a number of private companies that produce – and trade in – iron ore. There are two other important production zones in India – Kudremukh and Goa. The first is operated by Kudremukh Iron Ore, a state-owned enterprise; while in the second there are several mines (in Sanquelim, Sonsbi, Orasso Dongor, Rivona, Guelliem and Codli), which are run by Sesa Goa – a joint venture, partly owned by Ilva of Italy. Other prominent iron ore producers/traders include Dempo, Mandovi Pellets, Salgaocar, Chowgule, Orient (Goa), and several smaller companies. Rather paradoxically, India also appears as a very small importer of ore as well (e.g. in 1995 it imported 1.7 million tonnes of iron ore). This can be attributed, however, to existing contracts between foreign mines and Indian steel mills for ores or tightly specified qualities that could not be substituted by local grades. By and large, however, India remains a prime exporter, particularly to the Far East Asian markets.

China produced some 200m tons of crude ore (1992), but in 1993 it imported a further 33m tons, half of which come from Australia, and the rest from Brazil, South Africa, India, and Peru. While domestic ore production is expected to remain stable, imports of the raw material are expected to increase, with forecasts pointing to a figure of 50m tons of crude ore in the year 2000. Currently, the country's imports are handled by the state-owned China National Metallurgical Import & Export Corporation (CNMIEC), but its role is seen at best static or diminishing, with the major steel plants of the country, instead, set to become more active in procuring their own needs in iron ore. The three major steel producers – Shougang, Baoshan Iron & Steel, and Wuhan Iron & Steel – have already approached enterprises in Australia, Brazil and India, respectively, with a view to securing captive mines.

I.3.2.2.6 Africa

The most significant iron ore producers on this continent are located in the west and south of Africa. Traditionally, Liberia was the most important iron ore producer in Western Africa, but civil unrest hit production after 1988. As a result, Mauritania has now emerged as the second most important African producer, after South Africa.

Liberian production is mined at the Nimba project and handled by Liminco, a joint venture between Nimco (a subsidiary of BRGM, France) and AMCL (a subsidiary of Allied Domecq, the parent of Allied-Lyons).

In Mauritania, production is in the region of 10m tons per annum, and is controlled by SNIM SEM (Soci t Nationale Industrielle et Mini re), a joint venture between (among others) the state, Kuwait Real Estate Investment Consortium, Arab Mining, Iraq Fund for External Development, BRPM-Morocco, and the Islamic Development Bank.

The Republic of South Africa is the top iron ore producer in Africa, with about 30m tons produced in 1991. Most of the production comes from the Sishen mine, which is located in the heart of the country, north of the Orange River. Production is handled by Iscor, the formerly state-owned (but now privatised) company, which also operates the electric railway that transports the iron ore from the mine, over a distance of 860 km, to Africa's deepest port – Saldhana Bay.

The same port is used for exports from the Beeshoek mine, which is located some 930 km inland and operated by the Associated Manganese Mines of South Africa (ASSOMAN).

A few other African countries also produce iron ore, but in quantities which are rather insignificant for the international market, although their production is important for their domestic needs. These countries are Algeria, Tunisia, Zimbabwe, Nigeria, Morocco, Egypt; and deposits are also present in Gabon, Ghana, Cameroon and the Ivory Coast.

I.3.2.2.7 Eastern Europe

The combined production of all of its constituent democracies, places the former Soviet at the top of the world league of iron ore producers. Although production has been falling since the late 1980s, FSU production is in the region of 200Mmt per year, which accounts for about one-fifth of world production. Soviet ores are mostly low-grade, with %Fe contents ranging from 20-50%. All ores undergo beneficiation and have to be agglomerated to sinter or pellets. This is the reason why the FSU has the world's largest pelletising capacity – some 80 Mmt – which accounts for about 30% of global capacity.

Of the former Soviet states, Russia, Ukraine, Azerbaijan and Kazakhstan are the most important producers. In Russia there are several mining companies, most of which have annual run-of-mine capacities in excess of 10 Mmt. These are: Bogolovsky Ore-Mining in the Sverdlosk region in Urals (40.7 Mmt); Lebedinsky Mining & Dressing Plant in Belgorod (45 Mmt); Michailovsky Mine in the Kursk region (40 Mmt); Sibruda - Siberian Scientific & Industrial Mining Amalgamation in the Kemerovo region (22.8 Mmt); Stoilensky Mine in Belgorod (15.6 Mmt); Uralruda Mining Production Amalgamation in the Sverdlovsk region in Urals (61 Mmt). Many of these mines have rather low-grade ores – often as low as 20% Fe – which decreases the quantities of high-grade ore that can be produced after beneficiation and agglomeration.

In a similar manner, most Ukrainian mines have run-of-mine capacities in excess of 10 Mmt per annum. Most mines are located in the Dnepropetrovsk region: Inguletsky Ore Mine & Concentrator in (35 Mmt); Krivbassruda Ore Mining Amalgamation (21.7 Mmt); Krivorozhsky Central Mine (20 Mmt); Krivorozhsky Yuzhny Ore Mine (35 Mmt); Novokrivorozhsky Mine (30 Mmt); Poltavsky Mine (34 Mmt); and Severny Mine (48.5 Mmt).

Kazakhstan has five mines, three of which have annual capacities of over 10 Mmt. These are: Kotomukshky (24 Mmt); the Lisakovsky (10.6 Mmt); and Sokolovsko-Sarbaisky (27 Mmt). Finally, Azerbaijan has the much smaller Severo-Zapadny mine, which produces just about 2 Mmt per year. As in the case of Russia, Ukrainian, Kazakh and Azeri ores have an average 30% Fe content, which needs considerable beneficiation and agglomeration.

I.3.3 Demand Determinants

Iron ore is almost exclusively used in the production of steel. There are, however, a few chemical compounds of iron that have a variety of other minority uses. Ferrous sulphate ($FeSO_4$), called 'green vitriol', is used as a mordant in dyeing, as a tonic medicine and in the manufacture of ink and pigments. Ferric oxide, an amorphous red powder, is used as a pigment, known as either iron red or Venetian red; as a polishing abrasive, known as rouge; and as the magnetisable medium on magnetic tapes and disks. Ferric ferrocyanide ($Fe_4[Fe(CN)_6]_3$) is a dark-blue amorphous solid, called Prussian blue; it is used as a pigment in paint and in laundry bluing to correct the yellowish tint left by the ferrous salts of water. Finally, potassium ferricyanide ($K_3Fe(CN)_6$), called red prussiate or potash, is used in processing blueprint paper.

Despite all these 'exotic' uses of iron, however, steel production remains the main force that drives the iron ore industry. Steel, in its simplest forms, is the most basic good needed for the industrialisation process of any economy. In fact, crude steel production is often a signal of a buoyant manufacturing sector. The steel sector, of course, is not defined just from crude steel. Advanced steel products and steel alloys are goods of high added value, in which many industrial countries specialise, leaving the bulk of the production of 'plain', unalloyed steels to developing countries, with low labour costs.

Demand for steel products is derived from a variety of industries and it is, therefore, segmented. The biggest consumers of steel products are: transportation; construction; machinery; cans and containers; appliances and equipment; mineral exploration industries; and any other sector that is not covered above.

I.3.3.1 Ironmaking

The first step in processing the beneficiated – and, possibly, agglomerated – ore is its reduction to iron. There are two main processes for doing so: blast furnace reduction; and direct reduction. Blast furnace reduction is the most widespread method, so we are going to discuss it first.

I.3.3.1.1 Blast Furnace

The blast furnace is a 'tower', specially built to withstand high temperatures, into which sinter or pellets, coke and limestone are fed from the top. Coke is nothing more that coal which has been 'carbonised' in ovens, in order to improve its burning properties.

As these products fall in the tower they encounter the rising hot reducing gases and eventually settle on previous loads fed from the top. To keep the process going, hot air[17] is blasted through special nozzles – *tuy res* – so that the temperature of the coke remains at about 2,000°C. The iron in the iron ore, sinter, or pellets is melted out to form a pool of molten metal – known as *pig iron* – in the bottom – or *hearth* – of the furnace. As iron accumulates in the hearth, it is removed periodically from the furnace – an operation called *tapping*. The limestone combines with impurities and molten gangue from the ore, forming a liquid *slag* which, being lighter that the metal, floats on top of it, and is also removed periodically. The charging system at the top of the furnace also acts as a valve mechanism to prevent the escape of gas, which is taken off through large-bore pipes to a gas cleaning plant.

Blast furnaces rely on two important economic factors: first, that the process is continuous; and, second, that substantial quantities of pig iron are produced, in order to take advantage of scale economies. A modern blast furnace produces about 1 Mmt per annum, while an integrated steel facility should have a turnover of about 3 Mmt a year, in order to operate efficiently.

I.3.3.1.2 Direct Reduced Iron

An alternative reduction process was developed by Midrex and HYL, whereby iron ore is mixed with coke or natural gas, and heated to about 900°C, in order to increase its iron content, normally to over 80%. The result of the process is not pig iron, but a product known as *sponge iron*, which can be fed directly to an electric arc furnace (EAF) to produce steel. Sponge iron – or direct reduced iron (DRI) – is more desirable than scrap in EAF steelmaking, because it has a lower level of metallic residuals and other impurities, than recycled scrap.

The main drawback of this method is its high requirement for fuel. As a result, DRI plants are primarily located in energy-rich countries, like Venezuela, Mexico, Iran, Saudi Arabia, India and Indonesia.

There are a few more iron making methods, which are of small significance right now, but might have a bigger effect in the future. Most of these techniques are still in the developmental stage – although for a few, commercial production has already started – and are: Eldred, Inred, Plasmamelt, DIOS, HIsmelt, Krupp-COIN, Combismelt, and Corex. The common characteristic of all the above is that they employ *direct smelting* or *smelting reduction* technology. This process, which was originally developed by Nippon Kosan and Kawasaki, allows the smelting and reduction of iron ore in a single process and has four main objectives:

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[17] Frequently, hot air is enriched with oxygen.

- the direct input of iron ore, without need for sintering or agglomeration;
- the substitution of coal for coke;
- lower capital and operating costs; and
- production on a smaller, and ecologically more sound, basis.

The Corex process is now in operation in South Africa, where ISCOR produces some 300,000 mt per annum. Plans for Corex installations have also been approved by LTV Steel in the United States, and Pohang Iron & Steel in South Korea. The gist of the Corex process is that it uses coal instead of (more expensive) coke and the whole process has a useful by-product – gas – which can be used as fuel to produce hot-briquetted iron.

I.3.3.2 Steelmaking

The manufacture of steel is quite a separate procedure from that of iron, although both procedures co-exist in large, integrated steel mills. There are two methods of making steel, which are the most important – the basic oxygen furnace (BOF), and the electric arc furnace (EAF). Before these two, steel was produced with the open hearth method, but this process is now obsolete, although antiquated open hearth furnaces still exist in the FSU.

I.3.3.2.1 Basic Oxygen Furnace

In the BOF method, scrap (25%) and molten iron (75%) are charged into a vessel – the *converter*. A water-cooled oxygen lance is lowered into the furnace and high-purity oxygen is blown on the metal at very high pressure. The oxygen combines with carbon and other unwanted elements, thus eliminating the impurities from the molten charge.

These oxidation reactions produce heat, and the temperature of the metal is controlled by the quantity of the scrap added. The carbon leaves the converter as a gas (carbon monoxide) which can, after cleaning, be collected for re-use as a fuel. During the 'blow', lime is added as a flux to help carry off the other oxidised impurities as a floating layer of slag. Modern converters will take a charge of up to 350 tons at a time and convert it into steel with a *charge-to-tap* time of 40 minutes or less.

I.3.3.2.2 Electric Arc Furnace

Cold scrap, or sometimes DRI is the only input of the EAF process. As its name implies, the process uses a powerful AC or DC electric current to melt the scrap or DRI. The furnace consists of a circular 'bath' with a movable roof, through which three graphite electrodes can be raised or lowered. At the start of the process, the electrodes are withdrawn and the roof swung clear. The steel scrap is then charged into the furnace from a large steel basket lowered from an overhead travelling crane. When charging is complete, the roof is swung back into position and the electrodes lowered into the furnace.

When the current passes through the charge, an arc is created, and the heat generated melts the scrap. Lime is added as flux and oxygen is also blown into the melt, so that impurities form a liquid slag and are removed at the end of each charge. Modern electric furnaces can make up to 150 mt of steel in a single melt, in less than an hour-and-a-half.

I.3.3.2.3 Other Methods

With the exception of open hearth steelmaking, which is now obsolete, the only other alternative method is the High Frequency Induction Furnace. The process uses electricity to melt a charge of cold scrap, but it does it using a coil, rather than cathodes. Furnaces of this type are usually less than 5 Mt. capacity.

A number of secondary metallurgy methods are used to rid the steel from some harmful elements, which result from the oxygen process. More specifically, secondary metallurgy methods are used to: improve homogenisation of temperature and composition; remove deleterious gases, such as nitrogen, oxygen and hydrogen, in the steel; allow careful trimming of composition to exact ranges of analyses; remove phosphorus and sulphur; and refine the quantity of other metallic elements in the steel.

I.3.3.3 Trade

Just over 40% of the world production in iron ore is traded internationally. In 1995, world exports stood at just over 416 million tonnes, 58% of which were almost equally shared by just two countries – Brazil and Australia. Other important – although much smaller – exporters were India, Canada, South Africa and Ukraine. Brazilian exports are primarily channelled to Western Europe, with a smaller proportion going to the Pacific Rim. Australian exports, on the other hand, are destined for Japan, South Korea, and other Asian countries, including China. Canadian exports are primarily directed to the United States; however, both IOC and QMC are also very active selling their ore to Europe. Indian exports compete directly with those of Australia in Asian markets, while South Africa targets both European and Asian markets. Finally, Sweden exports all of its production to other European countries.

Iron ore imports are even more biased towards two importing areas – Japan and Western Europe. In 1995, Japan imported 30% of total iron ore traded internationally, while Western Europe imported another 30% of it. Other Asian countries generated 18% of iron ore imports; while Eastern Europe and North America accounted for 8% and 5%, respectively.

I.4 Conclusion

Iron ore is the among biggest, non-energy extractive industry in the world in terms of value, and the biggest in terms of the volumes of cargo it channels in international trade. Production and consumption of the ore is rather concentrated, with the top 10 importers and exporters accounting for some 90% of the annual trade flows.

On the supply side, Australia and Brazil lead the small group of exporters and dominate the Pacific and Atlantic markets, respectively. Following these two are Canada, South Africa and Sweden, with a few more smaller producers each of which does not controls more that 1-2% of world supplies. On the demand side, it is primarily a handful of industrialised countries that lead the world steel production and, as a result, absorb most of the world's iron ore imports. Leading force among these countries is Japan, United States, the EU (led by Germany), and more recently South Korea and China.

Figure I-1

Import shares of iron ore by country in 1996

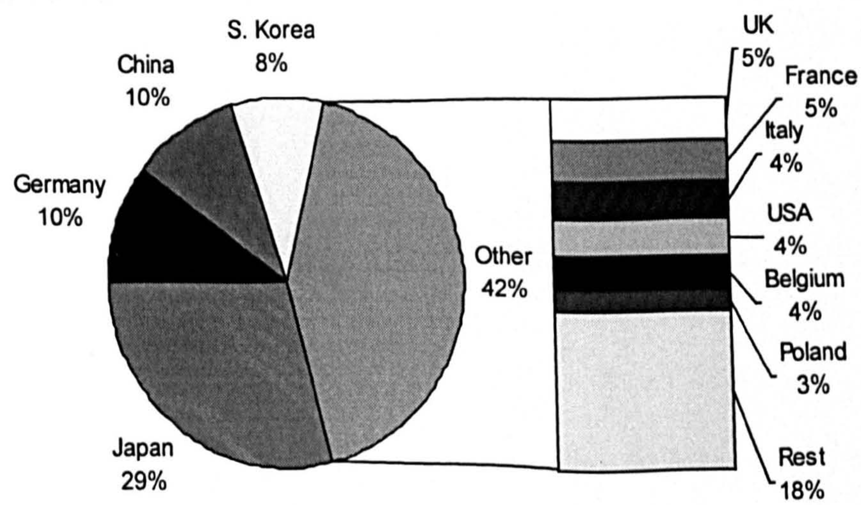
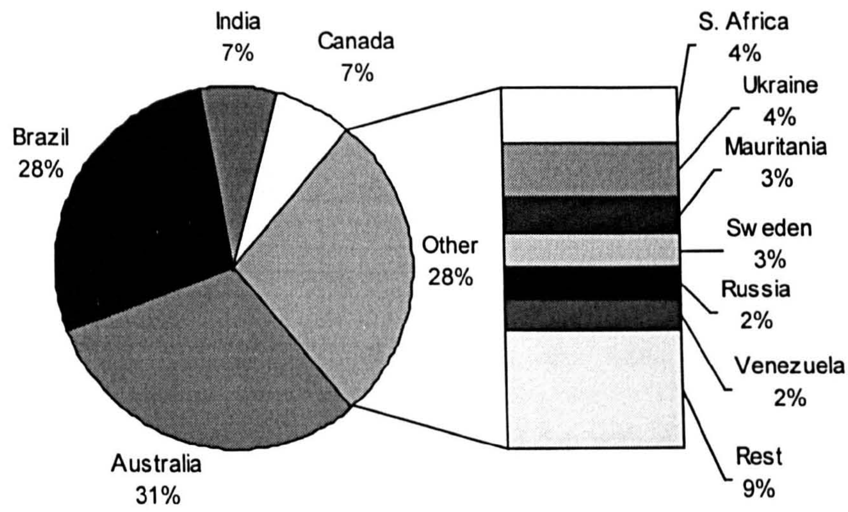


Figure I-2

Export shares of iron ore by country in 1996



Two key characteristics of the iron ore market will be central to the ensuing discussion: there is only a small number of buyers and sellers; there is a great degree of interdependence among buyers and sellers and both groups are aware of this interdependence.

II. Review of Literature

II.1 Non-Competitive Industrial Structures

After the overview and technical characteristics discussed in chapter I, this chapter will deal with the theoretical proposals found in international literature, which are subsequently used (in chapter IV) to analyse the economic structure of the iron ore industry. There are two types of considerations coming into play when theorising the construction of an economic model for iron ore: what is the economic behaviour of agents participating in the market; and the way demand and supply interact to produce economic exchanges of the commodity, i.e. trade flows.

The first section of this chapter is of particular importance to the subsequent discussion, as it sets the theoretical framework within which the iron ore industry – and in particular the trade flows it generates – is analysed. The focus is initially on oligopoly models and some of their extensions used to address more complex demand/supply structures. Following this, the attention is concentrated on bilateral monopoly models which, so far, have had only limited application to the iron ore trade. Concluding this first section is a review of the even more limited literature on bilateral oligopoly which seems to approximate much better the behaviour in the sector. Section II.2 turns its attention to the other important aspect of modelling the supply and demand interactions in commodity trade. The second section concentrates on trade models and the variety of methodologies that have been applied to commodities in general, and iron ore in particular.

As it was discussed in chapter I, iron ore can be found in several geographical regions, but exists in abundance in only a few countries, which also have a considerable cost advantage in its production. The top ten exporters account for 91% of world flows. As it can be seen from Table II-1, this degree of market concentration on the supply side is not unusual for the sector and has persisted for over 30 years, during which period the top 10 exporters have controlled between 85-90% of exports. Since 1975 Australia and Brazil are consistently at the top of this league and between them they have generated between 45-58% of exports flows. It is not surprising, therefore, that it is these two countries with their dominant position that usually take the lead in negotiating and setting international prices for the commodity.

II.1.1 The Supply Side

Disregarding the demand situation for the time being, we focus on supply which has the typical characteristics of an oligopolistic market structure, with two dominant players. The fact that it is companies, rather than countries, that conduct the business does not alter the situation much, as there is only a handful of very big mining corporations in each country. In the previous chapter we saw CVRD in Brazil and BHP with CRA in Australia being the world's leading iron ore producers, who are also the ones usually entering negotiations with buyers to determine ore prices every year.

Table II-1

Market shares of the top 10 iron ore exporters (1965-1995)

1995		1990		1985		1980	
Australia	30%	Brazil	28%	Brazil	25%	Australia	23%
Brazil	28%	Australia	25%	Australia	24%	Brazil	22%
India	7%	India	8%	Canada	9%	Canada	12%
Canada	7%	Canada	8%	India	7%	Sweden	6%
S. Africa	4%	FSU	6%	Sweden	5%	India	6%
Ukraine	4%	Venezuela	4%	Liberia	5%	FSU	5%
Mauritania	3%	Sweden	4%	FSU	5%	Liberia	5%
Sweden	3%	S. Africa	4%	S. Africa	3%	S. Africa	4%
Russia	2%	Mauritania	3%	Venezuela	3%	Venezuela	3%
Venezuela	2%	Chile	2%	Mauritania	3%	France	3%
Total	**91%**	**Total**	**90%**	**Total**	**90%**	**Total**	**87%**

1975		1970		1965	
Australia	25%	Australia	15%	Canada	18%
Brazil	19%	Canada	14%	Sweden	13%
Canada	11%	Brazil	10%	France	12%
Venezuela	7%	Sweden	9%	Venezuela	10%
India	6%	Liberia	8%	Liberia	9%
Sweden	6%	Venezuela	7%	Brazil	6%
Liberia	6%	France	7%	Chile	6%
France	5%	India	7%	India	5%
Chile	3%	Chile	4%	Peru	4%
Mauritania	3%	Peru	4%	USA	4%
Total	**90%**	**Total**	**85%**	**Total**	**87%**

***Source:** Authors' calculations based on trade figures from UN Statistics Bureau*

The distribution of iron ore export shares, shown in Table II-1, leaves little room for doubt about the degree of market concentration in the industry. The level of concentration reported above is simply the straight forward ***m-firm concentration ratio***, one of the most common, but simplest, measures of market power. This index adds up the *m* highest shares (in our case *m* = 10). Probably the most used index of market concentration in literature is the Herfindahl index which, in the iron ore market, has moved from 0.09 in 1965 to 0.18 in 1995, revealing an increased rate of concentration during these 30 years.

II.1.1.1 Using Game Theory

Because of the dominance of a very limited number of countries, i.e. the existence of a supply oligopoly, it is logical to expect that each market player is aware of the existence and the actions of the other players, and its behaviour takes the form of a strategy. Researchers have borrowed tools from mathematics in order to solve essentially problems of strategic behaviour, both in a static and dynamic context. In an oligopolistic market structure, where a firm no longer encounters a passive environment, such strategic interaction is better studied within the framework of non-cooperative games. In this context, oligopolists behave like players in a non-cooperative game, where each player behaves in its own self-interest.

Such games reach an equilibrium if, given the actions of its rivals, a firm cannot increase its own profit by choosing an action other than the equilibrium action. This state is known as a Nash equilibrium and is the basic solution concept in game theory. Nash equilibrium also generalises naturally to dynamic situations and to problems of incomplete information. This is quite important as soon as there are many time periods and any inter-temporal dependency of feasible action[1] sets, i.e. when players make choices in period t that affect their objective functions or their set of feasible choices in a future time period $t+t'$, where $t' > 0$. To determine the consequences of actions taken in t, the players must forecast what will happen in $t+t'$ given the state of the game at the beginning of that period (which is influenced by their actions in t). To calculate these expectations, each player assumes that all other players will play an optimal strategy in $t+t'$. Therefore, the solution of a dynamic game is "backward looking". For example, in a two-period game, the solution is given by starting with solving the second-period Nash equilibrium as a function of the state of the game at the beginning of the second period (that is what happened during the first period), This means that the players can determine the future consequences of their first-period actions, because their first-period actions determine which second-period equilibrium will ensue; in a sense the remainder of the game is a foregone conclusion. Therefore the players choose their first-period actions with an eye toward their consequences in both periods. Thus it suffices to determine the Nash equilibrium of the corresponding game in which players take only first-period actions but with the same set of consequences as in the original two-period game.

II.1.1.2 Cournot Oligopoly

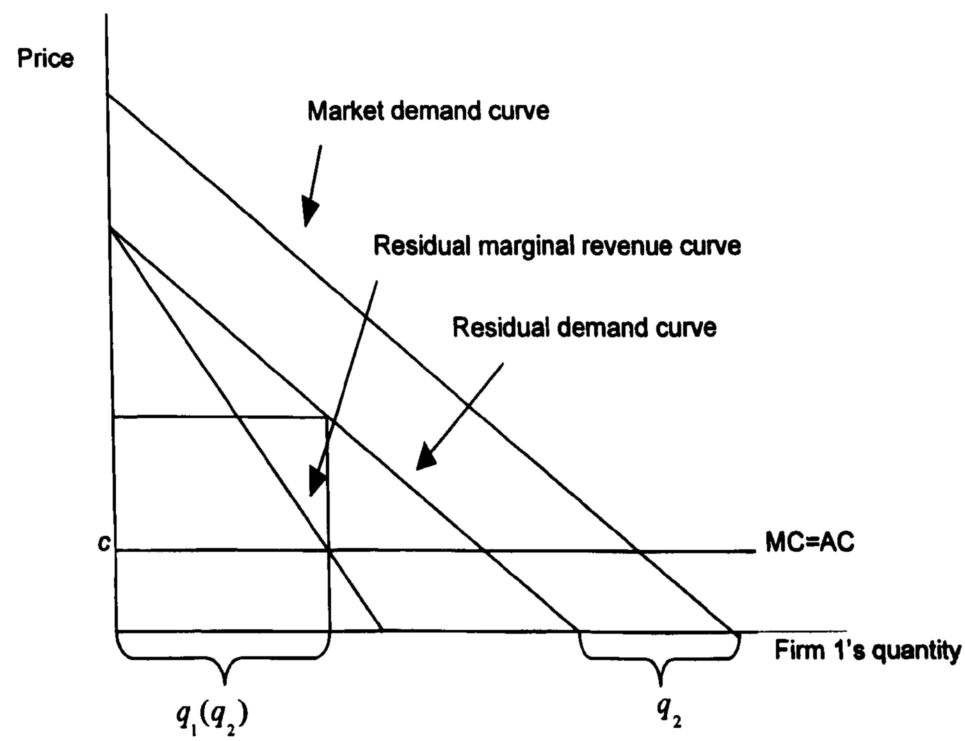
The first and simplest game, which might fit the case of the iron ore market, was first suggested by Cournot (1927) and was further developed and expanded by several other authors. Cournot's duopoly model is a one-stage game which makes

[1] In game theory jargon, "action" is a decision taken as part of a series of other decisions, all of

the smallest possible departure from monopoly and examines a market supplied by two identical firms.

Figure II-1

Firm 1's output in a Cournot (quantity-setting) oligopoly



The behaviour Cournot assigned to his duopolists is rather simple: each firm acts in the belief that the other will maintain a constant output level. There are no fixed costs, just a marginal cost per unit which is constant at some level *c*. Given these assumptions, firm 1 will maximise its profit along a residual demand curve obtained by subtracting firm 2's output from the market demand curve. Firm 1's profit maximising output will make its marginal cost equal to marginal revenue along the residual demand curve. This output is designated $q_1(q_2)$ in Figure II-1

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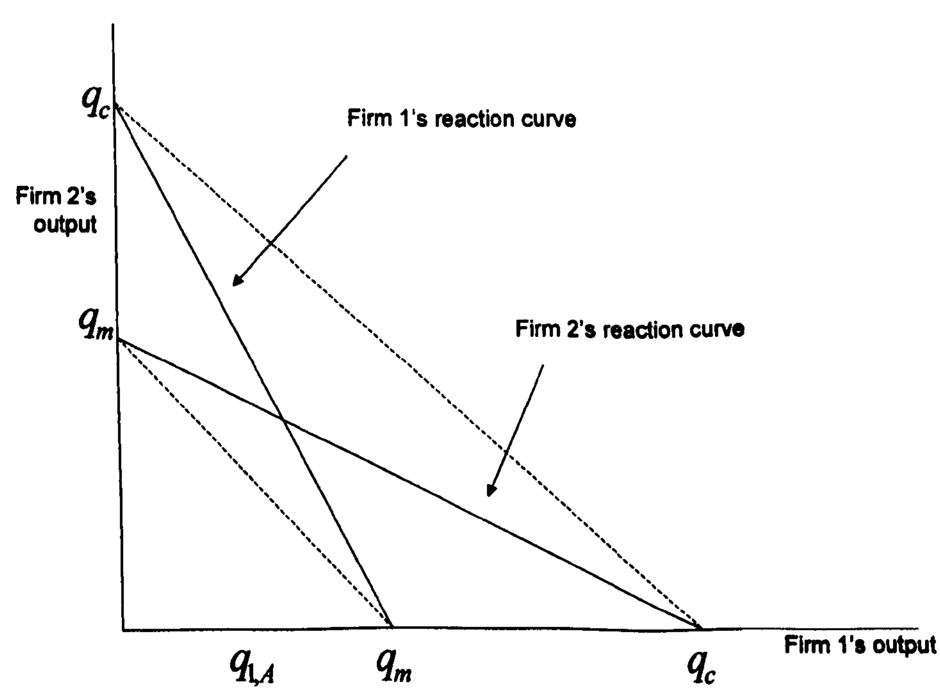
which are linked together to form a "strategy".

because the output firm 1 decides to put on the market depends on the output of firm 2. By going through firm 1's profit-maximisation exercise for different values of q_2, we can derive firm 1's reaction curve. The reaction curve shows the output firm 1 will produce to maximise its profit, depending on the output of firm 2.

Figure II-2 shows the reaction curves of both firms, i.e. the beliefs of each firm about the way the other firm will react. In general these beliefs are inconsistent, but there is one point in the diagram at which the beliefs of each firm about the actions of the other will be correct – the point at which the reaction curves cross.

Figure II-2

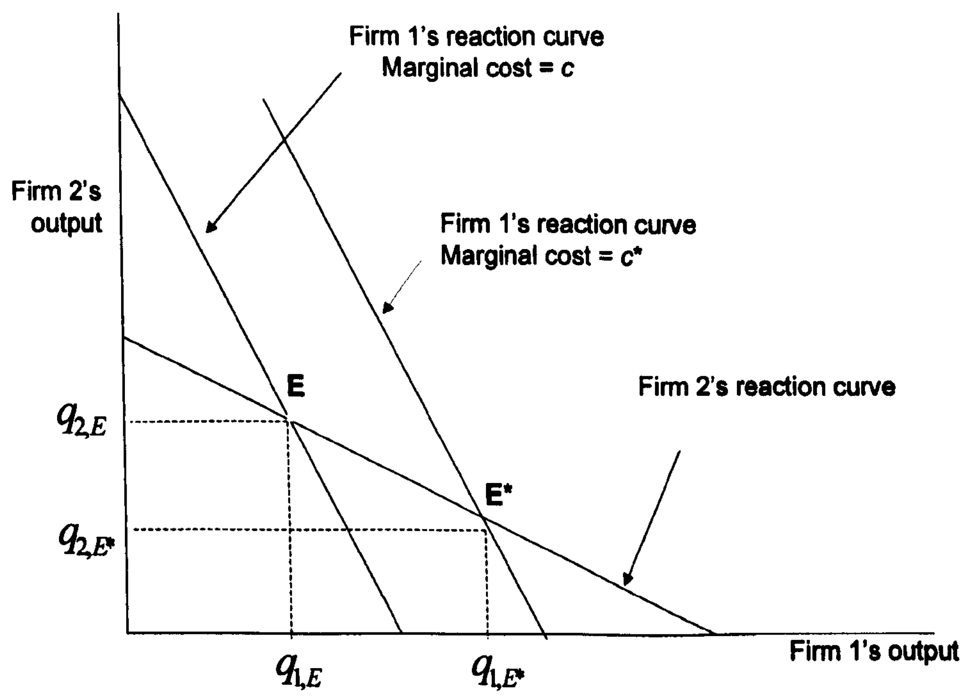
Reaction curves for firms 1 and 2



This is the well known Cournot equilibrium. In the same figure the equilibrium of the duopolists is depicted against the monopolist's equilibrium (line $q_m q_m$) and the competitive equilibrium (line $q_c q_c$). This implied that prices under a duopoly will be below those in the more restrictive monopoly but above those formed under competitive conditions.

Figure II-3

Equilibrium in Cournot duopoly with unequally sized firms



In short, each Cournot duopolist restricts output, trying to maximise its own profit. In so doing, each misunderstands the way the other makes decisions. Individual output decisions are imperfectly co-ordinated, and total output exceeds the monopoly level. The Cournot equilibrium price falls short of monopoly price.

Cournot duopolists succeed in exercising some market power, some control over price. But because they act independently, they do not maximise their joint profit.

The particular misunderstanding that is built into the Cournot model – the assumption that each firm believes that its rivals hold output constant – is implausible. However, the general prospect that in oligopoly firms will misunderstand the way rivals behave is quite *plausible*.

In the model discussed above, the assumption is made that the two firms are equal. In the more realistic scenario that the duopolists are of unequal size, the generalisation of the Cournot model intuitively suggests that increased market concentration will move the quantity determination closer to the monopoly equilibrium. In monopoly, if the firm raises price, the quantity demand falls. When the price elasticity of demand is large, a small increase in price will cause a large decline in sales. In such circumstances, the monopolist will not find it profitable to raise price far above marginal cost. This is formally expressed in literature in the following form, whereby the profit margin of the monopolist equals the inverse of the price elasticity of the demand for the product.

$$\frac{P-c}{P} = \frac{1}{\varepsilon_{QP}}$$

Eq. II-1

In the case of oligopoly now, the above formula can be transformed into the Lerner index of market power given below, where s_i is firm i's market share and c_i is its cost.

$$\frac{P-c_i}{P}=\frac{s_i}{\varepsilon_{QP}}$$

Eq. II-2

In oligopoly, a change in the underlying production cost of a firm, will shift the reaction curve of the firm, as it can be seen in Figure II-3. If firm 1, for instance, discovers a new production technique, so that its marginal cost falls to $c^*<c$, firm 1's marginal cost curve shifts down. Firm 1's profit maximising output will increase, for any output from firm 2, as the marginal cost curve moves down the residual marginal revenue curve. Given firm 2's output, firm 1's output will increase, resulting in firm 1's reaction curve shifting outward. If the lower-cost technology is unavailable to firm 2 there is no change in its reaction curve. As firm 1's marginal cost falls, the Cournot equilibrium point – the intersection of the two reaction curves – slides down firm 2's reaction curve (from E to E^*). It is a general result – whatever the number of oligopolists – that in quantity-setting models, firms with lower marginal costs have greater market shares.

The greater a firm's market share, the greater its market power. In Cournot-type models, each firm acts independently, and each fails to understand what the others are doing. Hence total output exceeds the monopoly level and the price falls short of the monopoly level. But if firm *i* has a very large market share – if s_i is near 1 – the fact that firm *i* misunderstands what its small rivals are doing is of little consequence for the market price. When firm *i* is large in the market, price will depend mostly on its actions and firm *i* will exercise almost as much market power as would a monopolist. The result is that even though firms act independently, larger firms will have more market power than smaller firms. What does this imply for industry performance? As Martin (1994) supports, "there is a recognition of interdependence in this market, but no co-operation." He continues, "the more concentrated the market in quantity-setting oligopoly, the greater the industry-average degree of market power."

As stated earlier, Cournot's original model, and the models later derived from it, have each oligopolist believe that its rivals hold their output constant. This belief seems especially implausible, given that the defining characteristic of oligopoly is that firms recognise their mutual interdependence. It is possible to get around this implausibility by adding to the Cournot model the elasticity of rivals' output with respect to firm *i*'s output, which describes the way firm *i* expects others to react to what it does. This is given as

$$\alpha_i = \frac{q_i}{q_{-i}} \frac{\Delta q_{-i}}{\Delta q_i}$$

Eq. II-3

where for notational simplicity q_{-i} is the output of all firms except firm *i*.

This is the percentage change in all other firms' output that firm *i* expects in response to a 1 percent change in its own output. This is called the *conjectural variation* for firm *i* because it describes the way firm *i* thinks competitors will react to what it does. When $\alpha_i = 0$ this means firm *i* thinks that the other firms will not change their output in response to its own output decisions. This is merely the basic Cournot assumption about behaviour. If instead $\alpha_i = 1$, then firm *i* makes its plans in the belief that if it restricts output by 1 percent, other firms will do the same. Firm *i*, in other words, expects rivals to co-operate in pulling output off the market. Finally if $\alpha_i = -1$, then firm *i* makes its plans in the belief that if it restricts output by 1 percent, its rivals will expand their output by the same percentage. Firm *i* believes that if it tries to pull output off the market, rivals will act to neutralise its attempt.

Conjectural variations can be built in the way Cournot market equilibrium works and it changes the way the firms' reaction curves move. In the general case of *N* firms with unequal costs, Eq. II-2 becomes

$$\frac{P-c_i}{P}=\frac{\alpha_i+(1-\alpha_i)s_i}{\varepsilon_{QP}}$$

Eq. II-4

where s_i, as before, is firm *i*'s market share. Following from the discussion above, if α_i=0 we are back to the basic Cournot model, where the market power of a firm is directly proportional to its market share and inversely proportional to the price elasticity of demand. If α_i=1 we are back to the monopoly case, where the firms market power is the inverse of its price elasticity of demand. Finally, if α_i is negative, the reaction of other firms reduces firm *i*'s market power. This is what we ought to expect: market power is the power to raise the price by holding output off the market and a negative conjectural variation means that the other firms act to neutralise attempts to keep output off the market.

The analysis above relies on the implicit assumption of 'one-shot' competition, i.e. firms simultaneously quote their prices or quantities and then disappear. In practice, though, firms are likely to interact repeatedly. Durable investments, technological know-how and barriers to entry promote long-run interactions among a relatively stable set of firms. This creates two problems: firstly, the one-period analytical framework becomes rather unrealistic; the usual assumption of lack of collusion between oligopolists is hard to justify any longer. Firms operate in a multi-period reality and are round long enough to know their competitors and may be able to recognise some of their strategies and anticipate some of their reactions.

II.1.1.3 Tacit Collusion

In a slightly different context, Chamberlain (1929) suggested that in an oligopoly producing a homogeneous product, firms would recognise their interdependence and, therefore, might be able to sustain the monopoly price without explicit collusion. The threat of a vigorous price war would be sufficient to deter the temptation to cut prices. Hence, the oligopolists might be able to collude in a purely non-cooperative manner, i.e. there is a possibility of tacit collusion. Tacit collusion has been discussed by several authors after Chamberlin and although they all recognised that repeated interaction between oligopolists might indeed facilitate it, they also suggest factors that might hinder it.

Starting with Chamberlin's concerns about collusion, he advocated (1933) that a small number of firms produce an identical product, they would end up charging the monopoly price, i.e. the price maximising industry profit. As he put it himself:

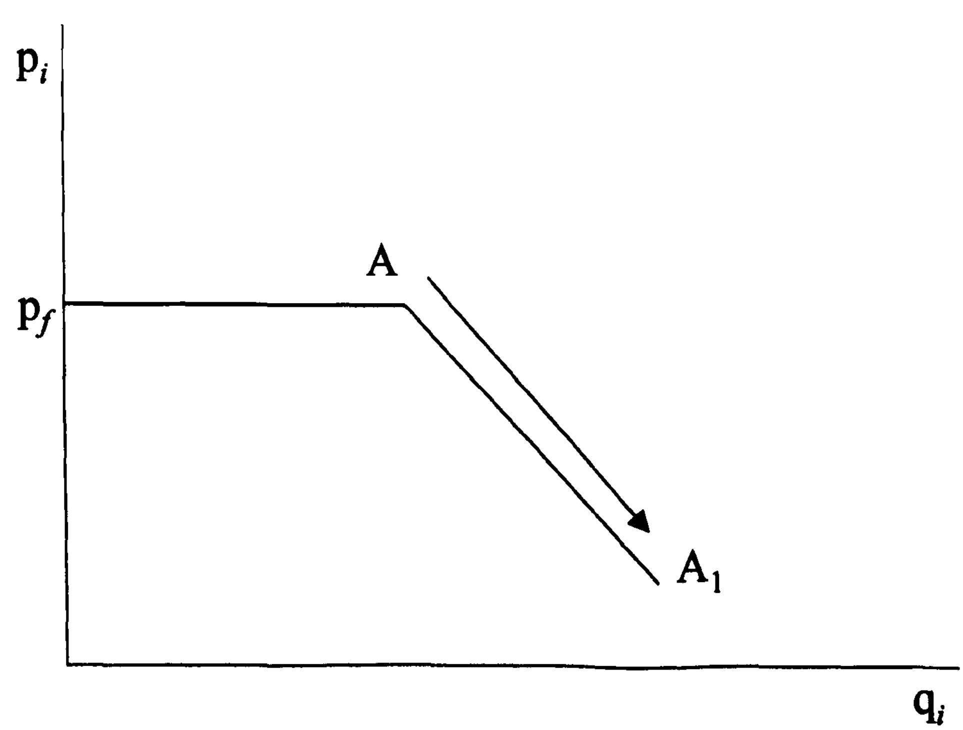
> "If each seeks his maximum profit rationally and intelligently, he will realise that when there are only two or a few sellers his own move has a considerable effect upon his competitors, and that this makes it idle to suppose that they will accept without retaliation the losses he forces upon them. Since the results of a cut by anyone is inevitably to decrease his own profits, no one will cut, and although the sellers are entirely independent, the equilibrium result is the same as though there were a monopolistic agreement between them."

Several contributions tried to formalise the discipline imposed by the possibility of reactions. The best-known among them is that of the kinked demand curve (Hall and Hitch 1939; Sweezy 1939) which oligopolists face in the market. In their duopoly model, both firms charge a so-called 'focal' price p_f, which is expected to be close to – but not necessarily identical to – p^m which is the long-run equilibrium price maximising monopoly profits.

Suppose that a firm contemplates deviating form the monopoly price and it conjectures that its rival will stay put at p_f if it raises it price above p_f and will follow suit (match the price) if it cuts its price. As it can be seen from Figure II-4, under such a conjecture deviating from the monopoly price is not profitable. An increase in price leads to a complete loss in market share and a zero profit. A reduction in price results in price declines in the direction A → A_1 and results in profits less than monopoly profits.

Figure II-4

Kinked demand curve faced by each duopolist (or oligopolist)



The kinked demand curve theory is not totally watertight and has been criticised. Although it is fairly straightforward that a firm will not set a focal price p_f above the monopoly price p^m, it is not clear what happens in the opposite direction. Any price p_f charged by all forms results in an 'equilibrium' as long as it lies somewhere between marginal cost c and monopoly price p^m, so no steady long-run equilibrium can be specified and, indeed, any price between marginal cost and the monopoly price can be the outcome of price competition.

As Chamberlin pointed out, there are factors that may hinder collusion. Two such factors, which are of particular importance and relevance to iron ore economics as well, are detection lags and asymmetries between firms. Chamberlinian tacit collusion is enforced by the threat of retaliation. But retaliation can occur only when it is learned that some member of the industry has deviated. In many industries, the prices charged by a manufacturer can be observed fairly quickly by its competitors. In others, however, prices may remain somewhat hidden. This may be the case, for instance, when the manufacturers sell to a small number of big buyers. This case is of particular to iron ore economics, as this is indeed the type of market interaction that takes place in reality. What happens in such case then is that rather than quoting a price, sellers make deals that are particular to each buyer and that the other competitors may observe only with a lag. Because retaliation is delayed, it is less costly to a price-cutting firm; therefore, tacit collusion is harder to sustain.

Information lags make the future more distant and thus make dynamic interaction less relevant. Scherer (1980) makes a similar point about the existence of some large sales situation, such as the arrival of a big order from a large buyer. In such a situation, one would predict that collusion will tend to break down because the short-run private gain from undercutting is large relative to the long-term losses associated with a subsequent price war.

Oligopolists are likely to recognise the threat to collusion posed by secrecy, and consequently may take steps to eliminate it. First, they may create an industry trade association that (among other functions) collects detailed information on the transactions executed by the association's members or allows its members to cross-check price quotations. The members of the industry can also give advance notice of their price changes. Second, the oligopolists may impose resale-price maintenance on their wholesalers or their retailers. The idea here is that any deviation from collusive behaviour is easily detected because a manufacturer's good is sold at a single price ungarbled by distribution idiosyncrasies and price discrimination. Parallel to this concept but on a scale involving countries rather than firms is the "most favoured nation" clause, requiring that the seller charge a buyer a price no higher than it charges any other buyer, which serves as a significant deterrent to price cutting. Thirdly, industries producing goods whose transportation costs are high relative to their value are often alleged to use basing-point pricing to collude. An example of basing-point pricing consists in charging a unique price at the point of production, e.g. ex-works, farm gate, ex-terminal, f.o.b. loading port; prices to various destinations are then equal to the announced base price plus freight to those destinations.

Chamberlin's suggestion that the likely market outcome is the monopoly price raises the question of what happens if the oligopolists have divergent preferences about prices and, in particular, different monopoly prices. For instance, their marginal costs may differ (as indeed they do among iron ore mines), so the lower-cost firms would like to co-ordinate on a lower price that the higher-cost firms. The firms may also offer differentiated products (differentiated according to quality, location, distribution channels, etc.). It is often felt that heterogeneity in both costs and products may make co-ordination on a given price difficult. Under symmetric conditions, the price to co-ordinate on seems to be naturally the monopoly price. This price maximises profit and involves a symmetric repartition of profits. Under symmetric costs, there is no "focal" price on which to co-ordinate.

II.1.2 Combining Demand and Supply

It is now time to introduce the industrial structure of the other "side of the coin" in the iron ore market, i.e. consumers. So far the discussion was based on the assumption that industry concentration exists only on the producer's side. Iron ore is the direct input in the steel production process, so it is expected that the world's biggest steel producers will be the major sources of demand for the commodity.

Steel production is concentrated primarily in the northern hemisphere, with Japan, the United States and European Union countries being the most prominent producers of steel. Within the European Union it is only a handful of countries that play a leading role in steel production and feature regularly in the league of top iron ore importers: Germany (also before unification as the Federal Republic of Germany), United Kingdom, France, Italy and Belgium. For the last 30 years these names have featured almost uninterruptedly in the top 10 world importers of iron ore.

Table II-2

Shares of the top 10 iron ore importers (1965-1995)

1995		1990		1985		1980	
Japan	29%	Japan	35%	Japan	39%	Japan	39%
Germany	10%	Germany	12%	Germany	14%	Germany	15%
China	10%	Korea	6%	Belgium	6%	USA	7%
Korea	8%	Belgium	6%	Italy	6%	Belgium	7%
UK	5%	France	5%	Poland	5%	Poland	6%
France	5%	USA	5%	France	5%	France	5%
Italy	4%	Italy	5%	USA	5%	Italy	5%
USA	4%	UK	4%	UK	5%	Korea	3%
Belgium	4%	China	4%	Korea	4%	UK	3%
Poland	3%	Poland	3%	Netherlands	3%		
Czech Rep.	2%	Romania	3%				
Netherlands	2%	Netherlands	2%				
Spain	2%						
Romania	2%						
Total	**90%**	**Total**	**91%**	**Total**	**91%**	**Total**	**90%**

1975		1970		1965	
Japan	41%	Japan	35%	USA	26%
USA	15%	Germany	17%	Germany	20%
Germany	14%	USA	17%	Japan	17%
Belgium	8%	Belgium	11%	Belgium	13%
UK	5%	UK	7%	UK	10%
Italy	5%	Italy	4%	Italy	4%
France	4%				
Total	**91%**	**Total**	**91%**	**Total**	**91%**

***Source:** Authors' calculations based on trade figures from UN Statistics Bureau*

Top of the league since the 1970s has been Japan, with import shares between approximately 30-40%. Germany has been a regular second largest importer, while this position used to be territory for the United States in the past. Among the most interesting recent development was the appearance of other Far East Asian countries in the list, most notably Korea and China which took third and fourth place in 1995. A complete listing of countries accounting for at least 90% of world iron ore imports is given in Table II-2 above.

II.1.2.1 Bilateral Monopoly

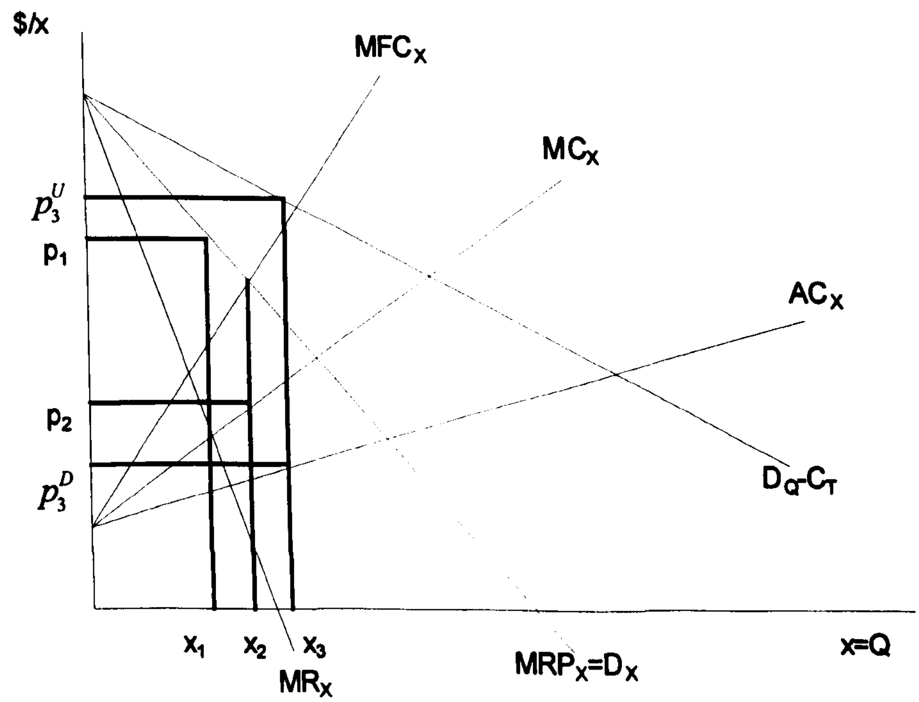
In view of the organisation of the demand side of the industry, it is reasonable to look at theories encompassing more restrictive types of industrial organisation, whereby agents (countries, companies) on both demand and supply are limited. The first candidate for such scrutiny is the bilateral monopoly model. To avoid some confusion which has occurred before in economic literature, a bilateral monopoly is present when an upstream monopolist sells its output to a single downstream buyer that may also be a monopolist in its output market. The theory of bilateral monopoly has a rich history that can be traced to the writings of Cournot (1838 and 1927) and Menger (1871). As Blair et al (1989) note, however, "over the 150 or so years that the problem has been under consideration, economists have offered a variety of solutions, ranging from a completely determinate intermediate good price and output to a completely indeterminate solution within a specified range ... this historical divergence of opinion concerning the correct outcome under bilateral monopoly still persists."

What is then that makes bilateral monopoly such attractive a concept but creates such a variety of approaches to its solution? There are a variety of assumptions made at the outset of each bilateral oligopoly discussion, but we will first look at the most "conventional" analyses that have been offered over the years. Models can be broadly classified into deterministic and stochastic, according to whether the economic agents make their decision under condition of certainty or uncertainty. Models of certainty are discussed first.

A "conventional" analysis of bilateral monopoly, found in several economics textbooks[2], is summarised in Figure II-5 below. A fixed input/output ratio equal to one is assumed, without loss of generality. If the downstream were competitive in the final output market, the derived demand for the input would equal $D_Q - C_T$, where D_Q is final product demand and C_T is the constant cost of transforming one unit of input x into one unit of output Q. Thus, $D_Q - C_T$ represents the average net revenue as a function of the quantity of x employed. With monopoly in the sale of Q, however, the derived demand for x will be the curve that is marginal to $D_Q - C_T$, which is labelled D_x in the graph. Thus D_x represents the net marginal revenue product of input x. The curve labelled MR_x is marginal to D_x and represents the marginal revenue associated with selling this intermediate good to a downstream firm that has monopoly power in Q but not monopsony power in x. Note, however, that D_X cannot constitute the downstream firm's derived demand in the bilateral monopoly situation because a monopsonist is not a price taker and does not have a demand curve.

Figure II-5

Bilateral Monopoly



Turning to the cost curves, AC_X denotes the upstream monopolist's average cost of producing input x, and MC_X is marginal cost. If the supplier of x were to behave as a perfect competitor, MC_X would correspond to its supply curve. Then, if the downstream monopsonist were hiring this input form such a competitor, MFC_X would be the marginal factor cost of the input. Authors adopting the standard

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[2] See for example Baird (1975), Barrett (1974), Koutsoyannis (1975) and Mansfield (1982).

approach typically arrive at their conclusion that the bilateral monopoly problem is indeterminate by alternately assuming that one trading partner and then the other behaves as would a perfect competitor.

If the upstream firm behaves competitively, then its supply curve will correspond to MC_x. In this case, the downstream firm will arrive at the standard monopsony solution, buying x_2 units of the intermediate product at a price of p_2 per unit. If, on the other hand, the downstream firm behaves as a perfect competitor in its hiring decision, then the upstream firm will exercise its monopoly power in supplying the input. In this case we have the input monopoly solution at x_1 and p_1. According to the conventional analysis, these two outcomes set the bounds on the equilibrium price-quantity combination. Many textbooks usually conclude that the solution to the bilateral monopoly model will fall somewhere within the $(p_1, x_1) - (p_2, x_2)$ range in Figure II-5.

This so-called conventional solution has been criticised as incorrect[3] because it fails to take into account one fundamental difference of bilateral monopoly (from perfect competition): the ability for co-operation and joint profit maximisation. Authors as early as Bowley (1928) have pointed out that there is a profit incentive for co-operation between upstream and downstream firms under the conditions of bilateral monopoly, where some negotiation between buyer and seller is required

[3] See for example Blair, Kaserman and Romano's (1989) critique of textbook treatment of bilateral monopoly.

for exchange to take place. The incentive to pursue joint profit maximisation arises because joint profits are not maximised at either of the two boundary solutions presented in the conventional analysis. Such co-operation may take the extreme form of vertical integration, as suggested by Stigler (1966) and Friedman (1976); or it may come about through the bargaining process. For the latter, it is important to realise that the negotiation that takes place must involve quantity if joint profits are to be maximised. In this market setting, however, it is theoretically unlikely that one firm would chose price and allow the other to select quantity without negotiation. Rather, as Machlup and Taber (1960) point out, both price and quantity will be determined through bilateral bargaining. They also speculate that failure to recognise this essential difference between bilateral monopoly and all other market structures accounts for the lack of unanimity among the authors writing on this subject.

To analyse the outcome of this bargaining process I use Blair's et al (1989) framework, assuming the following:

x = intermediate product that is traded under bilateral monopoly conditions;

$C(x)$ = total cost of producing x;

y = some other input that is competitively supplied at a constant cost of p_y;

$Q = Q(x,y)$ = final output quanity, a function of x and y;

p_x = price of the intermediate good x;

$P = P(Q)$ = final output inverse demand.

Now, if the two monopolists were to vertically integrate, the profit function of the integrated firm would be

$$\pi^I = P[Q(x,y)] \cdot Q(x,y) - C(x) - p_y \cdot y$$

Eq. II-5

Profit maximisation by the vertically integrated firm would result in the production and employment of inputs x and y such that

$$(p + QdP/dQ)(\partial Q/\partial x) = dC/dx$$

Eq. II-6

and

$$(p + QdP/dQ)(\partial Q/\partial y) = p_y$$

Eq. II-7

That is, integrated profits are maximised where the marginal revenue products of the inputs are equated to their marginal costs. For the special production function employed in Figure II-5, this corresponds to x_3 units of output (and input). It is at this output only that joint profits are at a maximum.

Suppose, however, that the bilateral monopolists do not integrate vertically. Instead, they continue to conduct arms-length negotiations on p_x and x. Then, as Bowley point out, such negotiations will necessarily result in precisely the same joint profit maximising quantity of the intermediate good being exchanged (and the same employment of input y). As a result, both the price of the final good and its output are determinate in this model and are equal to the price and output that result with vertical integration. Blair et al (1989) proceed further to prove this result in the two more specialised cases: firstly, where either of the firms dominates in the negotiation procedure; and secondly where none of the firms is dominant in negotiations. In the first case the price (at the extreme) is achieved either at p^U (if the upstream producer is dominant) or p^D (if the downstream consumer is dominant). In the second case, the contract curve is the vertical line going through the intersection of MC_X and MRP_X. The extend of this curve is bound by the fact that neither monopolist need ever have negative profits in the event of breakdown of negotiations. In Figure II-5 above, the contract curve does not stretch beyond p^U or beyond p^D.

Despite the very confident analysis of Blair, Kaserman and Romano (1989), however, there still seems to be persistent disparity in the results different authors get from their analyses of bilateral monopoly. Even their own analysis comes under scrutiny by Truett and Truett (1993), who argue that it is not reasonable to expect the solution to the traditional bilateral monopoly problem to yield a determinate quantity traded of the intermediate product but *not* a determinate intermediate product price. They find convincing the fact that under reasonable assumptions (downward-sloping demand curve for final product, increasing marginal cost of production of intermediate product) only one quantity traded of the intermediate good is consistent with joint profit maximisation. However, joint profit maximisation at all but one of the possible intermediate good prices over time requires either (a) accommodating non-profit maximising behaviour on the part of one of the two parties to the bargain or (b) that one firm has a degree of power over the other that would seem difficult to maintain over very long periods of time. In the latter case, the dominant firm would have to be able to control both the price and output of the second firm, a degree of market power that would be greater than that a monopoly seller firm has over perfectly competitive buyers. Truett and Truett (1993) tackle this apparent anomaly by going one step further than the usual, somewhat vague (in terms of price determination) solution to the bilateral monopoly situation. They look at the contract curve in bilateral monopoly as the locus of tangent points between different isoprofit curves for the monopolist and the monopsonist and suggest that there should also be a determinate equilibrium price, which is found at the intersection of the seller's marginal cost function and the buyers marginal value product function.

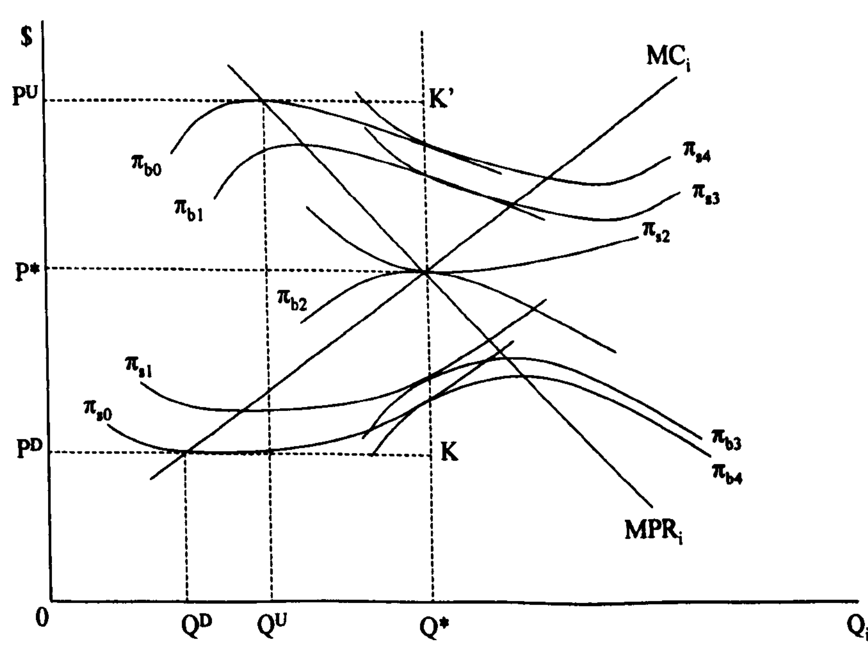
Figure II-6 recreates the diagram used in Truett and Truett (1993), also found in Blair, Kaserman and Romano (1989), and which is based on the suggestions of Fellner (1947).

The contract curve (KK') is vertical, indicating that Pareto-optimal joint profit maximisation is consistent with only one quantity traded, Q^*. Of the isoprofit curves, π_{s0} and π_{b0} indicate the zero-profit indifference curves of the seller and the buyer of the intermediate good, respectively.

According to the analysis mentioned earlier, Fellner (1947) and Blair, Kaserman and Romano (1989) argue that the firms will *somehow* discover that joint profit maximisation requires Q^* and will agree on that quantity and some price lying along the contract curve. Truett and Truett (1993) argue that despite earlier dismissals, it is at price P^* that the bilateral monopoly will reach its equilibrium. They state a very simple reason for such a result: any other price used in combination with the equilibrium quantity Q^* creates the incentive for one of the two firms to balk on the delivery of Q^*.

Figure II-6

Isoprofit Curves and the Contract Curve in Bilateral Monopoly



For example, let us assume that the dominant party is the buyer, who manages to impose the equilibrium quantity Q^* and the equilibrium price P^D which results is profits along π_{b4} for the buyer and π_{s0} (zero profits) for the seller. In view of this, the seller will have the incentive to perform worse than expected and end up delivering Q^U, which maximises its own profits for the given price. How can this be done? Quite easily and plausibly: production difficulties, shortages of raw materials, labour problems, and several other justifications can be (and have been) used. A similar situation can be envisaged in the case of the buyer balking on his purchase commitments, with a host of excuses and stalling techniques in his arsenal as well.

Moreover, despite the fact that many authors have noted that bilateral monopoly requires negotiation of both price and quantity, not many have accounted for the fact that contracts are normally of limited duration and they have to be renegotiated. On the basis of this, Truett and Truett (1993) argue that if the two firms periodically renegotiate and neither has absolute market power, the goal of profit maximisation and reasonable assumptions regarding the reaction and counter-proposals of one firm to price/quantity offers by the other will lead them to an equilibrium at P^*. This is the only price that does not create an incentive for either firm to either balk or renegotiate, given that each firm has acquired learning about the other firm's strategy through repeated renegotiations.

Much of the experience on which Truett and Truett (1993) build their arguments has been accumulated from the labour market and they often quote examples of labour disputes, labour contract renegotiations, balking on the part of both trade unions and employers, etc. Similar experiences, however, do exist in raw materials markets, as well. In the case of iron ore, more specifically, balking on deliveries has not been uncommon in recent years, as it is discussed in chapter III.

II.1.2.2 Bilateral Monopoly under Uncertainty

So far, the discussion has relied on an almost implicit, but very important assumption: modelling of economic behaviour is under conditions of perfect or complete information. There are other assumptions that have been made, of course, which are less or more critical, but the degree to which economic agents possess knowledge about their competitors and the market is quite important. In bilateral monopoly it is often assumed that both the monopolist and the monopsonist have complete information about each other's actions, strategies, preferences, cost characteristics, etc. Under these assumptions (and a few more like cost symmetry) the behaviour of both firms has been described as a two-person variable sum game.

Unfortunately, reality is quite different and does bring with it several degrees of uncertainty. Oligopoly – as well as game – theorists usually make a distinction between imperfect and incomplete information. According to Tirole (1988) an agent (or player) has *imperfect* information when he does not know what the other players have done beforehand.[4] On the other hand, an agent has *incomplete* information when he does not know the rival's precise characteristics (preferences, strategy spaces, cost structures, etc.) The two types of information asymmetry are often confused in literature, but it is games with incomplete information that are more interesting (and more relevant) in this context. This notwithstanding, we look only at the theoretical foundation of games with incomplete information (including one interesting application: sequential bargaining with incomplete information) and then focus on everything that has been written on bilateral monopoly under conditions of informational asymmetries.

First we look at the perfect Bayesian equilibrium, which is combination of (subgame) perfect-equilibrium concept for dynamic games and the Bayesian-equilibrium concept for games of incomplete information. A simple illustration of the perfect Bayesian equilibrium can be given with the help of Figure II-7.

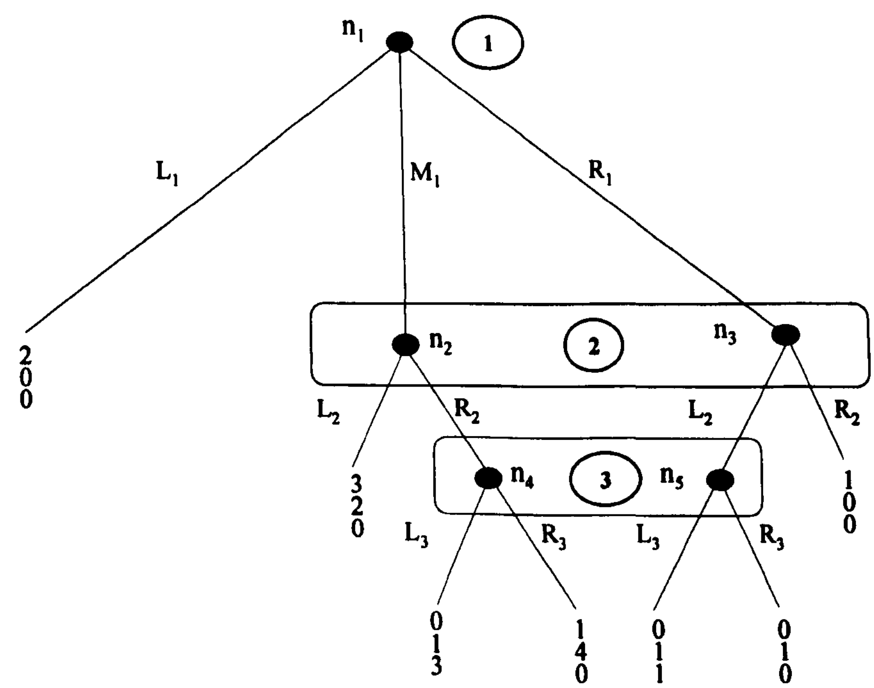
This game has three players and takes place over three periods. In period 1, player 1 can choose from among three actions: "left" (L_1), "middle" (M_1) and "right" (R_1). If player 1 chooses one of the latter two, player 2 gets to choose between "left" (L_2) and "right" (R_2), although he is not informed of player 1's exact choice (he knows only that player 1 did not choose L_1). The imperfect information of

[4] According to this definition, a whole sub-set of games – simultaneous games – are games of imperfect information, by assuming that one player chooses before the other and that the latter does not know the action chosen by the former.

player 2 is represented by an information set {M_1, R_1}, characterised by the rounded rectangle around the two corresponding nodes (n_2 and n_3). Given his state of information, player 2 is faced with the same choices at nodes n_2 and n_3.

Figure II-7

Game with Incomplete Information



Finally, for move {M_1, R_2} or {R_1, L_2} player 3 must choose between "left" (L_3) and "right" (R_3) in the third period without knowing which of the nodes (n_4 or n_5) the game has attained. The values of the objective functions are written at the bottom of the tree. For example, for moves (M_1, L_2) player 1 receives 3, player 2 receives 2 and player 3 receives 0.

Solving this problem can be done using two different approaches: that of a game theorist and that of a statistician. The game theorist will need to know the subjective probabilities attached o each information set and will then equate this problem to a perfect-information game. The (Bayesian) statistician, on the other hand, will ask for a set of strategies, from which he will be able to calculate the probabilities which the players should attribute to the various nodes. In short, the optimal strategies in such an equilibrium must satisfy two conditions: (a) strategies are optimal given beliefs (necessary for perfect equilibrium); and (b) beliefs are obtained from strategies and observed actions using Bayes' rule (necessary for Bayesian equilibrium).

The above game actually has a simple (trivial) solution, because of the existence of dominant strategies. Starting with player 3, he will always choose strategy L_3 (it is the one that gives him positive payoffs, instead of zero). Because of this the game can be converted to a two-period, two-player game. We observe that player 2 now has a dominant strategy (L_2). Consequently, the unique perfect Bayesian equilibrium is given by strategy (M_1, L_2, L_3).

One interesting application of a game with incomplete information is "sequential bargaining", for which we follow the discussion in Fudenberg and Tirole (1983). Bargaining usually involves asymmetric information. For instance, the seller (respectively, the buyer) may have incomplete information about the buyer's willingness to pay (respectively, the seller's reservation price). To the extent that bargaining proceeds through a series of offers, refusals, counteroffers, and so on, it is natural to model it as a dynamic game of incomplete information. A simple instance of such a formalisation is given below.

Consider the following simple bargaining problem: a buyer and a seller negotiate over one unit of a product (or a contract). The seller makes an initial offer of p_1, which the buyer either accepts or refuses. If the offer is refused, the seller makes a second offer, p_2. If the second offer is also refused, each party goes his own way and the seller keeps his product. The value of the product is s for the seller and b for the buyer. (*Value* must be interpreted in a broad sense that includes the possibility of outside exchanges with other parties).

Assume that the discount factor is δ_s for the seller and δ_b for the buyer and that both parties are risk-neutral. Therefore, the utilities of the seller and the buyer are $[p_1, b - p_1]$ if p_1 is accepted, $[\delta_s p_2,\ \delta_b(b - p_2)]$ if p_2 is accepted, and $[\delta_s s, 0]$ if p_2 is refused. Incomplete information is restricted in the following aspect: The seller does not know whether the value of the product is $\bar{b}$ or $\underline{b}(\bar{b} < \underline{b})$ for the buyer. The seller puts equal probabilities on these two values, whereas the buyer knows b. Both parties know everything else. Assume that there is always some potential gain from exchange: $s < \underline{b} < \bar{b}$. Moreover, it is assumed that $\underline{b} > (\bar{b} + s)/2$. This condition implies that if the seller were authorised to make only one offer, he would choose to sell surely (by charging $\underline{b}$) rather than run the risk of losing the sale (by trying to sell at price $\bar{b}$).

Looking now at the strategies and beliefs the following is possible. First, the seller makes an offer p_1. The buyer accepts ($d_1 = 1$) or refuses ($d_1 = 0$), depending on p_1 and on his willingness to pay. Thus, the buyer's strategy can be denoted as $d_1(p_1,b)$. If the buyer refuses p_1, the seller deduces from this a posterior probability that the buyer's willingness to pay is equal to $\bar{b}$, which is denoted as $\mu(\bar{b} \mid p_1)$. Obviously, $\mu(\underline{b} \mid p_1) = 1 - \mu(\bar{b} \mid p_1)$. The seller then makes a subsequent offer, $p_2(p_1)$. Finally, the buyer accepts p_2 ($d_2 = 1$) or refuses p_2 ($d_2 = 0$), according to the decision rule $d_2(p_1, p_2, b)$.

Fudenberg and Tirole (1983) and Tirole (1988) outline five steps in resolving this game.

(1) The first step consists of writing the "self-selection constraints" that must be satisfied by an equilibrium path. By self-selection constraints they mean the constraints expressing the fact that in equilibrium a player of a given type does not strictly prefer to adopt a strategy other than his own (such as that of the same player when he is of a different type). Here, the buyer can be of two types, $\underline{b}$ and $\bar{b}$. They refer to "the buyer of type $\underline{b}$" (respectively, "type $\bar{b}$) to designate the buyer who attaches a value $\underline{b}$ (respectively, $\bar{b}$) to the product. During the second period, self-selection constraints are trivial; the buyer of type b buys if and only if $p_2 \leq b$. Analogously, the buyer of type of type b will accept an offer p_1 during the first period if an only if

$$b - p_1 \geq \delta_b\{\max[b - p_2(p_1)),0]\}$$

The equation above represents the following: If the buyer accepts offer p_1, his utility is $b - p_1$; and if refuses, the seller charges $p_2(p_1)$.

(2) The second step is to look at the consequences of the self-selection constraints on the seller's posterior probability distribution over b. Clearly, it may be assumed that p_1 was refused (otherwise bargaining is completed and the distribution no longer matters). Since an offer accepted by the type-$\underline{b}$ buyer, the probability of facing the latter type when the offer is refused is, at most, ½.

(3) The third step is to return to the strategy space by examining the effects of this distribution on the strategy of the seller in the second period. When the seller can make only one offer, and his distribution over b is uniform he behaves cautiously by assumption (that is, he charges $\underline{b}$). A fortiori, when his subjective probability of facing buyer $\bar{b}$ is less than ½ he must also behave cautiously; therefore, regardless of p_1, we have $p_2(p_1) = \underline{b}$. And the final two steps of characterisation are now:

(4) Forecasting that the seller will charge $\underline{b}$ if he refuses the first offer, the buyer of type $\underline{b}$ accepts it if and only if $p_1 \leq \underline{b}$. Buyer $\bar{b}$ accepts p_1 if and only if $\bar{b} - p_1 \geq \delta_b(\bar{b} - \underline{b})$ or simply $p_1 \leq \tilde{b} = \delta_b \underline{b} + (1 - \delta_b)\bar{b}$

(5) Finally, the seller chooses p_1 in order to maximise his expected profit. He chooses between $\underline{b}$ and $\tilde{b}$ depending on whether $\underline{b}$ is greater or less than $(\tilde{b} + \delta_s \underline{b})/2$. If he proposes $\underline{b}$, this offer is accepted by both types of buyer. On the other hand, if he proposes $\tilde{b}$, he benefits from buyer $\bar{b}$'s impatience, knowing full well that he will be able to enter into an exchange in the second period if the buyer turns out to be of type $\underline{b}$. Because during the characterisation we defined the players' strategies and beliefs for each history of the game, we conclude that the game has a unique Bayesian equilibrium.

When the element of uncertainty is introduced in bilateral monopoly situations, several authors have reached quite interesting and insightful conclusions, although in most cases models had to be simplified considerably. Samuelson (1980), for example, looked at a very simple bilateral monopoly situation, whereby one of the two parties gets the chance (for some unspecified reason) to make a first and final offer to the other party. In this model each party is uncertain about the other party's *reservation* price[5] and, in making a price offer, each faces a trade-off between his individual gains (if a bargain is successful) and the probability that a mutually acceptable bargain is concluded. Williamson suggests some examples of where such a situation may arise, the most notable being that of a contract negotiation, whereby the respective reservation prices would represent the most generous offer of management and the minimum contract demand of labour. One could think of a similar situation in an iron ore contract negotiation, whereby price (but not only that) is negotiated in a similar manner. Following the obvious observation that a transaction will take place if the either party makes an offer between the two reservation prices, he also notes that usually the profit maximising buyer "shades" his offer below his true reservation price, while the seller "marks up" his reservation price in making an offer. More importantly, however, Samuelson also concludes that a risk-averse party makes a more ***truthful*** offer than a risk-neutral one, an important conjecture on which we will refer to again in chapter IV.

Williamson extended his observations on bilateral monopoly under uncertainty in a subsequent paper with Chatterjee (1983). Some of the most important points made there can be summarised as follows:

- bargaining under uncertainty will, in general, fail to be Pareto optimal;
- the higher the value placed on the good by the seller (buyer), the higher the price he demand (offers);
- an increase in the risk aversion of the seller (buyer) implies uniformly lower (higher) offers by both parties in equilibrium;
- the better the bargainer's information about his opponent, the better he can expect to fare in the negotiations;

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[5] Reservation price is the maximum (minimum) price that a buyer (seller) is willing to offer (receive).

- probability assessment becomes more complicated in an environment with stochastic dependence between the player values;
- single-stage bargaining is rather restrictive as it fails to capture the pattern of reciprocal concessions observed in everyday practice.

Rapoport and Fuller (1995) also look at the problem of bilateral monopoly with two-sided incomplete information, focusing on a more specialised case that involves a sealed-bid double auction mechanism. Although not directly relevant to our problem at hand, they make one very interesting conclusion: "Sellers tend to underbid and buyers to overbid … however, strategic behaviour is moderated by the tendency to bid honestly … honesty in bargaining is supported by social norms … *more importantly, honest bidding in the bilateral monopoly task maximises the probability of trade … if the subjects are more interested in maximising the efficiency of trade rather than their own expected value, their inclination to exaggerate their reservation prices must decline.*"

Closing this section is a most challenging contribution by Dobbs and Hill (1993) who also looked at bilateral monopoly under uncertainty and suggested a completely different approach to the usual pricing problem facing both theorists and firms: where exactly on the contract curve will the final price lie? The authors propose the use of a non-uniform pricing schedule, rather than the application of single uniform price. They maintain that "appropriately designed, a non-uniform pricing schedule will be acceptable to the buying firm so long as the appropriate profit transfer is effected and the joint profit maximising quantity traded. At the same time, the agreement need not involve *requiring* the firm to purchase the joint-profit maximising quantity ." They go on to support the use of a non-uniform pricing schedule in lieu of a contract when the bilateral monopoly takes place in an uncertain environment. They claim that a contract in such a case must be continually renegotiated, which would entail significant negotiation costs, or a "state-contingent"[6] contract would have to be used instead.

Following this initial observation, Dobbs and Hill investigate the advantages of using non-uniform pricing in bilateral monopoly under uncertainty, assuming risk-neutral players. They end up with two similar propositions: firstly , they conjecture that a non-uniform pricing schedule (involving marginal pricing) exists (under certain conditions) that can resolve the bilateral monopoly pricing problem; and secondly, that a take-or-pay pricing contract exists which solves the bilateral monopoly problem. This latter contract also involves marginal cost pricing on the interval of uncertain demand and a take-or pay quantity and minimum payment.

The authors conclude with some notable examples where take-or-pay contracts are indeed used in real life, such as in the case of gas, bauxite and coal. The same is not the case, to our knowledge, in iron ore, but their proposals offer a very

[6] A state-contingent contract specifies quantity and money transfer for each possible state of the world.

interesting challenge to the way long-term iron ore contracts are structured and their future survival.

II.2 Commodity Market Models

In the long history of studying the demand, supply and exchange of raw materials a multitude of models has been used. In the process, a number of methodologies has been applied to analyse different aspects of commodity economics. Labys (1983) and Labys and Pollak (1984) have collected and classified such models and their taxonomy is summarised in Table II-3, which is reproduced from Labys and Pollak (1984, p. 45).

Table II-3

Taxonomy of Commodity Modelling Methodologies

Modelling Process / Methodologies	What is the purpose of the methodology?	What quantitative method is used?	What economic behaviour is specified?	Examples of commodity applications
Market Model	Demand, supply, inventories interact to produce an equilibrium price in competitive or non-competitive markets	Dynamic micro econometric system composed of difference or differential equations	Interaction between decision makers in reaching market equilibrium based on demand, supply, inventories, prices, trade, etc.	Cobalt, Energy, Lauric Oils, Rubber, Soybeans, Sugar, Tungsten
Process Model	Demand and production determined within an industry, focusing on transformation from product demand to input requirements	Dynamic micro economic difference equation system suitable for integrating linear programming on production site	Interaction between decision makers in industries, markets, national economies based on demand, inventories, production, investment, capacity utilisation, commodity inputs, prices, etc.	Petroleum, Steel
Systems dynamics model	Demand, supply, inventories interact to produce an equilibrium price emphasising role of amplifications and feedback delays	Dynamic micro econometric differential equation system which features lagged feedback relations and variables in rates of change	Interaction between decision makers in adjusting rate of production to maintain a desired level of inventory in relationship to rate of consumption	Aluminium, Broilers, Cattle, Copper, Hogs, Orange Juice
Spatial equilibrium and programming models	Spatial flows of demand and supply	Activity analysis of a spatial and/or	Interaction between decision makers in	Bananas, Broilers,

Methodologies \ Modelling Process	What is the purpose of the methodology?	What quantitative method is used?	What economic behaviour is specified?	Examples of commodity applications
1. Linear and quadratic programming	and equilibrium conditions assigned optimally in equilibrium depending on configuration of transportation network	temporal form. Degree of complexity depends on endogeneity and method of incorporation of demand and supply functions	allocating shipments (exports) and consumption (imports) optimised through maximising sectoral revenues or minimising sectoral costs	Livestock, Oranges, Palm Oil, Wheat
2. Recursive programming	Production conditions and input revenue determined through primal/dual of linear programme. Recursivity introduced through feedback component which includes profit, capital and demand	Activity analysis involving a sequence of constrained maximisation problems in which objective function, limitation coefficients depend on optimal primal/dual solutions attained earlier in the sequence	Interaction between decision makers in reaching market equilibrium involves adaptive intertemporal processes related to production, investment and technological change	Coal, Iron, Steel, Wheat, Corn, Soybeans
3. Mixed integer programming	Spatial and temporal equilibrium embodying production-process, transportation, and project investment components	Activity analysis involving spatial and temporal optimisation but also including integer (0/1) variables to represent capacity additions	Interaction between decision makers in finding minimum discounted costs of meeting specific market requirements, i.e. project selection	Aluminium, Copper, Fertilisers
Optimisation model	Supply and demand analysed in relation to optimal resource exhaustion over time and cartel behaviour	Dynamic micro econometric system featuring formal cartel-fringe models such as that of monopoly, Stackelberg and Nash-Cournot	Interaction between decision makers in optimising resources allocation and prices over time in non-competitive markets involving bargaining activity	Aluminium, Copper, Oil
Input-output model	System regarded as process that converts raw materials into intermediate and final products via intermediate processes. Investment strategies evaluated in terms of raw material supply and demand	Input-output model combined with macro economic framework or disaggregated raw materials balance framework	Interaction between non-fuel and fuel commodities and macro markets in reaching materials and energy balance including supply-demand determination	Minerals, Energy, Agriculture
Systems simulation model	Demand, supply and other major variables and objectives considered as a complete system rather than a single market	Dynamic micro econometric equation system which when formed into a simulation framework is coupled with activity analysis and/or decision rules	Interaction between decision makers belonging to the system environment based on performance variables such as revenues, costs as well as market variables such as demand, supply, prices, etc.	Beef, Energy, Fish, Livestock, Multi-commodity, Rice

Among the earliest attempts to model trade flows are those of Tinbergen (1962), Poyhonen (1963), Pulliainin (1963) and Linnemann (1966). The ‘gravity’ models developed by them explain trade by the income of each of the trading partners and the distance between them.

The original Tinbergen-Linnemann framework is adapted by Tilton, Dorr and Whitney in their studies of non-ferrous metals. Tilton (1966) concluded that the choice of trade partners is strongly influenced by international ownership ties, political blocs, government regulation and participation in trade, established buyer-seller ties, and the heterogeneous nature of ores and metals. Dorr (1975) studied the trade in bauxite, alumina and aluminium and confirmed the findings of Tilton. Whitney (1976) showed that the geographical distances separating trading partners, together with their export and import potentials, are the most important determinants in the trade of more highly processed copper products.

II.3 Iron Ore Market Models

Unlike several other mineral commodities, iron ore has not been tackled extensively in international literature. There has only been a handful of attempts to model either the behaviour of the iron ore supply/demand mechanism or the resulting trade flows.

II.3.1 Gravity Models

The earliest attempt to deal with iron ore trade is by Margueron (1969). Apparently influenced by Tilton, Margueron hypothesised in his study that the flow of trade T_{ij}, from the exporting country i to the importing country j depends linearly on the following nine variables:

$$T_{ij} = f(X_i, M_j, TC_{ij}, PC_i, BF_i, OWN_{ij}, EFTA_{ij}, BCW_{ij}, EEC_{ij})$$

Eq. II-8

where T_{ij} is the volume of trade between country i and country j, in thousand metric tons contained iron;

X_i is the potential for export of country i, proxied by the total export of country i, in thousand metric tons contained iron;

M_j is the potential for import of country j, proxied by the total import of country j, in thousand metric tons contained iron;

TC_{ij} is the transportation cost per ton of contained iron from country i to country j, in US dollars;

PC_i is the per ton cost of iron ore export in US dollars;

BF_i is the cost of smelting the ore in terms of additional coke and limestone related to the chemical properties of the ore;

OWN_{ij}, are foreign ownership ties, proxied by the actual export of country i to country j from firms controlled by country j;

$EFTA_{ij}$, BCW_{ij}, EEC_{ij}, are dummy variables which take the value one if the trading countries are both members of the same political bloc (European Free Trade Association, British Commonwealth and European Economic Community) and zero otherwise.

Estimates of the parameters show that the coefficients of OWN_{ij}, BF_i and TC_{ij} are, respectively, significant at the 99, 94 and 86 per cent levels. Coefficients of X_i, M_j, PC_i, $EFTA_{ij}$, BCW_{ij}, and EEC_{ij} are not significant at the 86 per cent level. Signs of the coefficients are as expected except for PC_i and EEC_{ij}. On the basis of the above results Margueron concluded that the most important determinants of trade, in order of decreasing importance, are OWN_{ij}, BF_i and TC_{ij}.

Santos (1976) noted the following shortcomings in Margueron's work:

a) Margueron interpreted statistical significance as a measure of the relative importance of the explanatory variables, which led to an erroneous conclusion. On the basis of the size of the beta coefficients the ranking of the significant variables in descending importance is TC_{ij}, OWN_{ij} and BF_i.

b) It was noted that at the 95 per cent level of significance only OWN_{ij} is significant and at the 90 per cent level only OWN_{ij} and BF_i are significant.

c) X_i, M_j, PC_i, $EFTA_{ij}$, BCW_{ij}, EEC_{ij} are not significant in explaining trade flows, contrary to what traditional trade theories imply.

d) Since X_i depends on PC_i and BF_i, inclusion of the latter two variables in the model appears superfluous. This misspecification could bias the results of the model.

e) Since X_i and M_j are estimated by the total exports of country i and total imports of country j, they depend on T_{ij}, since X_i equals the vector that results when T_{ij} is summed all over j and M_j equals the resulting vector when T_{ij} is summed over all i. Since causality apparently flows in both directions and not just from the independent variables to T_{ij}, simultaneous equation techniques should have been used to estimate the model's parameters.

Santos (1976) in his study of iron ore trade, also used the Tinbergen-Linnemann framework to analyse international flows of the commodity. Like the Tinbergen-Linnemann approach, the model consists of variables used to measure three determinants of trade: export potential, import potential, and resistance parameters. More formally:

$$T_{ij} = f(XP_i, MP_j, RT_{ij})$$

Eq. II-9

where T_{ij} is the volume of trade between country *i* and country *j*;

XP_i is the potential for export of country *i*;

MP_j is the potential for import of country *j*;

RT_{ij} is a set of 'resistance' variables, like tariffs, neighbour ties, transport costs, etc.

Santos used the difference between mine production capacities and pig iron capacities in importing and exporting countries to measure, respectively, their import and export potentials. He also used neighbour ties (LN_{ij}), economic distance (ED_{ij}), long-term contracts (LTC_{ij}) and foreign ownership ties (OWN_{ij}) as resistance variables, while he correctly dropped variables representing membership to politico-economic groups (such as the British Commonwealth and the EEC), since there are no tariff on non-tariff barriers in iron ore trade.[7]

Santos's model consists of the main structural equation (III.3) and a number of ancillary equations used to estimate the export and import potentials of the trading partners, long-term contracts, pig iron and crude steel production capacities and reserves.

$$T_{ij} = t_0+t_1XP_i+t_2MP_j+t_3ED_{ij}+t_4LN_{ij}+t_5OWN_{ij}+t_6LTC_{ij}+e^t{}_{ij}$$

Eq. II-10

where $t_0....t_6$ are coefficients, $e^t{}_{ij}$ is the error term, and all the other parameters as explained above.

Santos (1976, p. 58) found that only about 20 to 30 percent of iron ore trade could be explained by XP_i, MP_j and ED_{ij}. He also found that ownership ties and long-term contracts were important determinants of trade, albeit the former diminishing in importance over time.

When trying to analyse the determinants of long-term contracts, Santos found that the three variables he used (export potential, import potential and economic distance) explained only a small proportion of the dependent variable. He

[7] The absence of any such barriers from iron ore trade is still valid, as confirmed by Lord (1991, p. 263).

attributed the unexplained portion to other factors affecting profitability or security of supplies.

Santos found considerable deviations of actual iron trade flows from those predicted by his model. Several of these deviations appeared in bilateral flows between important exporter-importer pairs, such as Brazil-Germany, Brazil-Japan, Sweden-Germany, Sweden-Benelux, Australia-UK and Australia-USA, Although the model prediction for the very important Australia-Japan trade was very close to actual figures.[8]

The model developed by Santos does not attempt to calculate any import demand or export supply elasticities for iron ore trade. When validated, the model yielded predictions significantly different to actual figures both for trade flows and mine production capacities.

The model is also found wanting about its basic assumption about ownership ties and long-term contracts, although, in fairness, these shortcomings can only be highlighted only with the benefit of hindsight. Santos, as well as Margueron, paid particular attention to foreign ownership ties, which were quite important in the 1950s and 1960s, but declined in importance in the late 1960s and early 1970s, as Santos himself observes. Ownership ties do still exist of course, but in many cases

[8] In all cases, deviations refer to the predictions for 1973. Other substantial deviations were also noted for most of the years Santos used in his calculations (1950, 1955, 1960, 1965, 1970, 1973).

just in order to take advantage of commercial profits, and perhaps establish a minimum level of commitment of mines to specific steel mills. The most recent example of steel producers acquiring such equity stakes in iron ore production has been that of Chinese mills in both Australian and Peruvian mines (reference from the FT to be provided).

Long-term contracts also had a pivotal role in trade determination in the models of both Margueron and Santos. Although, long-term contracts still account for a significant part of iron ore flows, the 1980s also witnessed considerable defaults by the purchasing parties (due to stringent economic conditions), resulting in less iron ore liftings. As a result, long-term contracts now have a much shorter life (5 years is the norm), incorporate more flexibility in terms of allowed deviations from agreed quantities, and price renegotiations are on a yearly basis.

II.3.2 Oligopolistic Model of the Iron Ore Market

Ten years after Santos's work, Priovolos (1986) presented the model he developed in the Commodities Division of the World Bank. His approach is different to those of Margueron and Santos in two ways. Firstly, he explicitly viewed the iron ore market within an imperfectly competitive framework, taking into account the idiosyncrasy of the market's price setting mechanism. Secondly, he focused on the production, consumption and price determination, with trade flows appearing only as a balancing element. Overall, his approach is quite similar to that of Morgan (1949), who also used the iron ore industry as an example of price and quantity determination in bilateral monopoly.[9] Priovolos essentially views the market as a bilateral monopoly in each geographic region, with prices being set each year by the biggest regional producer (e.g. Brazilian mines) and the biggest regional importer (e.g. European steel mills). He does note, however, that "...over the last few years, competition has increased. Consumers and small producers have started to negotiate prices and quantities before the conclusions of the negotiations between the representatives of Continental Europe and Brazil. The aim of consumers in doing so is to influence the outcome of the negotiations with Brazil, Australia and other major producers, whereas the aim of small producers is to lock in their share of exports early in the year."

Table II-4: First Price Setters in Japanese and European Markets

	Japanese Market			European Market		
	First Price Settlement	Setter	Fines % change	First Price Settlement	Setter	Fines % change
1981	26/2/81	CVRD	+7.5	15/2/81	CVG/Belgium	+6.1
1982	26/3/82	Newman	+17.2	5/2/82	CVRD/Germany	+15.7
1983	28/3/83	CVRD	-11.4	8/3/83	IOC/Germany	-11.2
1984	20/1/84	CVRD	-11.6	7/12/83	QCM/Germany	-8.5
1985	31/1/85	MMTC	0	7/12/84	QCM IOC/Germany	0
1986	13/2/86	MMTC	-1.88	3/12/85	QCM IOC/Germany	-1.1
1987	20/2/87	Newman	-5.0	5/3/87	QCM/Holland	-9.3
1988	22/12/88	Hamersley	-4.0	24/12/87	Hamersley/Britain	+8.6
1989	14/12/89	Hamersley	+13.0	19/12/88	CVRD/Germany	+13.0
1990	24/1/90	Hamersley	+15.96	17/1/90	CVRD/Germany	+15.96
1991	30/1/91	Hamersley	+7.93	31/1/91	CVRD/Germany	+7.95
1992	17/12/91	Hamersley	-4.90	17/12/91	CVRD/Germany	-4.90
1993	13/1/93	BHP, CVRD, Robe	-11.0	22/12/92	SNIM/France	-13.47
1994	8/2/94	Hamersley	-9.5	8/2/94	Hamersley/Germany	-6.77
1994	8/2/94	Robe River	-14.5	11/2/94	CVRD/Germany	-9.5

Note: Hamersley sales price in the European market is based on C&F price.
Source: TEX Report, *Iron Ore Manual 94/95*.

[9] The original standard exposition of bilateral monopoly is in Bowley (1928), and also in Hicks (1935) and Henderson (1940).

His observations are confirmed in Table II-4, which shows that pricing initiatives in the European market were frequently taken by Canadian (QCM and IOC), Australian (Hamersley), Venezuelan (CVG) and Mauritanian (SNIM) firms, with Brazil's CVRD being the first price setter only in 6 occasions between 1981 and 1994.

In his subsequent analysis, Priovolos assumes that "....the general reference iron ore price (the CIF North Sea for Brazilian 65% Fe sinter fines) is being negotiated and set between representatives of Brazil and Continental Europe. This reference price is assumed to affect the negotiations of all other iron ore prices (in a non-homogeneous way). Under these negotiations [he assumes that] market participants recognise their mutual interdependence and reach mutually satisfactory agreement as to the reference price and the quantity that Brazil will export to most EEC countries."

Both negotiating parties make estimates about prices and quantities of iron ore that will maximise their own profits. So, for example, a European steel mill solves its profit maximisation problem – as a discriminating monopsonist – by equating marginal revenue with marginal cost. In a similar manner, a Brazilian mine – acting as a discriminating monopolist – also equates its marginal revenue with its marginal cost in order to maximise profits.[10]

[10] In both cases the equality of marginal revenue with marginal cost is the first order condition of the profit maximisation problem.

However, adds Priovolos (1986, p. 26) "...both participants in the negotiations know that their desired price and quantity maximise their own profit but not the profit of the other party. During the negotiations they will apply their bargaining power in order to achieve an outcome (i.e. a set of price and quantity) as favourable as possible to their operations. The participants agree first on the quantity to be traded. Usually the allotment is greater that the actually traded quantity. The agreed quantity is not binding on either party. The existence of spot market makes the quantities of iron ore competitively determined. Moreover, the competitive determination of the output results from the theory of bilateral monopoly and the analysis of the collusion and bargaining process of negotiating parties."

Priovolos uses the bilateral monopoly theory to establish the range within which prices will be negotiated, so that none of the negotiating parties is driven out of business. The determination of a specific price depends on the relative bargaining power of the iron ore supplier and the steel consumer. This second stage of price setting is analysed within the framework of a generalised stochastic n-person game without transferable utility as analysed by Nash, Shapley and Harsanyi and discussed in Friedman (1979).

In his model specification, Priovolos estimates iron ore production by regressing it on the rental cost of capital and the cost of petroleum and per unit of ore, the deflated dollar price of ore and the potential ore output. Apparent production of iron ore, on the other hand, is regressed on crude steel production, scrap prices and the deflated import price of iron ore.

When dealing with iron ore trade, Priovolos observes that "...most iron ore producers are important exporters and most iron ore consumers are often important importers." For this reason, imports and exports are calculated as simply balancing any demand deficits and production surpluses, respectively.

Priovolos' simplifying assumptions about the price/quantity setting mechanism in the iron ore market facilitates his subsequent analysis, but does so at the cost of ignoring the actions of other exporters and importers of iron ore. It is true that West European countries source most of their supplies from Brazil, and similarly Japan from Australia, but it is also true that West European also buy from Canada, Sweden, Australia and African countries, while Japan also imports from Brazil, and India.

While the notion of viewing the iron ore market as a string of bilateral monopolies in the Atlantic and Pacific markets is attractive, bilateral oligopoly might be much closer to describing the situation in the iron ore market. As Scherer and Ross (1990, pp. 528-529) note "It is entirely conceivable that a few end product sellers could have sufficient power as buyers to hold the price of intermediate products supplied by upstream oligopolists at or near competitive levels. At the same time they might find themselves unable to depart appreciably from competitive pricing in their end product markets." They add that "...oligopolists are prone to cut prices in order to land an unusually large order, especially when they have excess capacity. Large buyers can exploit this weakness by concentrating their orders into big lumps, dangling the temptation before each seller, and encouraging a break from the established price structure.....Large buyers also play one seller off against the others to elicit price concessions. For instance, each of the major US automobile manufacturers has traditionally had a principal tire supplier, but each also spreads its business around to other tyre makers so that it can threaten to shift, or actually shift, its distribution of orders in favour of the supplier who offers more attractive terms."

A similar situation can be envisaged in regional iron ore markets, whereby importers may threaten to buy from suppliers other than the ones geographically closest, in order to achieve better purchasing terms. The threat by the buyer, however, is not so much that of ceasing imports from the closest supplier, as that of reducing his dependence on his main supplier. After all, buyers are also limited in their choice of suppliers by two main factors: (a) specification of the ore (quality), and (b) distance from the supply source (transportation costs).

II.3.3 Spatial Equilibrium Model of Iron Ore Trade

Toweh and Newcomb (1991) use a spatial equilibrium model to analyse iron ore trade. Their model is based on Samuelson's (1952) analysis of trade as a multimarket spatial equilibrium, shown as a computable programme which sums up over the competing regions a quasi-additive measure of welfare called net social pay-off. A linear programming approach to calculate the effects of trade was first suggested by Henderson (1958), but Toweh and Newcomb use a quadratic programming variant of this approach, as suggested by Takayama and Judge (1964, and 1971 pp. 129-172).

The authors use the supply function estimates by of the US Bureau of Mines, while they estimate econometrically the demand function for 5 regions: EEC, USA, Japan, Other Western Europe, and Other Pacific Basin. Their demand estimates are based on observations of iron ore prices, steel production and industrial production from 1956 to 1984. The coefficients of the ore price are as expected, but statistically insignificant, a fact which is partly attributed to the use of OLS methodology rather than 2-stage-LS. Steel production, on the other hand, is positively correlated with demand for iron ore and the coefficients are statistically significant.[11]

The authors maintain that "...that the model's estimates of demands in the five regions are indeed close to the observed. This indicates that the model's ability to estimate future demands is good." Looking closer at the model's predictions, however, there are several important trade flows which are missed. For instance,

[11] The only exception is Japan, in whose case the coefficient of industrial production is statistically significant,.

the model predicts zero trade between Australia-EEC, Canada-EEC, and Brazil-Japan, which were (in 1984) respectively 14 million tonnes, 13.7 million tonnes, and 28.8 million tonnes.

Despite these discrepancies, however, Toweh and Newcomb reach a number of very interesting conclusions. They note, for instance that "...there are significant costs attributable to misallocations. The discounts signalled are from $1-3 per tonne on deliveries of ore from Australia and Brazil to the most remote mills in Europe and Pacific Basin Respectively, while the obtainable premiums of Australia and Brazil in the markets of comparative advantage, the Pacific Basin and Europe respectively, are less than expected. Similarly, African producers (Liberia, Mauritania and South Africa) discount in their markets of apparent advantage, Europe, and more deeply yet to penetrate Pacific Basin markets." They also conclude that "...their results appear to confirm that competitive pressures exist in the world iron ore markets as of 1984 which encourage the penetration of markets remote from the major producers, leading to lower than equilibrium FOB prices. The welfare costs of these subsidies, combined with bilateral agreements, are not on average paid by consumers, but fall largely on the producers, who absorb transport costs to reach more remote buyers and lower rents obtainable under equilibrium conditions from closer mills. Australia subsidises Western Europe trade and collects lower rents from the Japanese market; Brazil subsidises Japanese trade, collects significant rents from Western Europe and US markets;

Canada subsidises Japanese trade and collects significant rents from the USA, but lower rents from Western Europe markets."

II.4 Conclusion

The purpose of this chapter was twofold. Firstly, the most relevant part of the theory of industrial organisation was reviewed with the aim to apply its learnings and important conclusions to the discussion of iron ore that takes place in chapter IV. The focus of this part of the literature review was the non-competitive market structures: oligopoly, bilateral monopoly and bilateral oligopoly. All structures have partial applications to the case of the iron ore market, but the one that seems to be closest to the international order in the sector is bilateral oligopoly.

The second part of the literature review focused on economic and econometric models that specifically turn their attention to international trade in commodities and in particular iron ore itself. To date there have only been two attempts to model iron ore trade: Santos (1976) and Priovolos (1986). Both models were discussed and criticised for their shortcomings. The aim of the chapter IV is: firstly, to apply the discussion so far in the iron market and particularly the interaction between the major trading partners who generate more that 90% of the world's trade in the commodity; and secondly, to test the theoretical foundation of this behaviour with a simple, partial equilibrium econometric model. Before proceeding with the theory, it is important to first turn our attention to one of the most significant characteristics of the iron ore market: the existence of long-term contracts which have dominated international trade flows over the last 30 years and the role they play in shaping the behaviour of the economic agents (countries) that are bound by them.

III. Long-term Contracts and Iron Ore Trade

III.1 Introduction

As discussed in Chapter I, three main points emerge, which have a bearing on the way international markets for iron ore are organised.

- iron ore is almost exclusively used for the production of steel;
- steel mills are the only customers of iron ore mines and, although scrap can be used to a certain extent, iron ore is by far the most important raw material for steelmaking;
- there are only very few dominant iron ore producing countries, which have large capacities and low costs, and dominate the supply side.

Because of these peculiarities, the procurement of iron ore supplies is handled directly by iron ore producers and steel mills. There is no scope for the existence of trading companies, and those that do exist are mere agents either for mining companies or for steel mills. As we have seen, steelmaking is a continuous procedure. A blast furnace needs a minimum throughput in order to operate at all, and production cannot be halted, except for necessary repairs to the refractory lining; it is paramount that iron ore feed be continuous and guaranteed.

In addition, the countries participating in the trade of iron ore are rather few, both on the buying and the selling side. Indicatively, in 1995 just the top five countries – Australia, Brazil, India, Canada and South Africa - shared between them 75% of world exports, while the top eight countries – Japan, Germany, China, Korea, UK, France, Italy and the USA – accounted for the same proportion of world imports.

Against this background, it is not unreasonable that, like for other raw materials (e.g. bauxite, copper and coal), buyers have always been anxious to secure supplies of iron ore. A steady procurement of iron ore is essential in the steel-making process, both for operational and strategic purposes. In the 1950s, the large quantities of steel needed for the reconstruction of post-war Europe could not have been sourced from the declining supplies of the continent, originating primarily in Germany, Sweden and France. This forced the largest of steelmakers to take the initiative in securing iron ore supplies from abroad, mainly in the form of majority stakes in new mine developments in Latin America and Africa. Following the example of many steel mills in the United States, European mills tackled the problem of supply security through the acquisition of equity stakes in foreign iron ore mines.

In the 1960s and 1970s strong economic growth brought about, apart from prosperity, concerns on the sustainability of the rate of such growth and fears that many raw materials would be exhausted in the space of 30 years. It was around that same time that Japanese economic growth took off to create the economic miracle that all other Pacific Rim countries would later try to mimic. With a pronounced lack of any natural resources and the relative inability to force their way into mining projects, the Japanese developed a completely different strategy to that of their Western counterparties for the long-term procurement of iron ore. The result, as Rodrik (1982) notes, was that "...Japan [was] able to procure much of her raw materials during the 1960s and 1970s at more favourable terms [than the US], even though the latter country had tighter links to its supply sources." Despite this initial success, however, Japanese long-term contracting has not been without its problems, as I will discuss later in this chapter.

In the last 20 years, long-term contracts (LTC's) have been the main form of procuring iron ore for most industrialised importing countries, especially Japan and the six most important EU steel producers (Germany, France, UK, Belgium, Netherlands and Italy). From the producers' point of view, LTCs have been the main method of securing long-term financing for mining developments in both leading exporters: Brazil and Australia. But why have LTCs been so popular?

III.2 Long-term Contracts: A Transactions Cost Approach

Indeed, one might ask, what factors determine whether transactions between suppliers and their customers are realised through vertical integration, long-term contracts or simple spot market deals?

To answer these questions, I first look at the paradigms offered by other raw materials markets, most notably coal. The reason for choosing coal is twofold:

a) Coal, like iron ore, is characterised by the extensive use of long-term transactions, with the pricing of such transactions being rather inflexible and dependent on factors other than purely competitive demand and supply economics. Although, like in iron ore, there is a spot market in coal, price quotations there are largely affected by the specific qualitative characteristics of each type of coal produced by individual mines and companies. This co-existence of a large term and a smaller spot market is not specific to coal and iron ore only. However, in other commodity markets where this occurs, the quality differentiation problem is very little or non-existent because of the widespread standardisation (e.g. in copper, aluminium, petroleum) and hence contracting parties can concentrate on price setting. The result, of course, is that spot market prices, even though strictly referring to relatively modest quantities, accurately reflect the market equilibrium and are hence used as benchmarks in 'spread' pricing formulas.

b) The industrial structure of both the coal and iron ore markets is largely devoid of important vertically integrated structures, which means that most of the pricing is taking place on an arm's-length basis. The same cannot be said for other raw materials, like copper and bauxite/aluminium, where transfer pricing has been (and still is) quite prominent.

Returning to the insight offered by the coal sector, Joskow, in a series of papers (1985, 1987, 1998 and 1990), looks in detail at the characteristics of a large number of contractual agreements between coal mines and power generating utilities across the United States. To do so, he resorts to the theory of transactions costs economics, whereby economic institutions emerge to minimise the costs of making transactions. "These costs" notes Joskow (1985) " include both ordinary production costs (land, labour, capital, materials, and supplies) that make up the components of a neo-classical cost function and certain transactions costs associated with establishing and administering an ongoing business relationship." "There exists" he continues "a continuum of potential governance structures for vertical relationships. At one extreme we have vertical integration. At the other extreme we have Walrasian auction markets. In between we have a wide array of potential contracting institutions that mediate transactions through the market but involve the use of a variety of specialised contractual provisions that arise as a consequence of efforts by firms to minimise the total costs of transactions over time."

III.2.1 Transactions Costs and Transactions Characteristics

Transactions costs include a number of elements, such as the costs of negotiating and writing contracts, costs of monitoring contractual performance, costs of enforcing contractual promises and costs associated with breaches of contractual promises. Joskow (1985) distinguishes four important characteristics that affect the nature and the magnitude of these transactions costs:

- the extent to which the contemplated transactions are characterised by uncertainty and complexity;

- the extent to which cost-minimising transactions (in the neo-classical cost function sense) require one or both parties to a transaction to make durable transaction-specific sunk investments;
- the extent to which there are diseconomies associated with vertical integration that must be traded off against transactions costs that arise when market transactions costs that arise when market transactions are relied upon;
- the frequency of transactions.

As uncertainty and complexity become more important in a vertical relationship the expected costs of writing, administering and enforcing full contingent contracts increases. When uncertainty and complexity are important it becomes uneconomical to write full contingent contracts and market contracts will tend to be incomplete. A contract is incomplete in the sense that it does not specify unambiguously the obligations of each party in every possible state of nature.

Under economic and financial duress ambiguities allowed for by incomplete contracts develop into incentives for one or both parties to 'misbehave' by taking actions that increase the cost or reduce the revenues that will be obtained by the other party. This 'rogue behaviour' has been termed 'opportunism' by Williamson, in the sense that such behaviour does not maximise joint profits and is thus inefficient. Much of the theory of transactions costs is set in a competitive framework, i.e. many buyers and sellers. Opportunism can emerge ex post because certain characteristics of the supply relationship give one or both parties to the transaction some monopoly power when certain contingencies arise. Such monopoly power is usually attributed to the presence of durable transaction-specific sunk investments, but may also be due to conventional moral hazard arising from information asymmetries. In the latter case, incentive problems arise because one party to the transaction both can affect (uncertain) outcomes by his own behaviour and has better (less costly) access to information about the causes of observed outcomes. The agent can exploit an information monopoly to its advantage.

Focusing on the iron ore market, within the conceptual framework described above, both sources of rogue behaviour are possible. With regard to the moral hazard argument, one might argue that both parties can withhold from each other vital information on short term (up to 1 year) future demand or supply (e.g. a steel mill has low-cost information on short term demand by looking at its orderbook, and a mine knows exactly when new capacity becomes available, also in the short term). Such information, however, is accessible to all parties once the short term is over and can be - and indeed is - used in subsequent contract negotiations. As a result, the incentive to 'misbehave' which may be created by moral hazard is not deemed of major importance.

More importantly, the presence of transaction-specific sunk investments can be an incentive for one party to 'hold up' the other ex post and can lead to costly haggling. Williamson (1983: p. 526) identifies four different types of transaction-specific sunk investments:

a) *Site specificity:* buyer and seller are in a 'cheek-by-jowl' relation with one another, reflecting ex ante decisions to minimise inventory and transportation expense.

b) *Physical asset specificity:* when one or both parties to the transaction make investments in equipment and machinery that involves design characteristics specific to the transaction and which have lower values in alternative uses.

c) *Human capital specificity:* arising as a consequence of learning-by-doing, investment, and transfer of skills (human capital) specific to a particular relationship.

d) *Dedicated assets:* general investments that would not take place but for the prospect of selling a significant amount of product to a particular customer. If the contract is terminated prematurely, it would leave the supplier with significant excess capacity.

Of the four types identified by Williamson, I consider (b) and (a) to be the most important, with (d) following suit and (c) being the least important. *Physical asset specificity* is very much connected with the smelting technology employed by the steel mill. To take advantage of scale economies, some flexibility has to be sacrificed, so that most of the iron ore input has to be of a certain grade and purity, often tied to a specific mining company or even a specific mine. Such specificity means of course that the mill needs to ensure a long stream of uninterrupted ore shipments that will let it use its furnace with maximum efficiency, with only a small degree of flexibility allowed to face supply disruptions. From the mine's point of view, long-term exports of ore are indispensable for planning and financing new mining projects, but the inflexibility of tying up certain mines to specific steel mills is not always desirable. Hence, the effort of many mining companies to offer a more standardised, beneficiated product, usually in the form of pellets, which can be marketed more easily and which also allows for some value to be added before leaving its country of origin.

Site specificity has also been an important factor in tying up mining companies and steel mills in long-term contractual relationships. As iron ore is a relatively cheap raw material, transport cost minimisation (more than inventory cost minimisation) has been a major decision factor to enter LTCs, with port terminal developments and project-specific acquisition of ships featuring frequently in contractual agreements. Since the late 1950s and throughout the 1960s and 1970s, iron ore trade benefited immensely from scale economies derived from the employment of large size bulk carriers and even larger dedicated ore carriers.

Under type (d), *dedicated assets*, come primarily investments in new mining capacity. Again the Caraj s project in Brazil is one such prominent example, since its viability largely depended on pre-selling a large part of its production[1] to European and Japanese steel mills under LTCs.

Finally, *human capital specificity*, may be important in the case of small, less experienced producers of iron ore - such as Mauritania and Liberia - which rely on the supply of technology and know-how by industrially developed trading partners.

III.3 Characteristics of LTCs in Iron Ore

Defining what is a long-term contract in the iron ore market is not as straightforward as it may sound. Rogers and Robertson (1987) define it simply as a contract whose duration is expressly stated to be five or more years. Joskow, however, when examining coal procurement contracts, adopts a more flexible definition. Contracts are considered to be long-term even when they are less than 5 years long, but are repeated often enough to establish a long-term relationship between suppliers and buyers.

Whatever the precise definition of an LTC may be, it is certain that they have been used extensively in international iron ore trade, especially since the mid-1960's with the initiation of Australian shipments to Japan. Rogers and Robertson (1987) believed LTCs to account for over 60% of international iron ore trade at the

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[1] Rogers and Robertson (1987) report that 25 million tonnes per annum out of a projected 35

beginning of the 1970s, while de Sa and Marques (1985) claimed they covered as much as 85% of that trade until 1983 when the first sharp price decreases took place. To date, the largest part of Brazilian and Australian exports are still realised through LTCs, and it is indeed the availability of such arrangements which is vital for the realisation of long-term investment strategies.

Following the example of their Japanese counterparts, European steel mills, led by Germany, have had similar arrangements with both Brazil and Australia, alongside captive mines in Liberia and Mauritania and short-term (annual), flexible contracts with other suppliers, like Sweden, Canada, South Africa and India. In the United States the bulk of imports originates from Canada, since most of the contractual relations are ruled by ownership ties between US mills and Canadian mines. The result is a rather confusing picture of trade flows running in both directions, with Canada, however, consistently being the net exporter. In addition, ore is imported from Venezuela and Brazil, although in the past Chile and Peru have also been important sources of US imports.

III.3.1 Contract Duration, Pricing and Quantities

Iron ore contracts come in a variety of formats, depending upon the time and duration of the agreement. Most LTCs are quoted on f.o.b. terms, with the exception of contracts between Australian mines and European mills which are

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million tonnes annual capacity were thus pre-sold.

negotiated on a C&F basis. Some of the features of LTCs include: quantity, term and delivery schedule; loading and discharge terms; quality and quantity monitoring; pricing and payment method; provisions in the case of *force majeure* and/or disputes; and any additional requirements like taxes, duties, export licences, etc.

The three most important of the these characteristics are duration, pricing clauses and contracted quantities. All three characteristics have changed since the 1960s with the overall effect being a move towards more flexibility in all aspects. Typically, LTCs between major purchasers and sellers signed in the 1960s were between 10 to 15 years with prices fixed for an initial period of three to six years, and price renegotiations at intervals of about three years thereafter. Tonnage flexibility was typically set at plus or minus 10% of the contracted quantity and the prices were set on an f.o.b. basis. There were several LTCs, however, with different terms and conditions, like alternative tonnage options, longer or shorter terms than 10-15 years and C.I.F. rather than F.O.B. pricing.

During that period, LTCs achieved the objective for which they had been designed. They provided an important element of stability to prices and quantities traded and served as collateral for obtaining new mine finance at a time when several new mines were developed. This was accomplished with relatively little conflict over terms and no serious negotiations of major contract terms. The events of the 1970s, however, presented a number of major difficulties to both iron ore producers and purchasers which had not been foreseen when the early LTCs were signed; and these were to result in substantial changes to contractual practice.

The inflationary pressures being exerted on the international economy and the fall of the US dollar (in which contract prices were stipulated) combined to lead producers, faced with rapidly rising costs, to seek to renegotiate the pricing provisions of contracts. In some cases prices were increased by invoking a contract's hardship clause (i.e. a clause providing for contractual adjustment in the event of one of the parties suffering substantial economic hardship). However, by the mid-1970s the practice under most LTCs had evolved to allow for annual price revisions. More frequent price revisions were ruled out due to operational and planning constraints.

Rogers and Robertson (1987) mention another innovation introduced during the 1976-77 contractual negotiations: 'brick' pricing. "Brick pricing involves splitting the annual tonnage into two parts, the price of each part to be negotiated at two yearly intervals in alternate years. This allowed the parties to adjust the contract for inflation and changing market conditions on an annual basis; but the fact that half the tonnage had a fixed price over two years gave more stability to the arrangement than if the price for the whole tonnage were negotiated every year."

Further problems with the instability of the US dollar have led to the introduction of a currency clause in some contracts, giving either party the right to request a review of the contract terms if a significant change in the value of the US dollar occurs.

What particularly hit iron ore producers, however, were the massive quantity renegotiations after 1983, forced upon them by buyers who were over-committed and could no longer lift the amounts of ore stipulated in their contracts. This was the culmination of pressures by importers since 1975, when their forecasts of the growth in steel production started looking largely overestimated. The result was that tonnages taken by steel mills under LTCs fell well short of 90% of the basic contract tonnages on several occasions. For example, the delivery of Brazilian and Australian iron ore to Japan was approximately 60% of the minimum basic contract volume for the year April 1982 to March 1983. Some contracts were even terminated by buyers without the prior agreement of ore producers. For example, in 1983 British Steel sought to terminate some of its LTCs in order to cut its contract commitments by 40% from 1982 levels and use the cheaper annual market instead.[2]

Since the dire mid 1980s, contracts have normally been shorter in duration (5-7 years normally), with more flexibility incorporated in tonnage options and pricing.

III.3.1.1 Pricing

Price determination for iron ores is probably the most intriguing and confusing of all commodity pricing procedures. Both the quotation of iron ore prices and the way they are reached are worth closer attention.

There is no 'international' reference price for iron ore. Ore qualities differ widely and it is common that ores from different mines have their own quotations. It is also common that prices are quoted for different types of ore; usually lumps, fines, pellets, and sinter. The following table gives an example of iron ore price quotations in 1994.

Table III-1

Iron Ore Prices (1994)

Japanese Market		
Hamersley (*Australia*)	*Fines*	*Lump*
	25.66	33.26
CVRD (*Brazil*)	*Fines*	*Lump*
Caraj s	23.51	-
Itabira	23.01	24.77
European Market		
Hamersley (*Australia*)	*Fines*	*Lump*
	32.80	40.28
CVRD (*Brazil*)	*Fines*	
Caraj s	26.47	
Itabira	25.47	
LKAB (*Sweden*)	*Fines*	*Pellets*
	28.10	45.60

Source: Bailey (1992)

[2] Tex Report, Iron Ore Yearbooks, 1982-1997.

All prices are quoted on the basis of their iron content. All the above prices are in cents per 1% Fe in a long tonne. Thus, assuming that Hamersley fines are 62% Fe, their price in the European market would be [25.66 x 62 =] $15.90 per long ton.

Prices in the iron ore market are renegotiated and settled once a year. There are two distinct markets: Japan and Europe. The Japanese steel mills start negotiations around November each year, with each of the Australian ore producers and with CVRD of Brazil. In the European market, negotiations start at about the same time, and are usually conducted between CVRD and two agencies representing interests of German steel mills – Rohstoffhandel and Erzkontor. Price negotiations usually carry through to the beginning of the following year, developing into a 'war of words', with suppliers and consumers trying to demoralise each other.

It is interesting to have a quick look at this 'game of charades' for the 1993/94 price negotiations, as they were described in the TEX Report:

> "For the Japanese market, ahead of the European market, the first-round preliminary price talks for 1994 began on November 10, 1993, between Japanese steel mills and four major Australian and Brazilian suppliers. The negotiations for price setting were made in the following order: November 10 = Australia's Hamersley Iron and Brazil's CVRD; November 15 = Australia's Robe River Mining; November 16 = Australia's BHP Iron Ore."

The steel mills' view was that....

"...the demand for iron ore for fiscal 1994 is expected to increase in some areas. However, the world's demand for iron ore is likely to decrease as a whole, particularly in the Pacific region, affected by the sharp decline in Japan's demand for iron ore. Since the Japanese steel industry is surrounded by a very severe environment, Japanese steel mills hope that the suppliers will kindly recognise the situation and have the spirit of 'the same crews in the same boat' in determining the price of iron ore for fiscal 1994."

Iron ore suppliers thought, however, that....

"...the world's demand and supply situation for iron ore for 1993 remained firm, compared with that for 1992. The iron ore suppliers expect that the situation will remain unchanged for 1994; even though Japan's demand for iron ore decreases, for other Asian countries, demand for DR-use iron ore can be expected to increase. Such being the case, it will not be unnatural for the suppliers to ask for a price hike for fiscal 1994, as long as viewed from the present demand and supply situation."

Meanwhile, in the European market....

"....the price setting negotiations commenced between German steel mills and Rio Doce International from December 13, 1993, a little later than usual. According to the sources concerned, the negotiations involved a total of 20 German representatives of Rohstoffhandel (the largest iron ore importing company) and Erzkontor (iron ore importing company, and steelmakers including Thyssen)."

Not surprisingly....

"...at the first-round price talks, German steel mills....call for a price reduction for 1994."

As was expected....

"...Rio Doce International showed reluctance to the request for price reduction from German steel mills. .... The CVRD side is well aware of, and understand, the difficult situation in which German steelmakers are placed. However, it is difficult for CVRD to accept a request for price reduction, in the light of CVRD's present financial conditions and the firm iron ore market."

Thus, both the Japanese market and the European market completed the price negotiations on December 21, 1993. The European market commenced the second-round price talks on January 2, 1994, and the Japanese market commenced the third-round preliminary talks on January 17, 1994. In the following few days, Australian suppliers agreed to talks on the basis of a price reduction. In view of the news in the Japanese market, negotiations between German and Brazilian parties were heading towards the same direction.

At the beginning of February, we had the final accords for price settlement in both markets.....

"At the price talks conducted on the morning of February 8, 1994, Hamersley Iron officially accepted the price reduction proposal demanded by Japanese steel mills. The proposal comprised the reduction rate of 9.5% for fine ore, and that of 5.9% for lump ore."

Soon afterwards, agreements were achieved with Robe River Mining, BHP, CVRD, MBR, CMP of Chile, Iscor of South Africa, IOC of Canada, and MMTC of India. Meanwhile, in the European market....

"Hamersley Iron Pty. acted quickly for price settlement in the European market. On February 9, one day after the first price settlement was completed in the Japanese market, the price of Hamersley iron ore on a C&F basis was settled between Hamersley Iron and BSC (British Steel) of the UK. ... On February 11, Rio Doce International reached an accord on the price for Itabira and Caraj s iron ore with German steel mills. ... LKAB of Sweden completed, on February 17, the price settlement with German steel mills on fines and pellets for shipment in 1994. ... Meanwhile, the price settlement was completed within February 1994 for SNIM of Mauritania, BHP Iron Ore of Australia, Sydvaranger of Norway, and MBR of Brazil. The price settlement was also completed within March for QMC and IOC of Canada, and CMP of Chile."

It is also interesting to observe the market leaders in price settlement. Traditionally, CVRD leads the European market negotiations with Germany's Rohstoffhandel or Erzkontor, and either BHP or Hamersley (owned by RTZ) do the same with a representation of Japanese steel mills in the Pacific market. The 1980s saw, however, numerous disruptions to that tradition, as shown in Table 2 below. For instance, during the 14 price negotiations between 1981-1994, CVRD reached an agreement first only 5 times, and in all but one cases it did so in a rising market. IOC and QCM of Canada took the initiative in price negotiations between 1983 and 1987 in the Atlantic with all negotiations resulting in price decreases. In other instances, Hamersley (a marginal supplier to Europe) and SNIM (a rather small-size supplier) were first to conclude negotiations, thus forcing the leading Atlantic market participants to end speculation and complete their bargaining process.

In a similar fashion, in the Japanese market CVRD was the first to complete negotiations in 1981, 1983 and 1984, with MMTC of India doing the same in

1985 and 1986, thus stealing the wind off the sails of Australian mines, which are the natural leaders in the Pacific market.

Table III-2

Iron Ore Price Fixing

	Japanese Market			European Market		
	First Price Settlement	*Setter*	*Fines (%)*	*First Price Settlement*	*Setter*	*Fines (%)*
1981	26/02/81	CVRD	+7.5	Feb-81	CVG/Belgium	+6.1
1982	26/03/82	Newman	+17.2	05/02/82	CVRD/Germany	+15.7
1983	28/03/83	CVRD	-11.4	08/03/83	IOC/Germany	-11.2
1984	20/01/84	CVRD	-11.6	07/12/83	QMC/Germany	-8.5
1985	31/01/85	MMTC	0	07/12/84	QMC IOC/Germany	0
1986	14/02/86	MMTC	-1.88	03/12/85	QMC IOC/Germany	-1.1
1987	20/02/87	Newman	-5.0	05/03/87	QMC/Holland	-9.3
1988	22/12/88	Hamersley	-4.0	24/12/87	Hamersley/Britain	+8.6
1989	14/12/89	Hamersley	+13.0	19/12/88	CVRD/Germany	+13.0
1990	24/01/90	Hamersley	+15.96	17/01/90	CVRD/Germany	+15.96
1991	30/01/91	Hamersley	+7.93	31/01/91	CVRD/Germany	+7.95
1992	17/12/91	Hamersley	-4.90	17/12/91	CVRD/Germany	-4.90
1993	13/01/93	BHP, CVRD, Robe	-11.00	22/12/92	SNIM/France	-13.47
1994	08/02/94	Hamersley	-9.50	08/02/94	Hamersley/Germany	-6.77
	08/02/94	Robe River	-14.50	11/02/94	CVRD/Germany	-9.50

Source: TEX Report, Iron Ore Yearbook, 1995/96

The pattern emerging from the discussion above is not what one would have expected from a market characterised by oligopoly, although on the buyer side the almost uninterrupted appearance of Germany and Japan could suggest the existence of an monopsony in the Atlantic and Pacific markets, respectively.

I doubt the existence of such an oligopsony in the Atlantic market, mainly due the fact that Germany - the most important importer - relies more on Brazil for its supplies - the largest exporter - than Brazil relies on Germany as a market for its imports. Evidence to this effect is also provided by Figure III-1, which shows an increasing dependence of Germany on Brazil for its imports, and Figure III-2 which shows the opposite being true for Brazil.

Figure III-1

German Imports by Source

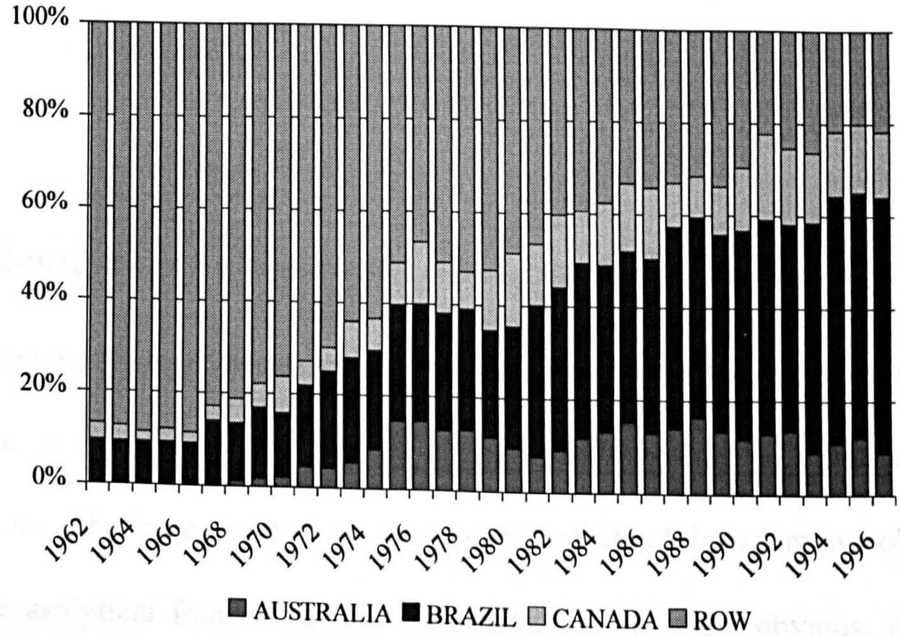
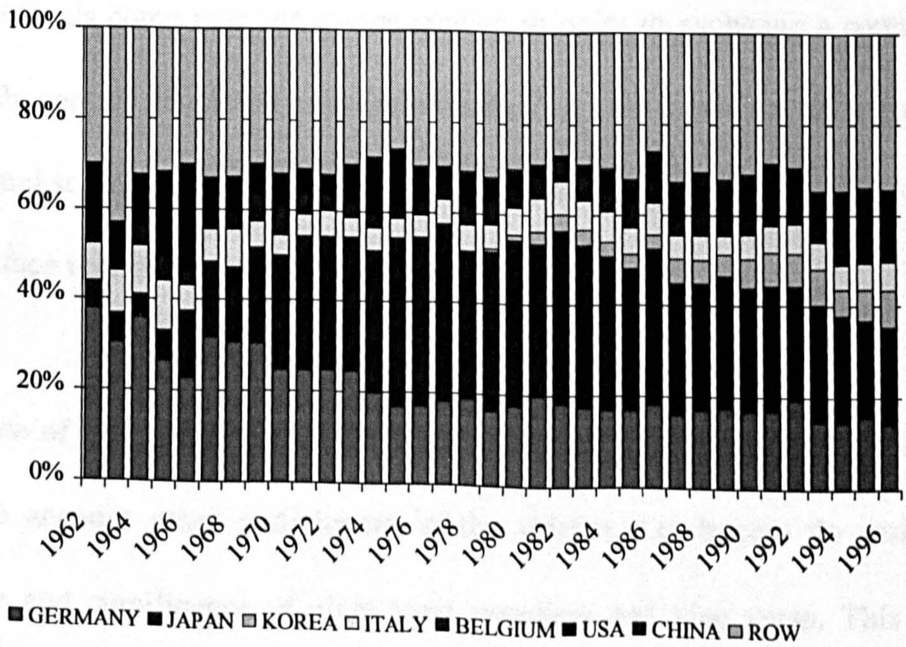


Figure III-2

Brazilian Exports by Destination



The case for Japan, however, offers evidence, at least in the past, for the existence of monopsony in the Pacific market. This case will be examined in more detail in a following section, where I discuss the long-term Japanese procurement strategy since the 1960s.

III.4 Long-term Contracts as a Bargaining Tool

In the previous chapter I discussed a possible framework for the explanation of the behaviour of steel mills and iron ore mines when they engage in annual price negotiations. The largest part of the discussion looked at bilateral monopoly as an attractive analytical framework, but the limitations are quite obvious. Bilateral monopoly is an attractive model for studying economic behaviour, but it is not very often that it is applicable in real life.

Many models of bilateral monopoly have looked at everyday life situations when two individuals come into one-to-one contact in order to exchange a commodity. Any such contact involving two individuals (e.g. the purchase of a car, or a holiday and so on) may be viewed a trade between two monopolists which may or may not face information asymmetries.

In the case of iron ore, however, the negotiating agents do think strategically and take into account other participants in the market, i.e. buyers do realise the existence and significance of alternative suppliers and vice versa. This is also reinforced by the repeated interaction of the agents over several periods and by the existence of long-term ties between them, whether these are called minority equity stakes, financing deals or long-term contracts.

Table III-3

Contracted and Actual Imports of Iron Ore by Japan

	Imports from Australia			Imports from Brazil		
	Contracted Volume (m.tonnes)	Actual Imports (m. tonnes)	Imports/ Contracts	Contracted Volume (m.tonnes)	Actual Imports (m. tonnes)	Imports/ Contracts
1966	1330000	2043491	154%	1000000	1704461	170%
1967	2660000	8313833	313%	2350000	2430664	103%
1968	4270000	13813940	324%	3200000	2198482	69%
1969	13730000	23234523	169%	5890000	4185450	71%
1970	15890000	36596955	230%	5890000	6779361	115%
1971	18140000	46287396	255%	8690000	8996651	104%
1972	27740000	48294755	174%	9690000	9334542	96%
1973	33840000	64238641	190%	14690000	12821283	87%
1974	37040000	67880987	183%	22940000	19522809	85%
1975	40640000	63253080	156%	24440000	23459583	96%
1976	44490000	64094316	144%	25840000	25380371	98%
1977	47740000	63103364	132%	26240000	23742697	90%
1978	49265000	52626268	107%	35315000	20815439	59%
1979	54360000	55297480	102%	39640000	26136093	66%
1980	66862000	60040060	90%	43390000	28522932	66%
1981	79562000	54860965	69%	45990000	27164735	59%
1982	79762000	54139956	68%	53450000	27346237	51%
1983	66937000	49772804	74%	45990000	23509201	51%
1984	62737000	58357452	93%	46090000	29017413	63%
1985	66637000	54321348	82%	46090000	29064068	63%
1986	70137000	46893889	67%	48590000	26633279	55%
1987	71087000	43413754	61%	47565000	26831270	56%
1988	66500000	52415696	79%	44990000	27931730	62%
1989	73780000	56275433	76%	38430000	29520127	77%
1990	72015000	53852628	75%	38835000	30198492	78%
1991	52710000	58353791	111%	42560000	28470416	67%
1992	55200000	104137622	189%	42600000	53514070	126%
1993	54250000	106946248	197%	36150000	55644356	154%
1994	53920000	55409205	103%	41880000	27873986	67%
1995	55250000	58727456	106%	34800000	27627593	79%
1996	53720000	59527894	111%	34860000	26645608	76%

Long-term contracts are not unusual in commodity markets, even the most liquid ones, like crude oil for example. The fact that many raw materials are quite frequently located away from consuming markets, usually in developing countries and at large distances makes the use of long-term contracts quite natural. For the importers contracts ensure availability of supplies, hopefully at the most competitive price. For the exporters contracts mitigate the risk of developing new reserves and have no markets to sell them to.

The existence of long-term contracts is not unique to iron ore. Bauxite, copper ores and most metallic ores are sold on that basis. More notably, crude oil is also sold largely on the basis of the long-term contracts, despite the fact that oil supplies are far from short in current (late 1990s) markets.

What makes iron ore contracts rather more unusual in commodity markets is that they also include in the price negotiations that take place every year between steel mills and mines. Whereas in commodities such as copper, aluminium and oil, among others, there is a very liquid end-market with price discovery taking place in organised exchanges, iron ore prices are fixed with a series of bilateral negotiations, with the first few prices fixed between leading buyers and sellers acting as signals to the rest of the market participants for their own negotiations.

More importantly, however, a long-term contract is also a statement of commitment between the two parties. The extent to which a contract is fulfilled demonstrates firstly the conviction of each party in the quantity/price decision they have made and secondly their willingness to maintain this commitment in the future. The first characteristic is very important in the whole bargaining procedure. One would theoretically expect that once the two parties of a bilateral monopoly agree on the quantity maximising their profits they will keep the commitment to this quantity stable and only haggle on price.

However, when one compares actual import volumes with contracted volumes the picture is quite different. One such notable example is Japan and its main two partners with which it has a series of long-term contracts. Japan's relation with its iron ore suppliers is discussed in the next section, but it suffices to say that the Japanese were probably the first to actively pursue a strategy of building relationships through long-term contracts rather than vertical integration with mines. Table III-3 above shows the contracted and actual import volumes of Japan with Australia and Brazil. It also shows the ratio of imports to contracted volumes. It is interesting to see how this ratio fell below 100% during the 1980s, even below the usual lifting margins of 5-10% stipulated in most contracts.

In fact, throughout the 1980s one wonders what was the real value of such long-term contracts. Their quantity-setting function is certainly questionable in light of the repeated failures to stay within contract specifications almost every single year of that decade. Also interesting is the observable difference between Australia and Brazil in the variations of the above take-up ratios. The worse hit from this evidence seems to be Brazil, not an unlikely outcome in view of the fact that Brazil is at a relative disadvantage due to its distance from Japan.

If quantity-setting is not anymore the reason for long-term contracts, what is then? Price-setting is certainly a very important function but does not need the long-term contract framework to function properly. Price negotiations taking place every year do not really price the specific contracts. Rather they price any transaction that may take place within the year. The continued existence of such contracts I can attribute to two reasons: they still provide a solid basis for bringing on line new mining projects (whether greenfield or extensions); or they are used as a bargaining weapon by buyers in order to countervail the apparent dominance of the comparatively fewer iron ore suppliers. Let's examine each of these two possible reasons separately.

It is quite obvious why a mining project would need long-term contracts in order to take off. Exploration and development of a mine is always expensive, especially in the case of greenfield projects. Even when the ore is located near the surface and does not require underground mining methods, a large capital expenditure is required to create the infrastructure to move the ore from production site to export outlet. Unfortunately not many mines are conveniently located near the coast. In most cases a transport system has to be put in place before any output can be channelled to the international market. The case of the Caraj s project is again quite typical. The ore extraction itself is not particularly difficult, but the mines are located some 1000 km inland; as a result, a dedicated transport system had to be put in place, including a railway, an export terminal on the north Brazilian coast, and a pelletising plant.

This type of investment does indeed need the level of buyer commitment implied by the existence of long-term contracts. It is doubtful, however, how many such new project come into production anymore. The last such big project was Caraj s and only very few, much smaller mining projects have been put in place since the mid-1980s. The majority of all existing contracts are mere extensions to older contracts and in most cases these extensions are shorter in duration than the original contracts. There does not seem to be any compelling reason why such contracts should still be in place.

The second possible reason for such contracts to exist is their function as a bargaining tool in annual price negotiations between steel mills and iron ore mines. Contract extensions can be interpreted by sellers as positive signals from the buyers about their commitment. In exactly the same, but opposite, manner the amount of long-term contracts with other sellers signals the long-term intentions of a buyer with regard to their import allocation preferences. Scherer and Ross (1990) describe this as countervailing power in bilateral negotiations.

A very interesting and slightly more formal view of a similar bargaining process is discussed in Sadanand (1996). Departing from Rubinstein's (1982) seminal model of bargaining with full information, Sadanand looks at the bargaining process with an endogenous element of waiting times and the risk of no-trade also present. Practically this means that one party may gain benefits from delaying the reaching of an agreement by introducing waiting during the bargaining process, so that he learns more (reduces his information asymmetry) about the other party. It also means, however, that such delay also brings with it the risk of a deal not being reached because the other party might reach a deal with outside competitors in the meantime.

It is not difficult to relate this kind of situation to the iron ore market, although this time instead of waiting it is long-term contracts that enter process as a bargaining tool. The risk of not doing business at all is rather difficult to envisage in the iron ore market. When large importers are concerned, e.g. Japan or Germany, it is quite unthinkable that they will not purchase at all from Australia or Brazil, respectively. After all, these are their most competitive suppliers. The risk here is not the complete collapse of negotiations, but the erosion of market share that each importer might suffer in relation to his competitors. It is this risk and how strongly it is perceived by sellers, that buyers will count on to gain a stronger bargaining power over them.

III.5 Japan and its Strategy in Long-term Contracting

As discussed earlier on, the Japanese were among the first to resort to long-term contracts in order to secure a continuous uninterrupted supply of iron ore. From the mid-1960s onwards, Japan entered the international raw materials markets on a large scale in order to fuel the growth of their manufacturing sector. Possessing little or no domestic supplies, Japan was unable to establish vertically integrated structures. Part of the disadvantage faced by Japanese enterprises was mitigated by the country's institutional framework. On the one hand, the relatively high levels of domestic protection shielded metals processors from foreign competition. On the other, the more relaxed Japanese anti-trust environment (especially in comparison with the US) allowed the formation of import cartels by the largest firms (*sogo sosha*), thus enhancing their bargaining leverage vis- -vis ore-exporting countries.

The combination of these two factors eventually led the Japanese to adopt a strategy of long tem contracting in the 1960s, which at the time might have been considered a second-best strategy, in comparison to the strategy of vertical integration adopted by their American and European competitors. That strategy, however, appeared to have paid quite handsomely[3], especially in view of the effects that widespread nationalisations had on vertically-integrated metal manufacturers. Illustrating this point, Rodrik (1982) compared iron ore prices charged to US and Japanese steel mills between 1960 and 1976. He found his data to point to a significant improvement over time of Japan's import prices relative to those of the US. Such was this improvement that by the 1970s Japan was obtaining iron ore at discounts of 20-50% below the US prices. In 1960, US steel mills had a 16% cost advantage over Japan in their iron ore input; by 1976, this cost advantage had been dissipated into a 43% disadvantage, Japan having

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[3] At least that was the perception of American researchers (e.g. Rodrik, 1982) who witnessed considerable problems with the vertical integration strategy adopted by US steel mills.

obtained its ore at lower cost since 1967. The Japanese steel mills had managed to incur only a 23% increase in iron ore costs between 1960 and 1976, whereas US steelmakers were faced in the same period with a massive cost increase of 148%.

To achieve this, Japanese importers had come along way from the 1950s when most of their requirements for minerals were obtained through spot or short-term contracts with developing countries. Mainly due to transport costs, it appears that Japanese steel mills were at the time paying around 50% more for their iron ore than European mills. Following the lifting of the Australian iron ore export embargo in 1960, there was a rush of American and European capital to mine the vast deposits of that country. Finance for these ventures was obtained in large part with the assurance provided by the long-term contracts signed between the Australian mines and Japanese steel producers.

In those initial long-term contracts Japan exhibited a strategy which is followed to date: its largest steel mills formed a buying cartel in 1964 when the vast extent of the Australian deposits became evident. Called the Committee of Ten, the cartel allowed the Japanese to negotiate as a single unit while the Australian mining companies and the different states competed with each other on the terms of the contracts. None of the Australian entities knew the precise extent of Japan's ore needs, and they certainly had no way of correctly forecasting the explosive growth Japan's steel industry was about to undertake. Consequently, each mine feared the prospect of being underbid by the others and of being left with no secure future outlet. In addition, Australian producers felt the pressure from mines in India and Brazil which were also waiting in the wings to sign long-term contracts with Japan. As a result, the prices Japan obtained from Australian producers were on average close to 20% lower than those paid for imports from other sources in Asia, Africa and America. Moreover, despite the insistence of the Australians for c.i.f. prices, the contract prices were stipulated in f.o.b. terms, which allowed the Japanese to reap the benefits of future declines in freight costs.

Twenty years later, the Japanese were still successful in maintaining their strategy both in the iron ore and coal markets. As Frost (1984) observes, that "Japan relies exclusively on external suppliers of iron ore. In order to remain competitive, Japan must ensure the lowest price for its raw materials. Quality and continuity of supply are assumed. Having established a dominant position, the Japanese are often able to control the negotiations." "However", he continues, "the Japanese are conscious that the tactic they have successfully employed over time, particularly in the purchase of coal, may well be used against them." Responding to this challenge to their negotiating power, the Japanese have learnt to adapt their bargaining strategy. In the 1980s they followed a tactic of identifying a weak link - a supplier in a particular country that would, for various reasons, be prepared to settle on a lower price in favour of a definite contractual agreement over a given period. These negotiations are concluded prior to the formal negotiations for large tonnages from that country's (or other countries') main producers. Table 2 above shows the results of this tactic. From 1981 to 1986 Japan concluded pricing negotiations with companies who were outside its main supplier (Australia) like Brazil's CVRD and India's MMTC or with relatively smaller suppliers from Australia, like Hamersley.[4]

Long-term contracts continued to serve the Japanese well throughout the 1960s and 1970s. Despite frequent renegotiations of these contracts, the superior bargaining position of the Japanese deriving from their monopsony power in the Pacific market, ensured that the contracts would work to the advantage of the Japanese steel producers. The three largest exporters of iron ore to Japan - Australia, Brazil and India - have always been more dependent on the Japanese than Japan has been dependent on them, although in more recent year both Australia and Brazil have been trying to diversify away their large dependence on Japan, and have partly succeeded in doing so.[5] Australia, more specifically, has systematically managed to degree of its dependence on exports to Japan, with the percentage of Australian exports directed to Japan decreasing every single year from a 77.7% in 1981 to 52% in 1992.

Apart from smart negotiating tactics, the Japanese also promoted improvements in shipping technology so as to reduce the transport components of iron ore costs.

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[4] On the basis of conatcted long-term tonnage, Hamersley (owned by CRA/RTZ) was the largest supplier with almost 30 million tons per annum, while Newman (owned partly by BHP) came second with 23 million tons per annum.

[5] In 1982, for example Japan imported 44.5% of its needs from Australia, 22.5% from Brazil and 13% from India. In the same year, Australia directed 74% of its exports to Japan, Brazil 38.3% and India 63%. For comparison, in 1992 Japan depended 45.8% on Australia, 23.5% on Brazil, and 14.6% on India; a situation largely unchanged. On the other side of the equation, however,

The Japanese pioneered the construction of large bulk/ore carriers and highly efficient port unloading facilities. As a result, freight charges as a share of the landed cost of Japanese iron ore fell by more than 50% in the two decades between 1956 and 1976[6], while the average shipping distance increased by almost 1000 miles in the same period. Although developments in shipping of iron ore are also very important in the iron ore industry, they are beyond the scope of this thesis, which does not propose tackling such issues at all.

Finally, the Japanese enterprises have tried to assure adequate supplies of iron ore world-wide by taking small equity stakes in mining projects, and by increasingly offering financial assistance for the development of new mines, expansion of existing ones, new port facilities and new pelletising plants to earn the commitment of their suppliers. This strategy has often elicited complaints that Japan has been deliberately attempting to maintain excess supply in the iron ore market by financing more new capacity than was warranted by the incremental growth in demand.

Overall, the strategy of long-term contracting supplemented by infrastructure investments at home and abroad and small equity stakes in mines has served the Japanese well, but not without problems. The successful early negotiations of Japanese mills with Australian mines, left the latter dissatisfied quite soon after

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Australia depended on Japan for 52% of its exports, Brazil for 25.5%, while India with 62% remained unchanged.

[6] Lieberman, M. (1981)

contracts were signed. In the 1970s Australian complaints became more bitter as world inflation and the devaluation of the US dollar eroded the rice provisions of the contracts. From the Japanese point of view, long-term contracts provided security but often proved cumbersome with their inflexibility in terms of both quantities and prices. Since 1972 the Japanese have been concerned about the steel slump and have consequently been asking for - and usually getting - reductions in contracted tonnages. The short-lived recovery of the world economy in the early 1980s led many to believe that the then forecasted scarcity of iron ore supplies would soon curtail the strong negotiating position of the Japanese.[7] After 1982, however, the sharp decline of steel production combined with the increased iron ore supply from new mining projects, made the Japanese even more anxious to renegotiate their long-term commitments and seek even more flexibility.

An idea of how this aspirations were fulfilled in practice can be given from the duration and terms Japanese long-term contracts with its three most prominent suppliers: Australia, Brazil and India. Table IV.3(a)-(c) shows all the outstanding contractual commitments with Australian mines. As one can see evidence of the flexibility sought by the Japanese in the duration, and in some cases in the quantity stipulations, of the contracts. LTCs negotiated in the 1960s and 1970s were almost invariably in excess of 8 years, with some of the older contracts lasting for over 20 years. The Hamersley contracts, for example, lasted between 10 years (No. 1 contract) to 19 years (No. 4 contract) with quantity variations

[7] Frost, F. (1982)

normally being at ±10% at the mill's option. In a similar manner the contracts negotiated in the 1970s with BHP for Mt. Newman ore were between 10 and 16 years long. Such long contractual arrangements also existed with smaller mining companies, such as Robe River and Savage River. In contrast to the above, contracts negotiated in the early 1980s, when Japan started feeling the pressure on its steel industry, contract duration decreased to between 5 and 8 years, whether new or renegotiated contracts. Interestingly enough, quantity stipulations also became more flexible, with the usual ±10% margin, being replaced in many cases with alternative arrangements.[8]

Japanese LTCs with Brazil have experienced similar changes (see Table IV.4(a)-(b)). Contracts renegotiated in the 1980s were generally shorter than their predecessors, with the notable exception of the Caraj s contract which was signed in 1986 for 15 years, but provided adequate flexibility (+10%/-20%) for the steel mills. LTCs with Indian companies have been shorter on average than with their Australian and Brazilian competitors. Duration normally varies between 5 and 8 years, with many contracts being of annual duration only, but usually renewable for a number of years, thus establishing a form of long-term relationship between suppliers and buyers.

[8] A common margin option featuring in Japanese LTCs with Australia in the 1980s and 1990s is +10%/-15% at mill's option, with margins such as ±15% and ±20% also featuring. In one case (the 3-year Robe River Flex contract) tonnages were allowed to vary at ±1.5 million tons, which implies a variation margin of just over ±25%.

III.6 Conclusion

Long-term contracts have been, and still are, the main vehicle used in international iron ore trade. They have been used extensively by all the major importers and exporters of the commodity, the former wishing to secure continuous supplies of raw material and the latter striving to earn long-term commitment (and revenue) from their customers. Initially used by the Japanese as the most viable solution to procure raw materials for their booming economy, LTCs became popular with other developed economies, especially after the restrictions on foreign participation imposed by host countries and their nationalisation programmes.

In the 1960s and 1970s LTCs served well the international iron ore trade and brought a relative stability in prices, thus maintaining the impetus of world economic growth. In the 1980s, however, many importers found themselves over-committed to LTCs and sought, and achieved, massive renegotiations in contract terms. The main outcome of this readjustment to world economic conditions, has been a tendency towards relatively shorter contracts (5-8 years instead of 15-20 years) with more flexible quantity requirements and an annual price renegotiation a standard in all markets.

Long-term contracts have evolved over the years, and I believe them to be more of a bargaining tool, rather than a mechanism that determines the optimal quantity of ore that must be traded between partners in order to maximise their joint profits. The experience of the 1980s was one of successive failures on the part of importers to take delivery of their contracted quantities. Increasingly, the reasons for the existence of such contracts remain thin on the ground. Their persistence could be attributable to their qualities as bargaining tools during the annual price negotiations.

In the last part of this chapter, I focused on the LTCs Japan has negotiated over the years. Most of the general observations made earlier are also valid in the case of Japan, which in fact pioneered the widespread use of LTCs. For a considerable amount of time Japan exerted an almost oligopsonistic advantage over its suppliers, especially over Australia, which has been for a long time largely dependent on Japanese imports. This state of affairs, however, has shown evidence of changing towards a more competitive market structure as more prominent steel producers have appeared in the Pacific market and Australia has been systematically trying to diversify its export markets.

Table III.4(a)

Japanese Long-Term Contracts with Australia

Quantities in '000 tons

	Hamersley No.1	*Hamersley No.2*	*Hamersley No.3*	*Hamersley No.4*	*Hamersley Fines*	*Independent No.1*	*Independent No.2*
1966	1330	--	--	--	--	--	--
1967	2660	--	--	--	--	--	--
1968	2670	--	--	--	--	--	--
1969	3340	3640	1500	--	--	--	--
1970	4000	3640	1500	--	--	--	--
1971	4000	3640	1500	--	--	--	--
1972	4000	3640	1500	3000	--	--	--
1973	4500	3640	1500	6000	--	--	--
1974	4500	3640	1500	9000	--	--	--
1975	4500	3640	1500	10500	--	--	--
1976	5000	3640	1500	10500	--	--	--
1977	5000	3640	1500	10500	--	400~600	700
1978	5000	3640	1500	10500	--	525	750~900
1979	7250	3640	1500	13500	--	450~550	750~900
1980	8000	4237	1500	13500	2500	550	900
1981	8000	4237	1500	13500	2500	550	900
1982	8000	4237	1500	13500	2500	550	900
1983	8000	4237	1500	13500	2500	550	900
1984	8000	4237	1500	13500	2500	550	900
1985	8000	4237	1500	13500	2500	550	900
1986	8000	4237	1500	13500	2500	550	900
1987	8000	4237	1500	13500	2500	550	900
1988	8000	--	--	13500	2500	550	900
1989	8000	--	--	13500	2500	550	900
1990	11000	6500	0~3000	13500	--	550	900
1991	11000	6500	0~3000	--	--	--	--
1992	11000	6500	0~3000	--	--	--	--
1993	11000	6500	0~3000	--	--	--	--
1994	11000	6500	0~3000	--	--	--	--
1995	11000	6500	0~3000	--	--	--	--
1996	11000	6500~9500	0~3000	--	--	--	--
1997	11000	6500~9500	0~3000	--	--	--	--
1998	11000	6500~9500	0~3000	--	--	--	--
1999	11000	--	--	--	--	--	--
2000	11000	--	--	--	--	--	--
2001	11000	--	--	--	--	--	--
2002	--	--	--	--	--	--	--

Table III.4(b)

Japanese Long-Term Contracts with Australia
Quantities in '000 tons

	Mt. Newman Core 1996	Mt. Newman Flex	Mt. Newman HG1	Mt. Newman HG3	Mt. Newman HG5	Mt. Newman HG9	Mt. Newman HG10 (A)	Mt. Newman HG10 (B)	Mt. Newman Additional	Mt. Newman LG1	Mt. Newman SF1	Mt. Newman ROM 2	Mt. Newman ROM 3 (Sumitomo)	Mt. Newman ROM 3 (Kawasaki)	Mt. Newman ROM
1966	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1967	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1968	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
1969	--	--	3000	--	--	--	--	--	--	--	--	--	--	--	--
1970	--	--	4500	--	--	--	--	--	--	--	--	--	--	--	--
1971	--	--	6500	--	--	--	--	--	--	--	--	--	--	--	--
1972	--	--	7500	--	--	--	--	--	--	--	--	--	--	--	--
1973	--	--	7500	--	--	--	--	--	--	--	--	--	--	--	--
1974	--	--	7700	--	--	--	--	--	--	--	--	--	--	--	--
1975	--	--	7700	--	--	--	--	--	--	--	--	--	--	--	--
1976	--	--	7500	--	--	1500	--	--	--	--	--	750	500	500	--
1977	--	--	7500	--	--	2200	--	--	--	--	--	750	500	500	--
1978	--	--	7500	--	--	2200	--	--	--	--	--	750	500	500	--
1979	--	--	7500	--	--	2200	--	--	--	--	--	750	500	500	--
1980	--	--	7500	--	--	2200	--	--	--	--	--	--	500	500	--
1981	--	--	7500	4800	6500	2200	--	--	--	--	900	--	500	500	--
1982	--	--	7500	4800	6500	2200	--	--	--	--	900	--	500	500	--
1983	--	--	3100	4800	6500	2200	--	--	--	--	900	--	500	500	--
1984	--	--	3100	4800	6500	2200	--	--	350	--	900	--	500	500	--
1985	--	--	7500	4800	6500	2200	--	--	350	--	900	--	500	500	--
1986	--	--	7500	4800	6500	2200	--	--	1400	350	900	--	500	--	800
1987	--	--	7500	4800	6500	2200	--	--	1400	350	900	--	500	--	800
1988	--	--	7500	--	6500	2200	--	--	1400	350	900	--	500	--	800
1989	--	--	7500	--	6500	2200	--	--	1400	350	900	--	500	--	800
1990	--	--	7500	--	--	2200	8500	0~1500	--	--	--	--	--	--	800
1991	--	--	7500	--	--	--	8500	0~1500	--	--	--	--	--	--	--
1992	--	--	7500	--	--	--	8500	0~1500	--	--	--	--	--	--	--
1993	--	--	7500	--	--	--	8500	0~1500	--	--	--	--	--	--	--
1994	--	--	7500	--	--	--	8500	0~1500	--	--	--	--	--	--	--
1995	--	--	7500	--	--	--	8500	0~1500	--	--	--	--	--	--	--
1996	10000	--	7500	--	--	--	--	--	--	--	--	--	--	--	--
1997	10000	6600	--	--	--	--	--	--	--	--	--	--	--	--	--
1998	10000	6600	--	--	--	--	--	--	--	--	--	--	--	--	--
1999	10000	6600	--	--	--	--	--	--	--	--	--	--	--	--	--
2000	10000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2001	10000	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2002	10000	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table III.4(c)

Japanese Long-Term Contracts with Australia

Quantities in '000 tons

	Marra Mamba	*Goldsworthy*	*Robe River Core 1996-2002*	*Robe River Flex*	*Robe River No. 1*	*Robe River No. 2*	*Robe River No. 3*	*Robe River 5-year contract*	*Savage River*	*Yampi Sound*	*Yandi (BHP)*
1966	--	N/A	--	--	--	--	--	--	--	--	--
1967	--	N/A	--	--	--	--	--	--	--	--	--
1968	--	N/A	--	--	--	--	--	--	1600	--	--
1969	--	N/A	--	--	--	--	--	--	2250	--	--
1970	--	N/A	--	--	--	--	--	--	2250	--	--
1971	--	N/A	--	--	--	--	--	--	2500	--	--
1972	--	N/A	--	--	4800	800	--	--	2500	--	--
1973	--	N/A	--	--	6800	1400	--	--	2500	--	--
1974	--	N/A	--	--	6800	1400	--	--	2500	--	--
1975	--	N/A	--	--	6800	3500	--	--	2500	--	--
1976	--	N/A	--	--	6800	3500	--	--	2500	300	--
1977	--	N/A	--	--	7600	3400	--	--	2500	1450~1650	--
1978	--	N/A	--	--	8200	4000	--	--	2500	1950~2350	--
1979	--	N/A	--	--	8200	4000	--	--	2500	2320~2720	--
1980	--	7775	--	--	8200	4000	--	--	2500	2500~2900	--
1981	--	7775	--	--	8450	4250	--	--	2500	2500	--
1982	--	7775	--	--	8450	4250	--	--	2500	2700	--
1983	N/A	N/A	--	--	8400	4200	--	--	2500	2150	--
1984	N/A	N/A	--	--	9200	--	--	--	2500	1000	--
1985	N/A	N/A	--	--	9200	--	--	--	2500	500	--
1986	N/A	N/A	--	--	7600	5000	--	--	1400	N/A	--
1987	1350	N/A	--	--	7600	5000	--	1000	N/A	N/A	--
1988	1800	1903~2246	--	--	7600	5000	--	2000	2500	2000~2200	--
1989	1800	3330	--	--	7600	5000	4200	2000	1750	2500~2700	--
1990	1800	3690	--	--	6500	5000	0~4000	2000	875	700	--
1991	1800	3690	--	--	6500	5000	0~4000	2000	220~440	2090~2290	--
1992	1800	3690	--	--	6500	5000	0~4000	--	220~440	2010	2700
1993	1800	3690	--	--	6500	5000	0~4000	--	220~440	460	3300
1994	1430	3690	--	--	6500	5000	0~4000	--	--	--	3800
1995	1430	3690	--	--	6500	5000	0~4000	--	--	--	5130
1996	300	3000~3300	9000	--	6500	--	--	--	290	--	6130
1997	--	3000~3300	9000	5500	--	--	--	--	--	--	6630
1998	--	3000~3300	9000	5500	--	--	--	--	--	--	6630
1999	--	--	9000	5500	--	--	--	--	--	--	1500
2000	--	--	9000	--	--	--	--	--	--	--	--
2001	--	--	9000	--	--	--	--	--	--	--	--
2002	--	--	9000	--	--	--	--	--	--	--	--

Table III.4(d)

Australian Contract Notes

Hamersley (CRA/RTZ)

No. 1	On April 16, 1965 a 16-year contract was signed for a total 65.5 million MT until 1976. On September 1976 an additional and extension contract was signed with 1990 the final contractual year and annual volume increased from 5 to 8 million MT. Total quantity 156.2 million tons over 25 years / Plus or minus 10%
Extension of No. 1	11 million tons per year from April 1995 for 7 years, totalling 77 million tons / Plus or minus 10% at mill's option
No. 2	Original contract: 40 million tons from 1969-1979 2-year extension contract for 8.4 mt for 1980-81 6-year extension contract for 1982-87; 4.23 mtpy
No. 3	Original contract: 15 million tons for 10 years starting in 1969. 2-year extension for 3 mt for 1980-1981 6-year extension for 9 mt for 1982-1987
Extension of No. 2 ~ No. 3	6.5~9.5 million tons per year from April 1996 for 3 years, totalling 19.5~28.5 million tons.
No. 4	The original 15 year contract starting from 1972 for 140 million MT was replaced by an extended 19 year contract for 222 million tons.
Fine ore	Annually 2.5 million MT for 6 years; 1979-1984
Extension Contract of Fine Ore	Annually 2.5 million MT for 5 years covering 1April 1985 to 31 March 1989

Mt. Newman (BHP)

Core	10 million tons per year from April 1996 for 7 years, total 70 million tons / 10 more or less at mill's option
HG1	100 mt total for 16 years starting from 1969. No quantity margins. Several pı clauses. Extension contract - 7.5 million tons per year from April 1985 for 5 years, tot 37.5 million tons Extension contract - 7.5 million tons per year from April 1990 for 7 years, tot 52.5 million tons / 10% more or 15% less at mill's option each year / For 19S more or 40% less following conclusion of Core.
HG3	7-year contract for total of 33.6 mt, from 1981 to 1987. Plus/minus 10%
HG5	6.5 million tons per annum from 1981 to 1988 / Extension for 1 year (1989) f milion tons
HG9	10 year contract for total of 21.3 mt; 1976-1985, plus/minus 10%. 5 year extension contract for 2.2 million tons per annum / Plus-minus 10%
Additional	5 year contract linked to port extension, total 7 million tons
LG1	Independent contract with Kobe Steel, 1986-1989, 0.35 million tons
SF1	Originally known as LG2, independent contract with Kobe Steel, 1981-1987, 0.9 mt p.a. Extension for 2 years to cover 1988-1989
ROM	Independent contract with Sumitomo Metal, 1986-1990, 0.8 million tons p.a.
ROM 2	4 year independent contract with Sumitomo Metal, 1976-85, 0.75 million ton
ROM 3 (Sumitomo)	10 year independent contract with Sumitomo Metal, 1976-85, 0.5 million ton 4 year extension contract for 1986-1989.
ROM 3 (Kawasaki)	10 yeas contract with Kawasaki Steel, 1976-1985.
Flex	6.6 million tons per year from April 1997 for 3 years / Plus or minus 2 million tons per year at buyer's option.
HG10 (A)	8.5 million tpy from April 1990 for 6 years. / 10% more or 15% less at mill's c
HG10 (B)	0~1.5 mtpy from april 1990 for 6 years.

Marra Mamba Fines	Total 9 million tons for five years from April 1992. / Buyer's option ±10%

Robe River (RRMC)

No. 1	15 year contrat from 1972 for pellets and fines; renegotiated several times. Plus/minus 10% Additional 6.5 million tons per year for 7 years from April 1990, total 45.5 mil tons / No mill's option except 1996 when minus 70% or plus 10% applicable to Core conclusion.
No. 2	13 year contract, 1972-1983 Extension for 5 years, 1986-1990 5 mtpy for 6 years from April 1990, total 30 million tons. / ±20% at mill's opti
No. 3	0~4 mtpy for 6 years from April 1990, total 0~24 million tons.
Core	9 million tons per year from April 1996 for 7 years totalling 63 million tons / F or minus 500,000 tons per year at buyer's option.
Flex	5.5 million tons per year from April 1997 for 3 years / Plus or minus 1.5 millic tons per year at buyer's option.

Mt Goldsworthy (BHP)

3 year extension contract	1980-1982, 7.775 mt p.a., plus/minus 10% buyer's option
1 year contracts	1988: 1903~2246 mt; 1989: 3.33 million tons
3 year contract	Total 11.07 million tons from April 1990 to March 1993. / No tonnage option specified
3 year extension contract	Total 11.7 million tons from April 1993 to March 1996. / ±15% at buyer's opti
3 year extension contract	Total 11 million tons from April 1996 to March 1999 / Plus or minus 15% at t option.

BHP

Yandi	Originally from April 1992 to March 1999, 3.3 mtpy, 22.5 million tons total. / - -15% at mill's option. From April 1992 to March 2000, variable shipments / +10% or -15% every y
Yampi Sound	Annual contracts with primarily individual mills, with progressively decreasin quantities towards the mine's closure in 1993.

Savage River

Long term contract	Total 45 million tons for 20 years after 1968
3 year contract	3 year contract for 220~440,000 tons.

Source: TEX Report, 1980/81 to 1994/95

Table III.5(a)

Japanese Long-Term Contracts with S.America

Quantities in '000 tons

Brazil	Itabira No. 1	Itabira No. 2	Itabira No. 3	Itabira No. 4	Itabira No. 5	Itabira No. 6	Itabira No. 7	Itabira No. 8 (A)	Itabira No. 9 (B)	Itabira PSC	Itabira BCP	Carajas	Carajas (add.)	NIBRASCO
1966	1000	--	--	--	--	--	--	--	--	--		--	--	--
1967	2000	350	--	--	--	--	--	--	--	--		--	--	--
1968	2000	1200	--	--	--	--	--	--	--	--		--	--	--
1969	3000	2890	--	--	--	--	--	--	--	--		--	--	--
1970	3000	2890	--	--	--	--	--	--	--	--		--	--	--
1971	3000	2890	2800	--	--	--	--	--	--	--		--	--	--
1972	3000	2890	2800	1000	--	--	--	--	--	--		--	--	--
1973	4000	2890	2800	4000	--	--	--	--	--	--		--	--	--
1974	4000	2890	2800	7250	--	--	--	--	--	--		--	--	--
1975	4000	2890	2800	7750	--	--	--	--	--	--		--	--	--
1976	4000	2890	2800	7750	--	--	--	--	--	500		--	--	--
1977	4000	2890	2800	7750	--	--	--	--	--	1500		--	--	--
1978	4000	2890	2800	7750	--	--	--	--	--	1500		--	--	6000
1979	4500	--	--	7750	3300	5690	--	--	--	1500		--	--	6000
1980	4500	--	--	7750	6550	5690	--	--	--	2000		--	--	6000
1981	--	--	--	7750	6550	5690	4500	--	--	2000		--	--	6000
1982	--	--	--	7750	6550	5690	4500	--	--	2000		--	--	6000
1983	--	--	--	7750	6550	5690	4500	--	--	2000		--	--	6000
1984	--	--	--	7750	6550	5690	4500	--	--	2000		--	--	6000
1985	--	--	--	7750	6550	5690	4500	--	--	2000		--	--	6000
1986	--	--	--	7750	6550	5690	--	--	--	2000		7000	--	6000
1987	--	--	--	7750	6550	5690	--	--	--	2000		8500	--	6000
1988	--	--	--	--	6550	5690	--	--	--	2000	750	10000	--	6000
1989	--	--	--	--	6550	5690	--	--	--	2000	750	10000	--	6000
1990	--	--	--	--	6550	5690	--	--	--	2000	375	10000	--	6000
1991	--	--	--	--	6550	5690	--	--	--	2000	--	11000	--	6000
1992	--	--	--	--	6550	5690	--	--	--	2000	--	10000	1000	6000
1993	--	--	--	--	6550	5690	--	--	--	2000	--	10000	1000	Balance
1994	--	--	--	--	6550	5690	--	--	--	2000	--	10000	1000	3500
1995	--	--	--	--	--	--	--	3000	3000	2000	--	10000	1000	3500
1996	--	--	--	--	--	--	--	3000	3000	1000	--	10000	1000	3500
1997	--	--	--	--	--	--	--	5000	5000	--	--	10000	1000	3500
1998	--	--	--	--	--	--	--	5000	5000	--	--	10000	1000	3500
1999	--	--	--	--	--	--	--	5000	5000	--	--	10000	1000	--
2000	--	--	--	--	--	--	--	--	5000	--	--	10000	1000	--
2001	--	--	--	--	--	--	--	--	--	--	--	--	--	--
2002	--	--	--	--	--	--	--	--	--	--	--	--	--	--

Table III.5(b)

Japanese Long-Term Contracts with S.America
Quantities in '000 tons

	SAMARCO	MBR	MBR (7 year/Flex)	MBR (12 year/Core)	Peru P.F.	Chile	Romeral	Romeral P.F.	Algarrobo	Venezuela
1966	--	--	--	--	--		--	--	--	
1967	--	--	--	--	--		--	--	--	
1968	--	--	--	--	--		--	--	--	
1969	--	--	--	--	--		--	--	--	
1970	--	--	--	--	--		--	--	--	
1971	--	--	--	--	--		--	--	--	
1972	--	--	--	--	--		--	--	--	
1973	--	1000	--	--	--		--	--	--	
1974	--	6000	--	--	--		--	--	--	
1975	--	7000	--	--	--		--	--	--	
1976	--	7000	--	--	900		--	--	--	
1977	300	7000	--	--	1000~1400		--	--	--	
1978	400	7000	--	--	1100~1300		--	--	2975	
1979	400	7000	--	--	1775~1975		--	--	3500	
1980	400	7000	--	--	2025~2225		--	--	3500	
1981	500	7000	--	--	2100~2300		2500	--	3500	
1982	500	7000	--	--	7460		2500	--	3500	
1983	500	7000	--	--	N/A		2500	--	3500	
1984	600	7000	--	--	N/A		2500	--	3500	
1985	600	7000	--	--	N/A		2500	--	3500	
1986	600	7000	--	--	N/A		2500	--	3500	
1987	--	7000	--	--	N/A		2500	--	1575	
1988	400	7000	--	--	950		2500	--	2450	700
1989	400	3200~3500	--	--	400~550		1350	--	1500~2083	590
1990	400	--	3600~4050	--	550		1320	900~1000	1450	N/A
1991	400	--	3800~4250	800	600		1100	1200	1450	1970
1992	400	--	3800~4250	1000	750		1100	1200	1450	1660
1993	--	--	3800~4250	1200	750		1100	1200	1450	1410
1994	1000	--	3800~4250	3000	750		1100	1200	1450	840
1995	1000	--	3800~4250	3000	750		1100	1200	1450	N/A
1996	1000	--	3800~4250	3000	750		1100	1200	1450	1060
1997	1000	--	1800~3300	3200~3500	750		1100	1200	1450	--
1998	1000	--	1800~3300	3200~3500	750		1100	1200	1450	--
1999	1000	--	1800~3300	3200~3500	--		--	--	--	--
2000	1000	--	--	3200~3500	--		--	--	--	--
2001	--	--	--	3200~3500	--		--	--	--	--
2002	--	--	--	3200~3500	--		--	--	--	--

Table III.5(c)

S. American Contract Notes

Brazil

Itabira No. 5	Total 95 million tons in 15 years from fiscal 1979. / ±10% at mill's option.Bric pricing.
Itabira No. 6	Total 85.35 million tons from fiscal 1979. / ±10% at mill's option.Brick pricing
Itabira No. 8 (A)	5 million tons per year for 5 years for April 1995 - March 2000 / +5% / -15% year at buyer's option.
Itabira No. 9 (B)	5 million tons per year for 6 years for April 1995 - March 2001 / +5% / -15% year at buyer's option.
Itabira PSC	Total 37 million tons in 20 years from 1976. / Same conditions as CVRD No. contract.
NIBRASCO (pellets)	Originally, 15 years at 6 mtpy from August 1978. Then renewed for 3.5 millic tons per year for 5 years from April 1994 to March 1999
Carajas	Total 145.5 million tons in 15 years from April 1986 / +10%, minimum 80% c contract base quantity guaranteed by mills.
Carajas (additional)	1 million tons per year for 9 years from April 1992, total 9 million tons / Sam conditions as for base agreement.
MBR	16 year contract from 1973 to 1988. Also a 1 year extension for 1989.
MBR (Core)	6 years form April 1997 to March 2003. This replaces the second part of the original 12 year contract which run from 1991 to 1996
MBR (Flex)	3 years from April 1997 to March 2000. This extends the 7 year contract wh ran from 1990 to 1996.
SAMARCO (48% BHP)	400,000 tons per year for 4 years from April 1989 / ±10% at buyer's option
SAMARCO (48% BHP)	1 million tons per year in 7 years from January 1993 / +10% or -15% at buy option.

Peru

Shougang Hierro Peru	All contracts with Hierro Peru and: Nippon Steel (1979-83), NKK (annual), K Steel (1976-83), Sumitomo Metal (annual), and Nishin Steel (annual). 750,000 tons per year for 7 years from April 1992, total 5.25 million tons. / + -20%.

Chile

Romeral	2.5 mtpy 1981-85, 5 year contract 2.5 mtpy 1986-1989, 3 year contract 3.52 million tons from April 1990 to March 1993 / ±10% at buyer's option. 1.1 million tons per year from April 1993 to March 1998, total 5.5 million tons Plus-minus 10% at buyer's option.
Romeral P.F.	April 1990~March 1993, Total 3.3~3.4 million tons April 1993~March 1998, Total 6 million tons / Plus-minus 10% per year.
Algarrobo	10 year contract, 1978-1987. Several restrictions on price variation. April 1990~March 1993, Total 4.35 million tons April 1993~March 1998, Total 7.25 million tons / Buyer's option ±10%

Venezuela	All contracts are for one year only.

Source: TEX Report, 1980/81 to 1994/95

Table III.6(a)

Japanese Long-Term Contracts with India

Quantities in '000 tons

	MMTC				Goa			
	Bailadila	MOH	Paradeep	Kudremukh	Tudou	Chowgule	Dempo	Salgaocar
1981	7800	3300	--	--	--	500	2000	1550
1982	7800	3300	--	--	--	500	2000	1550
1983	7800	3300	N/A	N/A	--	N/A	2000	1550
1984	7800	3300	N/A	N/A	--	N/A	2000	1550
1985	7800	3300	N/A	N/A	--	N/A	2000	1550
1986	7800	3500	N/A	N/A	--	N/A	2000	1550
1987	7800	3500	--	2500	--	N/A	2000	1550
1988	7800	3500	700	2500	--	2100	2000	1350
1989	5400	2500	800	2500	--	2100	2100	1350
1990	5400	2500	700	2250	--	2100	2000	1350
1991	4500~5500	2500~3000	1500~2000	3030~3250	--	2070	2250	1350
1992	4500~5500	2500~3000	1500~2000	3030~3250	--	2070	2120	1550
1993	4500~5500	2500~3000	1500~2000	3030~3250	500	2070	2120	1550
1994	4500~5500	2500~3000	1500~2000	3030~3250	500	2070	2000	1550
1995	4500~5500	2500~3000	1500~2000	3030~3250	500	2070	2000	1550
1996	1800~3400	1400~3200	300~1000	1000~1500	500	2070	1737	1900
1997	1800~3400	1400~3200	300~1000	1000~1500	500	--	1600	1035
1998	1800~3400	1400~3200	300~1000	1000~1500	--	--	1600	1035
1999	1800~3400	1400~3200	300~1000	1000~1500	--	--	1600	1035
2000	1800~3400	1400~3200	300~1000	1000~1500	--	--	1600	1035
2001	--	--	--	--	--	--	--	1035

Table III.6(b)

Japanese Long-Term Contracts with India

Quantities in '000 tons

	Fomento	Fomento add. 1-year	SMIL (Shan-Kan)	Sesagoa	Bandodkar	Bandekar	Sarmalkar	Damodar	Terekhol	Timblo	Mandovi Pellets
1981	850	570	1100	1040	480	50	450	250	--	300	1800
1982	850	570	1100	1040	480	50	450	350	--	160	1800
1983	850	N/A	N/A	N/A	480	N/A	N/A	N/A	N/A	N/A	1800
1984	850	N/A	N/A	N/A	480	N/A	N/A	N/A	N/A	N/A	1800
1985	850	N/A	N/A	N/A	480	N/A	N/A	N/A	N/A	N/A	1800
1986	850	N/A	N/A	N/A	480	N/A	N/A	N/A	N/A	N/A	1800
1987	850	N/A	N/A	N/A	480	N/A	N/A	N/A	N/A	N/A	1800
1988	850	570	1100	1140	480	--	600	350	--	--	1800
1989	850	570	1100	1340	480	--	700	350	--	--	--
1990	850	570	1100	N/A	480	--	N/A	N/A	--	--	--
1991	850	570	1100	1440	340~480	--	650	350	--	--	--
1992	850	570	1100	1460	340~480	550		350	--	--	--
1993	600~850	570	1100	1460	340~480	--	550	350	--	--	--
1994	600~850	--	1100	1460	340~480	--	550	350	100~200	--	--
1995	600~850	--	1100	1460	340~480	--	N/A	N/A	N/A	--	--
1996	600~850	200	1100	1457	340~480	500	--	320	100	200	--
1997	600~850	--	--	--	340~480	--	--	--	--	--	--
1998	600~850	--	--	--	340~480	--	--	--	--	--	--
1999	--	--	--	--	--	--	--	--	--	--	--
2000	--	--	--	--	--	--	--	--	--	--	--
2001	--	--	--	--	--	--	--	--	--	--	--

Table III.6(c)

Indian Contract Notes

Bailadila	7.8 mtpy for 5 years, 1981-85 4.5~5.5 mtpy for April 1991~March 1996
MOH	10 year contract from April 1981, total 34.6 million tons 2.5~3.0 mtpy for 5 years, from April 1991 to March 1996.
Paradeep	1988 & 1989: Yearly contracts for 0.7 million and 0.3 million tons at mill's op 1.5~2.0 mtpy from April 1991 to March 1996
Kudremukh	Annual contracts for 1987, 1988, 1989 3 year contract 1990-92 for 2.25 million tons p.a. New terms to previous contract: 3.03~3.25 mtpa from April 1991 to March 1!
Chowgule	2 rolling annual contracts with 4 mills and NKK
Tudou	500,000 tons per year for 5 years, from April 1993 to March 1998.
Dempo	Total 16 million tons in 8 years from 1981. Total 10 milion tons for 5 years from 1991.
Salgaocar	11.8 million tons in 8 years from 1982 Total 7.75 million tons for 5 years from 1992
Fomento	5 year contract with Sumitomo, 850,000 tpy, 1985-89 3 year contract with Sumitomo, 600~850,000 tpy, starting 1993.
Fomento	1 year contracts for 1993 with Godo steel for 70-100,000 tons
Fomento	1 year contracts with NSC for 500,000 / ±10% buyer's option.
SMIL (Shan-Kan)	3 year contract from 1989 to 1992 for 1.1 million tons p.a.
Bandodkar	5 year contract, 480,000 tpy, 1985-89
Mandovi Pellets	10.5 year contract, 1978-1988.

Source: TEX Report, 1980/81 to 1994/95

Table III.7 (a)

Japanese Long-Term Contracts with Africa, Canada and Sweden

Quantities in '000 tons

	S.Africa		Mauritania	Liberia	Canada		Sweden
	Iscor	Assoman	SNIM	LAMCO	Carrol Lake	Tasu	LKAB
1973	--	--	2200	--	5000	--	--
1974	--	--	2200	--	5000	--	--
1975	--	--	2200	--	5000	--	--
1976	2000	--	2200	--	5000	185	--
1977	5000	--	2200	--	5000	360	--
1978	7000	--	2200	--	5000	350	--
1979	7000	--	2200	440	5000	350	--
1980	7000	--	2200	360~440	5000	350	--
1981	7000	600	1400	360~440	5000	350	--
1982	7000	1000	--	400~560	5000	500	--
1983	7000	1000	--	400~560	5000	500	--
1984	7000	1000	--	400~560	5000	--	--
1985	7000	1000	--	400~560	5000	--	500
1986	7000	1000	--	--	5000	--	1000
1987	7000	--	--	--	5000	--	1000
1988	3826	700	--	120	2070	--	1000
1989	3826	700	390	160	2070~2300	--	1000
1990	N/A	N/A	--	--	2300	--	--
1991	4000	1000	--	--	2300	--	--
1992	4000	1000	130	--	2300	--	--
1993	4000	1000	--	--	2300	--	--
1994	4000	1000	--	--	2300	--	--
1995	4000	1000	--	--	2300	--	--
1996	4000~5000	1000	--	--	2300	--	--
1997	4000~5000	1000	--	--	2300	--	--
1998	4000~5000	1000	--	--	--	--	--
1999	4000~5000	1000	--	--	--	--	--
2000	4000~5000	1000	--	--	--	--	--
2001	--	1000	--	--	--	--	--
2002	--	--	--	--	--	--	--
2003	--	--	--	--	--	--	--

Table III.7(b)

Rest-of-world Contract Notes

S.Africa	
Iscor	12 year contract for total 77 mt, from 1976. 5 year contract for 4 mtpy, 1991-95 5 year extension, from April 1996 to March 2001. Lump 4 million tpy. Fines (million tpy. / Buyer's option: +15%/-10% (lump); 0~1 million tpy (fines)
Assoman	Originally 1mtpy, April 1991~March 1994. Then renewed for 1 mtpa from Ap 1994 to March 1997./ ±20%. Subsequently renewed as 5-year contract for s quantity.
Canada	
Carrol Lake (IOC)	15-year contract for total 75 m tons form 1973 to 1988 1-year contract for 1989 April 1990~March 1993 / Buyer's option ±10% April 1993~March 1997 / Buyer's option ±15%.
Tasu	8 year contract, 1976-1983
Liberia and Mauritania	9 year contract with SNIM, from 1973, 2.2 mtpy. 7 year contract with LAMCO from 1979. Spot contracts (1 year), mines developed primarily with French assistance
Sweden	
LKAB	Total 4.5 mt for 4.5 years. 1mtpy contracted.

Source: TEX Report, 1980/81 to 1994/95

IV. An Economic Model of Iron Ore Trade

IV.1 Introduction

In the previous two chapters I looked at two most important aspects of the current thesis: existing literature that could be applied – with some modifications – to the iron ore industry; and the central role played by long term contracts in the international trade of the commodity.

This chapter proposes a new approach towards the explanation of the behaviour of participants in the international iron ore market, and tests the validity of this theory with a series of simple econometric tests, which look at the strategic import allocation decisions of the importers since the early 1960s (in most cases) taking simultaneously into account price signals from all major exporters to each importing nation. The chapter starts with my explanation of the behaviour of partners engaging in iron ore trade and continues with the methodology and data considerations for the econometric tests mentioned above. Test results and their interpretation are covered chapter V.

IV.2 Explaining the Behaviour of Trading Partners

IV.2.1 Demand for Iron Ore

A concept central to the analysis of demand for commodity imports, and iron ore imports in particular, is that of differentiation. This essentially means that an importer perceives commodity exports from alternative countries as embodying different proportions of characteristics. This interpretation of commodity differentiation is based on the characteristics approach in the economics of consumer behaviour. Commodities become horizontally differentiable when importers differ in their choice of product types even though their quality may be the same; in contrast, commodities are said to be vertically differentiable when their product types differ only in quality and all importers have the same preference ordering.

Characteristics that have to do with horizontal differentiation may include, for example, marketing conditions, and cultural, historical, or political ties between trading partners. Characteristics giving rise to vertical differentiation are directly or indirectly linked with the quality of the commodity.

When iron ore is the commodity in question, quality is a source of vertical product differentiation in terms of the iron content of ores originating in different countries. In contrast, marketing arrangements, in the form of long-term supply contracts is the predominant source of horizontal product differentiation.

Another factor that may be used to explain commodity flows is the fact that importers often prefer to diversify the suppliers of a commodity rather than purchase from only one country. This situation is described by the variety approach to consumer preferences. Both approaches are next discussed in more detail.

IV.2.1.1 Commodity Characteristics and Commodity Trade

The commodity characteristics approach to analyse imperfect market structures was formally introduced by Hotelling (1929) in his seminal work on spatial economic theory. He used geographic location as a characteristic explaining consumer behaviour for goods otherwise physically homogeneous. Apart from transport costs, he attributed commodity differentiation to existing socio-economic ties, 'the mode of doing business', and 'differences in service or quality'.

An alternative approach, originally developed in household theory, is borrowed from Gorman (1959 and 1980) and Becker (1965), according to which utility is derived from the consumption of characteristics produced by the household from purchased goods. This concept was adopted by Kelvin Lancaster who further developed and expanded it. According to Lancaster (1966, 1971), the characteristics contained in a commodity are objectively defined, whereas the consumers' preferences for characteristics are subjectively determined. Each consumer, therefore, derives a different level of utility from the consumption of those characteristics. A consumer's behaviour may then be explored without knowledge of his or her utility function. In Hendler (1975) and Lucas (1975), however, it is shown that Lancaster's formulation depends on two critical assumptions: the non-negative marginal utility of characteristics; and their weak separability so that utility depends only on the total amount of characteristics in a commodity and not on their proportions in alternative supply sources. Lancaster later (1979) extended his approach to analyse markets which are monopolistically competitive, a generalisation which lends itself to many applications in the analysis of consumer demand and non-competitive markets.

The characteristics approach offers an intuitively appealing explanation of why importers differentiate between supplying countries even though the commodity itself might be homogeneous. Unfortunately, it suffers from the inherent limitation of yielding a solution in which each buyer purchases from only one supplier. Diversification of supply sources arises only from aggregation of consumers (Lancaster 1975, pp. 571-572). Thus, a country's diversification of different exporters of a particular commodity is simply interpreted as the summation within the country of purchases by individual agents from a single supplier. Clearly, this approach is unrealistic; however, alternative approaches have been proposed.

IV.2.1.2 The Variety in Trade Approach

The analytical framework of this approach has been borrowed from consumer preference theory, which discusses product choice and optimal product variety. The central argument of this theory is that products that are near substitutes for one another will give rise to monopolistic competition because of consumer preferences for product diversity. As shown by Spence (1976) and Dixit and

Stiglitz (1977), a consumer's desire for diversity arises from the convexity of the indifference curve for imperfectly substitutable products. Strict convexity means that any straight line drawn between two points of an indifference curve will always lie above any point along the curve. As a result, a combination of products is always preferred to specialisation in just one product.

In the context of international trade, a 'product' is the commodity originating from a specific supplier, hence embodying a set of intrinsic characteristics. Strict convexity of an importer's preference curve results in the importer opting for a diversity products, which is translated into a diversity of exporting countries, which supply him with a slightly different version of the commodity he is after. Krugman (1979, 1981), Dixit and Norman (1980), Hart (1985a, 1985b), Helpman and Krugman (1985), and Venables (1987) have used the preference for diversity implied by strictly convex indifference curves to derive a monopolistic competitive model of international trade for examining the welfare implications of markets with differentiated goods.

This approach is not, however, without its flaws. Strict convexity of indifference curves for import demand imply a relentless strife for import diversity, which is not always true. An importer may be unwilling to diversify his supply sources, if choosing one supplier only means favourable marketing arrangements. Moreover, a strictly convex indifference curve is unlikely to hold for all products. If the importer of a physically homogeneous commodity views exports from alternative suppliers as perfect substitutes, then the importer's indifference curve for alternative suppliers will be a straight line.

IV.2.1.3 The 'Diversity as a Characteristic' Approach

A third line of thought, suggested by Lord (1991), offers a fresh approach which reconciliates the two approaches discussed above. More specifically, the concept of 'commodity type' is introduced, which embodies the consumer's choice of characteristics from a variety of products. In the trade context, differentiation of a commodity exists at the level of the exporter. It is not the physical characteristics of a commodity only that determine importer preferences; it is also the characteristics of the exporters themselves, as well as the wish for diversity, which can also be considered as a characteristic.

In the case of iron ore, this approach offers an insight where other approaches (e.g. spatial equilibrium analysis) cannot always explain export demand (e.g. in Japan) for ores originating from distant suppliers (e.g. Brazil), when closer suppliers (e.g. Australia) are available. Indeed, the history of iron ore trade, especially from the 1980s onwards, shows that the biggest importers of iron ore show a clear tendency to diversify their sources of supply. Japan, South Korea, and the most prominent West European importers each source their imports from over 10 suppliers, albeit each of them having one or two predominant suppliers.

IV.2.1.4 Imperfect Competition in Iron Ore Trade

As noted in previous chapters, the most salient feature of iron ore is that it is almost exclusively used in the blast furnace operation of pig iron, which is further processed into crude steel in basic oxygen furnaces. The demand for iron ore is, therefore, derived from the demand for steel by end users, such as the construction industry, manufacturing, engineering, shipbuilding the automotive industry, etc. Since the demand for steel is relatively insensitive to changes in its own price, particularly in the short run, aggregate demand for iron ore can therefore be expected to also be insensitive to its own price changes in the short run (Tilton, 1978).

There are several more factors contributing to this price inelasticity. Iron ore only accounts for a relatively small proportion of the costs for finished steel, approximately 5% of it. Large price reductions in iron ore prices are unlikely to induce additional demand. On the other hand, large increases in demand are unlikely to undermine short-term demand as the amount of resources dedicated to steel production are quite inflexible. To achieve much needed scale economies a steel mill requires the highest possible rates of capacity utilisation. In addition to the difficulty of quick divestments, labour is also difficult to scale down in the short term. In some of the traditional large steel manufacturing nations steel workers' unions have accumulated considerable rights for their members, making quick labour downsizing almost impossible.

In Europe, for example, the steel industry went (and still is going) through a painful and prolonged restructuring process in order to decommission some of its excess capacity. In the USA, on the other hand, the industry has followed a different path, opting increasingly for electric arc furnace capacity which are of considerable smaller scale than integrated steel mills. Although less efficient[1] for large scale production of pig iron, electric arc furnaces offer considerable flexibility in production, allow for more precision in product specification and are ideal for the production of small consignments of high specification steel alloys.

Despite the considerable incursion of the electric arc furnace in iron smelting, however, the vast majority of the world's production still comes from basic oxygen converters and iron ore is very much the dominant feedstock of the iron and steel industry. So what about the situation on the supply side?

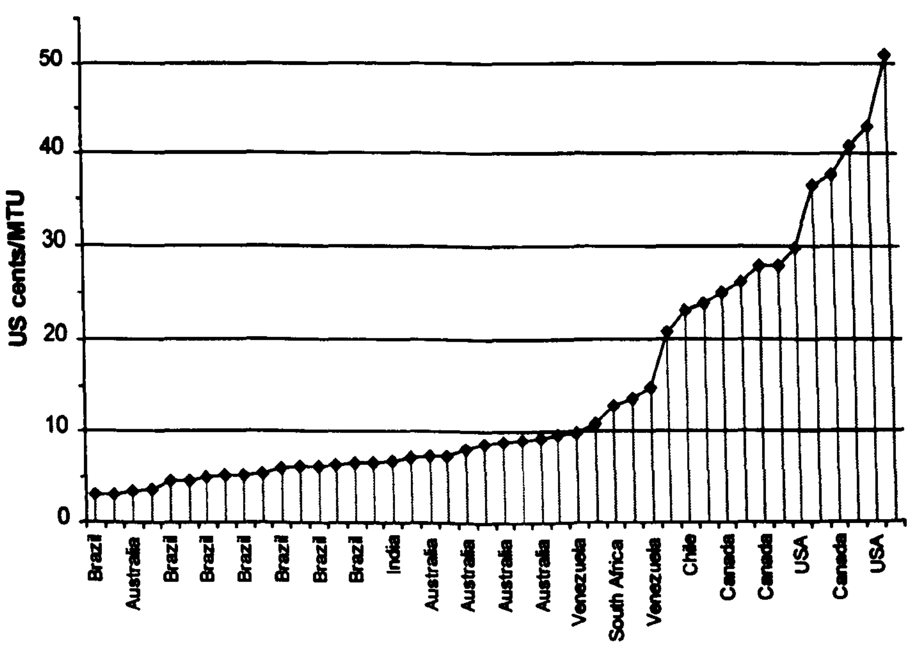
Over the last 30 years, the dominance of Brazil and Australia is quite indisputable and one may well wonder whether the supply side is not in fact quite close to the duopoly model discussed in chapter II. However, there still remains some 40% of international supply which is accounted for by an additional 8 countries, some of which like Canada, India and Sweden are always in the league of top exporters. So the traditional oligopoly model needs to be modified to accommodate 2 dominant firms (countries in our case) as well as a number of non-dominant small firms.

[1] A typical blast oxygen furnace (or converter) yields about 400 tonnes of molten (pig) iron in about 40-45 minutes; an electric arc furnaces produces about 150 tonnes in about 30-35 minutes.

The theoretical expectation that the low cost producers tend to dominate the market can be broadly accepted as valid in the case of iron ore. As it can be seen from Figure IV-1 and Table IV-1, the lowest cost producers are predominantly located in Brazil and Australia, while some of the highest cost ones are found in Canada and the USA.

Figure IV-1

Industry Cost Curve (fob) for Iron Ore (1993)



Source: Hellmer (1996)

Table IV-1

Major iron ore mines in the Western world ranked by cost of production, 1993

Mine	Country	Operator	Grade	Mining cost US /mtu
Morro Agudo	Brazil	Samitri	52	3.06
Corrego do Meio	Brazil	Samitri	63	3.13
Channar	Australia	Hammersley	63	3.52
Mina do Andrade	Brazil	Samitri	66	3.69
Aguas Claras	Brazil	MBR	68	4.57
Carajas	Brazil	CVRD	66	4.73
Mina Pau Branco	Brazil	Mannesmann	67	5.01
Feijao Mine	Brazil	Ferteco	65	5.21
Pico Mine	Brazil	MBR	67	5.28
Dominalai	India	NMDC	63	5.42
Mutuca Mine	Brazil	MBR	68	5.94
Conceicau	Brazil	CVRD	58	6.20
Timbopeba	Brazil	CVRD	65	6.21
Brockman No 2	Australia	Hammersley	62	6.30
Caue	Brazil	CVRD	56	6.49
Casa de Pedra	Brazil	Siderurgica	61	6.61
Kudremukh	India	Kudremuch	39	6.84
Bailadia	India	NMDC	64	7.09
Middleback	Australia	Hammersley	65	7.29
Mount Tom Prince	Australia	Hammersley	64	7.30
Robe River	Australia	Robe River	57	8.15
Alegria	Brazil	Samarco	52	8.67
Yandi	Australia	BHP	58	8.83
Mount Goldworthy	Australia	BHP	59	9.15
Paraburdoo	Australia	Hammersley	64	9.25
Fabricia Mines	Brazil	Ferteco	55	9.65
Piar Division	Venezuela	Ferrominera	65	9.96
Mount Whaleback	Australia	Mount Newman	64	10.79
Sishen	South Africa	ISCOR	59	12.77
Romeral	Chile	Mineral del Pacifico	48	13.47
Pau Division	Venezuela	Ferrominera	64	14.75
Mamberget	Sweden	LKAB	62	20.80
Algarrobo	Chile	Mineral del Pacifico	48	22.95
Kiruna	Sweden	LKAB	62	23.90
Wabush	Canada	Cleveland	38	24.92
Carol Lake	Canada	IOC	58	26.11
Mount Wright	Canada	QMC	30	27.88
Savage River	Australia	Cleveland Cliffs	35	27.96
Eveleth	USA	Eveleth Taconite	24	29.81
Mines Terres Rouges	France	ARBED	30	36.57
LTV Steel	Canada	LTV Steel	54	37.74
Algoma	Canada	Algoma Steel	35	40.88
Hibbing Taconite	USA	Bethlehem Steel	27	42.91
Empire Mine	USA	Inland Steel	29	50.91

***Source:** AME (1994)*

Among the lowest cost mines are those of CVRD, which is the dominant Brazilian producer holding about three quarters of Brazilian iron ore production and which is the most likely company to lead annual price negotiations both with German and Japanese importers.

In the Pacific market it is two dominant companies, BHP and Hamersley, which are the first usually to negotiate (separately) with the team representing collectively the Japanese steel mills. Given the weight of Australia in the Pacific and Brazil in the Atlantic market, one would expect that the biggest buyers in each of these markets (Japan and Germany) to procure the great majority, if not all, of their supplies from the cheapest and closest supplier.

If one could envisage a situation like the one described above, the economic structure in each of the two geographically separate markets would be akin to that of bilateral monopoly; in our case, two sets of bilateral monopolies in different parts of the world. Indeed some authors (e.g. Priovolos, 1986) have based their analysis of the iron ore market as a string of bilateral monopolies between pairs of countries. As was shown in the previous chapters, however, the past patterns of iron ore trade flows have shown several considerable diversions from the profit maximising quantities and in some cases complete break down in negotiations; all offering very little evidence of collusive behaviour to maximise profits.

The model of bilateral monopoly is a very attractive theoretical proposition, but it is rather difficult to encounter it in practice. It is not surprising, therefore, that in all bibliography considerable discussion has gone into the theoretical specification of bilateral monopoly interaction, but little has actually been empirically tested. As Azzam (1996) notes, "what is surprising is that bilateral oligopoly, which would seem to be a more realistic case, has attracted little theoretical or empirical interest. In theory, one could devise a game-theoretic model of bargaining between sellers and buyers. In practice, this would require models of coalition as there are more than two players (Meyerson, 1991). The empirical possibilities from such models would, however, still remain limited."

Concomitant evidence on why the bilateral monopoly analytical framework would be wrong (especially when looking at the global market for iron ore) does exist. All major consumers do import ore from than one sources. The United States, for example, uses domestic reserves, imports from Canada (in some cases from subsidiary mining companies there) and also imports from Brazil. Japan is geared up for imports from Australia and perhaps India. In a bilateral monopoly framework, little explanation can be offered as to why Japan should also import from Brazil. Germany imports from Brazil most of its needs because they are the most competitive resources. Again, its imports from Sweden[2] and even Australia are not theoretically justified.

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[2] In the case of Sweden as an exporter to North West European countries, Hellmer (1996) maintains that the reason for its continued presence is the successful product differentiation it has implemented, especially through the production of high value added/high specification

Ownership ties still exist between steel producers and mines. They may not be as dominant as they used to be in the 1950s and 1960s, but they can still serve as an important bargaining chip. European steel mills have minority stakes in several Brazilian mines, frequently in partnership with CVRD, who – theoretically – is their major adversary. France and Italy both have equity stakes in West African (Mauritanian) mines, trying also to reduce their dependence on Brazil and Australia.

In the United States, where steel mills depend on Canada, Brazil and Venezuela for 95% of their imports, steel production economics have advanced more rapidly than in other parts of the world. Steel 'mini-mills' have mushroomed and now provide possibly some 30% of US steel production (Crandall, 1996). Mini-mills depend on steel scrap and direct reduced iron (a form of very high grade iron ore, also known as 'sponge iron') and are thus much less dependent on iron ore.[3] In view of this development, a swift move away from the dependence on iron ore from Latin America can become a credible threat in iron ore price negotiations

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pellets. Although not exactly an unrealistic claim, it is disputed by Ericsson (1996) who sheds doubt on the survival of LKAB (the Swedish iron ore exporter) due to its product differentiation policy. "The effects of this oligopolistic structure [of sellers] with the relatively few [...] well organised buyers of iron ore are not studied" says Ericsson. He continues, "the steel works of Western Europe see a strategic advantage in having at least one local supplier to compete with the overseas producers of Latin America and Australia. [...] European steel mills have interests in several overseas iron ore producers. Rather than exapnd their production capacity they choose to buy ore from LKAB."

[3] Direct reduced iron (DRI), however, does come from iron ore itself, so that dependence on high quality, low cost, producers from abroad is still inevitable. Only mills exclusively using scrap can rely on domestic recycle supply and scrap imports, possibly from other developed countries.

between the United States and its trading partners. The move may not be possible to implement within a year or two, but the threat is a lot more realistic nevertheless. A move away from basic oxygen reduction to electric arc production can only be detrimental for the long term market shares of iron ore exporters and strategic behaviour may restrain them from forcing their bargaining advantages in periods of high import demand.

Last, but not least, in the string of reasons making the bilateral monopoly framework less and less adequate, is the development of long term contracts and their changing role in the last ten years. As it was discussed in chapter III, long term contracts gradually took over large equity stakes in iron ore mines as the most widely spread medium of ensuring long term, continuous supply of raw material to steel mills. This is not only true for iron ore; it is also the *modus operandi* of the coking coal industry, whereby steel mills rely on such arrangements to secure adequate supplies of anthracite and high quality bituminous coal, which they subsequently carbonise and use in the iron manufacturing process.

Despite the long term commitment implied by such contracts, the trading partners (predominantly importers) have repeatedly demonstrated their unwillingness to adhere to their contractual obligations and have on many occasions failed to lift the amounts of cargo stipulated in the contracts (see Table IV-2). As a result, long term contracts become progressively less of a means to provide security of supplies. Contributing to this malaise (for exporters) is the chronic overcapacity of iron ore supplies and increasing price competition (Chang, 1994). What long term contracts still provide, however, is a form of approval for a supplier's reliability, ability to deliver iron ore at the right quality and price and the accompanying credit worthiness that such an endorsement entails. For the exporter, long term commitments from buyers are essential for long term planning and development of existing and new production capacity, as they help to secure the backing of investors and financiers.

Despite the advantages of long term contracts for both buyers and sellers, they are without a doubt too restrictive. The sharp downfall of world industrial production, and the subsequent decline in steel production and iron ore imports highlighted the inflexibility of long term contractual arrangements. Since the 1980s contracts have factored in additional flexibility, primarily through shorter durations and wider margins for the quantities of ore that are to be lifted every year. Contracts lasting 15-20 years are a thing of the past. It is now more likely that 5-8 contracts are used even for greenfield projects, shorter terms for simple extensions of existing contracts. At the same time, the typical lifting margin of ±5% on the contracted quantity is more likely to be ±10 or 15%.

Long term contracts and minority stakes may not be used effectively to directly secure supplies, but their existence does signal the importer's intention to procure his raw material year after year. In the negotiating process that takes place every year in order to determine prices, long term contracts are bargaining chips rather than determinants of the quantity maximising the joint profits of bilateral monopoly.

Table IV-2

Contracted and Actual Imports of Iron Ore by Japan

	Imports from Australia			Imports from Brazil		
	Contracted Volume (m.tonnes)	**Actual Imports (m. tonnes)**	**Imports/ Contracts**	Contracted Volume (m.tonnes)	**Actual Imports (m. tonnes)**	**Imports/ Contracts**
1966	1330000	2043491	154%	1000000	1704461	170%
1967	2660000	8313833	313%	2350000	2430664	103%
1968	4270000	13813940	324%	3200000	2198482	69%
1969	13730000	23234523	169%	5890000	4185450	71%
1970	15890000	36596955	230%	5890000	6779361	115%
1971	18140000	46287396	255%	8690000	8996651	104%
1972	27740000	48294755	174%	9690000	9334542	96%
1973	33840000	64238641	190%	14690000	12821283	87%
1974	37040000	67880987	183%	22940000	19522809	85%
1975	40640000	63253080	156%	24440000	23459583	96%
1976	44490000	64094316	144%	25840000	25380371	98%
1977	47740000	63103364	132%	26240000	23742697	90%
1978	49265000	52626268	107%	35315000	20815439	59%
1979	54360000	55297480	102%	39640000	26136093	66%
1980	66862000	60040060	90%	43390000	28522932	66%
1981	79562000	54860965	69%	45990000	27164735	59%
1982	79762000	54139956	68%	53450000	27346237	51%
1983	66937000	49772804	74%	45990000	23509201	51%
1984	62737000	58357452	93%	46090000	29017413	63%
1985	66637000	54321348	82%	46090000	29064068	63%
1986	70137000	46893889	67%	48590000	26633279	55%
1987	71087000	43413754	61%	47565000	26831270	56%
1988	66500000	52415696	79%	44990000	27931730	62%
1989	73780000	56275433	76%	38430000	29520127	77%
1990	72015000	53852628	75%	38835000	30198492	78%
1991	52710000	58353791	111%	42560000	28470416	67%
1992	55200000	104137622	189%	42600000	53514070	126%
1993	54250000	106946248	197%	36150000	55644356	154%
1994	53920000	55409205	103%	41880000	27873986	67%
1995	55250000	58727456	106%	34800000	27627593	79%
1996	53720000	59527894	111%	34860000	26645608	76%

Japan has been a master at this game and has consistently used to improve its position vis- -vis Australia who is naturally the most cost efficient supplier due to its competitive mining cost and low freight costs. Australia has been supplying 40-50% of Japanese needs, despite the fact that Japan has consistently been trying to increase its 'portfolio' of importers by forging relationships with – mainly – Brazilian and Indian mines. However, in periods of crisis (for example 1980-1990 in Table IV-2) it is the more distant, less competitive, importers that are hit the hardest.

Under the light of the observations made above, I find it very difficult to accept that the market for iron ore functions as a bilateral oligopoly where two partners determine their mutual profit maximising quantity and simply bargain to get a price as favourable as the circumstances allow. In bilateral monopoly models a breakdown in negotiations is a possible outcome, with no trade taking place. The reality of iron ore trade has demonstrated cases where price negotiations were unsuccessful; however, trade in the commodity did continue to flow between partners and prices were later determined retroactively. The negotiating parties do realise that their mutual dependence extends far beyond a single period and for this reason their actions are appropriately mitigated. Room for manoeuvring is mostly available for long term changes and such strategic decisions are made in view of the realisation that other market participants (apart from the pair of negotiators) do exist and can be used as credible threats during negotiations.

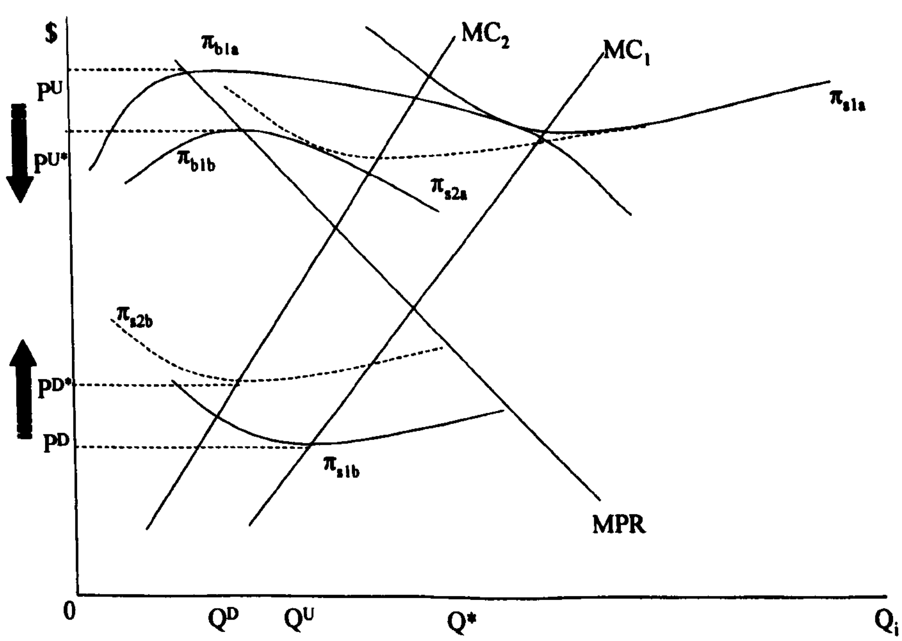
Although profit maximising behaviour is not an unreasonable target for each partner, long term survival is in many cases a more realistic objective, given that there is such strong interdependence between – at least the major – trading partners. This interdependence among more than just two partners (i.e. the bilateral oligopoly situation) gives bilateral negotiations a different weight. In perfect competition it is a very large number of such bilateral deals between market participants that eventually produce a market consensus on market prices and traded quantities, although each such individual deal cannot drastically influence the market on its own. In bilateral monopoly it is just one negotiation that clears the market. In the case of bilateral oligopoly however, each bilateral transaction is made in the knowledge that each of the partners will also trade with the remaining buyers and sellers and whatever price is reached will function as a signal for any subsequent negotiations. In addition, each bilateral transaction is made in the knowledge that subsequent partners will be limited in their options by what has already been agreed in the previous negotiations. It would be easier, however, to understand the issues that arise by means of an example.

When Germany enters negotiations with Brazil it realises that Brazil is the most competitive supplier, but over-dependence on one country is risky. So Germany also looks at alternative – perhaps higher cost – suppliers, such as Canada, South Africa and Australia, or other smaller producers who will provide some cushion in case negotiations with Brazil turn sour. This effectively means that the price target for Brazil is not necessarily what maximises its profit. From the theory of bilateral monopoly in chapter II, we saw that bargaining for price is limited in the range $[P^D, P^U]$, with P^D being the minimum acceptable price for the supplier and P^U the maximum the buyer is willing to pay. For convenience, Figure IV-2 reproduces price setting under such circumstances.

Normally Brazil will try to push its advantage as closer to P^U as possible, where its zero-profit indifference curve π_{s1a} shifts along its marginal cost curve (MC_1) as further to the right as possible, indicating higher profits. However, Brazil now has to keep in mind that Germany is also going to negotiate with one or more alternative suppliers whose indifference curves might lie lower, in our example they could be represented by π_{s2a}.

Figure IV-2

Price Setting in Bilateral Oligopoly



The reasons why the profit maximising point of other suppliers lies below that of Brazil need not be discussed without loss of generality.[4] These competitors might have overall higher costs, represented in the above figure by curve MC_2. It is also likely that a competitor might even have a minimum acceptable price (P^{D*}) higher than Brazil (P^D). The key issue here, though, is that they are willing to bargain up to a price (P^{U*}) which is lower that that aimed for by Brazil (P^U). The net result is that Brazil cannot afford to disregard what other competitors have offered or are willing (according to its estimates) to offer. If long-term security of export markets is important it will have to lower its ambition from P^U to a lower level, possibly P^{U*} if we assume, as above, that the competitors' profit maximising curve is π_{s2a}. If it pushes hard to achieve P^U, it is quite likely that Germany will choose to buy some of its needs at least from the alternative supplier and hence move its profit curve from π_{b1a} to the more desirable π_{b1b}.

There is of course the 'catastrophe' scenario where the market is so low that sellers will have to settle for very low prices, close to their minimum acceptable levels. In such case, Brazil has the overall advantage as its profit indifference curve can slide down as far as π_{s1b}, which is lower that the π_{s2b} curve that the alternative supplier needs to at least achieve. At the end of the day Brazil is the overall cheaper producer and the most able to survive a protracted bout of low prices.

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[4] One such reason might be, for example, that third suppliers might be happy to settle for lower prices (at least for a short time) in order to gain market share at the expense of more competitive suppliers.

Germany, as I mentioned, is actively trying to diversify its heavy reliance on Brazil by procuring some of its needs from other countries, even though such supplies might not be as competitive. On the other hand, it also realises that Brazil is becoming a more aggressive supplier, who actively seeks other outlets for its exports, in order to ensure long term survival. During negotiations, Germany will push for a price as close as possible to P^D, but a very low price might end in a no trade situation, if Brazil manages to find alternative outlets for its exports, willing to pay a better price.

The no trade situation in a market with so heavy interdependencies is rather unlikely, as we noted earlier. It does send signals, however, that the long term relationship between Brazil and Germany may be at stake if the parties push too hard their bargaining strengths. The overall result is, first the closing up of the $[P^U, P^D]$ range, and then a long term movement towards the middle of the range. Destabilising factors do exist, that will create diversion from the long run tendencies. For example, new dynamic importers entering the market (like Korea in the 1980s and China in the 1990s) may create an upset in the balance of power between the main importers and exporters.

From the above discussion, a set of principal characteristics for the behaviour of the iron ore market – and perhaps any similar market finding itself in an oligopoly/oligopsony situation – could be derived.

- All market participants are well aware of the presence of, and mutual dependence on, each other;
- Straightforward joint-profit maximisation between each pair of trading partners may not be the prime objective due to their strategic behaviour.
- Pursuit of joint-profit maximisation is mitigated or hindered by a variety of factors, such as the threat of reduced long term contractual commitment in the future, loss of import market share, reduced financial assistance for new projects.
- When joint-profit maximisation is a goal, it is likely that the price range that constitutes the negotiating interval in order for trade to take place will be narrower that the price interval set by the seller's marginal cost and the buyer's marginal revenue in a bilateral monopoly situation.
- Implied by the above is the fact that all partners have a decision horizon that stretches beyond the one-year restrictive framework suggested by many models.

The market for iron seems to be moving away from the bilateral monopoly to a bilateral oligopoly state, with a possible future as a more 'mature' market. As Chang (1994) also notes, there have been changes in the nature of contracts and increased competitive pressures on the steel industry world-wide with a trend towards the closure of the least efficient steel producers. What is the next stage?

Observing similar markets, like the market for coal for example, the natural progression is towards a more flexible and open market. Coal also has a long history of transactions based on long term contractual commitments, with many power generating utilities being tied to specific mines that could provide the exact grade of coal suitable for the furnace of the particular power plant. Under the mounting competitive pressures imposed by oil and gas and with the aid of technological improvements that made possible the 'cleaner' combustion of 'dirtier' coal, the industry moved towards a more liberal organisation of its procurement strategies. The coal market today still relies on long and medium term contracts, but increasingly buyers and sellers resort to the active spot market that has emerged. The pacemaker in this process is the United States, which possesses some of the most competitive coal reserves, has a very competitive domestic coal market and is a dominant exporter to the international market. The increased liberalisation of the coal market in the 1980s culminated in the launching of the first coal futures contract on the New York Mercantile Exchange in 1998. Although mostly of domestic importance, this development highlights the move towards a more competitive market, with a solidly founded spot segment that allows the determination of reliable benchmark prices, and the added advantages of price discovery and price risk hedging offered by an organised futures market.

Without a doubt, the iron ore market is still far from the progress achieved in the coal market. There are signs, however, that indicate a desire for a move towards the same direction. The increased demand for flexibility in long term contracts and their use as bargaining chips rather than means of determining profit-maximising traded quantities; the move of both buyers and sellers towards more diversification of their imports sources and export outlets, respectively; the oversupply of iron ore in the world market; technological developments that make use of less iron ore and more scrap; are all contributing to this move. A first step will be perhaps in the structure and pricing mechanism of long term contracts. In most commodities, including coal, the usual pricing structure is based on the 'cost-plus' system. Prices are determined as premia paid on top of what both negotiating parties agree as a reasonable and true cost basis.

Cost-plus pricing is by nature more transparent and open to comparisons across buyers and sellers. More transparent pricing leads to more reliability of a nascent spot market. If this grows into a strong and reliable spot market it can provide a solid recourse for buyers and sellers, both to satisfy their transaction needs and to generate benchmark prices. It is the spot market then that will absorb demand and supply imbalances and will reflect the market consensus on the fair market of the commodity. Business can still be conducted with the help of contracts o varying duration; pricing, however, can be done on a formula basis as a differential from the spot market. This is the case of the oil market and several agricultural markets and this is, possibly, where the gas and coal markets are heading towards.

IV.3 Estimating World Import Shares of Iron Ore

As it was discussed in the previous section, the target for many importers of iron ore is not to simply determine a joint-profit maximising quantity and then negotiate on a price settlement as far below as possible from their maximum acceptable price P^U. Profit maximisation is of course one of the targets of each pair of trading partners, but they cannot negotiate without taking into account information (not necessarily complete or correct) and speculation/expectations about the possible (re-)actions of their competitors. An oligopolistic seller negotiates knowing that other sellers will take advantage of any 'slip-up' in order to increase their market share. He also knows that the buyer has a portfolio of importing options and will allocate his imports among several sellers according to the price advantages they offer. In a similar manner, the oligopsonistic buyer negotiates in the knowledge that the seller has alternative outlets for his exports, i.e. other buyers will step in to pick up some of the imports if he fails to secure them first.

Apart from the relative bargaining power of the partners, there are also transport and quality issues. Iron ore is a relatively cheap commodity and, as a result, transport costs make up a relatively high proportion of the landed cost of iron ore. On the world market, freight costs for iron ore over the period 1982-1991, for example, accounted for 15-25% of the landed costs (Rogers, 1992). The normally higher unit import costs from distant suppliers can be largely attributed to the cost of freight, but this may not be the only source of price differentials. As it was discussed iron ore prices also differ due to quality specifications, with ores high in Fe content fetching overall better prices. However, it is also true that importers will often blend their ores as they have to rely on more than one sources providing diverse degrees of chemical, physical and metallurgical properties. As Rogers and Robertson (1987) note, technical considerations may affect the degree of reliance on a particular importer.

True as this may be for the short run, however, this is not expected to last in the long run. Short run technological inflexibility may result in a sort of forced 'loyalty' to a particular supplier. Ultimately – in the long run – however, the importer with the most competitive price structure has to prevail, if profit maximisation is still one of the importer's objectives (but not necessarily the sole objective). The important point of this argument is that it is not unreasonable to suggest that iron ores from different sources are close substitutes, although differentiable on both physical and perceived characteristics. The import share of an individual supplying country, therefore is likely to depend on the delivered prices of ores from competing sources.

IV.3.1 Methodology

The approach suggested here is that of a partial adjustment model which captures the inter-temporal decision making of each of the 10 top world importers of iron ore, which collectively account for at least 90% of international imports over the last 35 years. The partial adjustment approach is not new, it is in fact borrowed from consumption theory and has been transplanted in international trade in the past. This is the first time it is employed in the world iron ore trade for all major importers. The methodology uses volume shares of iron ore imports, rather than value. This is consistent with the suggestions of Tilton (1992), who postulates that volume shares provide a common measure of market share in assessing the degree of competitiveness.

The partial adjustment methodology is consistent with the preceding discussion, which postulated that long-term changes in import shares do occur although they may be delayed by technological and institutional constraints. The model hypothesises that the current levels of iron ore import prices from various sources and the total volume of ore imports determine the current 'desired' level of the share of imports originating from a particular supplier. This relationship can be denoted as:

$$s_{i,t}^{d} = \alpha_i + \sum_j b_{i,j} \ln P_{j,t} + c_i \ln Q_t + \varepsilon_{i,t}$$

Eq. IV-1

where $s_{i,t}^{d}$ is the desired volume share of iron ore from source i in period t. Such an equation is constructed for each importing country; with i being all of its trading partners including the residual category 'rest of world' (ROW); P_j being the unit price of iron ore from source j, where $i \neq j$; Q being the total volume of iron ore imports for the particular importing country, used as a proxy of possible scale effects of steel production on market shares.; and ε being the error term which is assumed to be distributed normally with mean zero and constant variance.

However, because of the inherent inflexibility of importers in changing quickly from one partner to another, the desired level of imports cannot be achieved immediately. As a result, only a fixed fraction r of the desired adjustment takes place in a single period. Therefore

$$s_{i,t} - s_{i,t-1} = r_i(s_{i,t}^d - s_{i,t-1})$$

Eq. IV-2

where $s_{i,t}$ is the market share for supplier i in period t, $s_{i,t-1}$ is the market share for supplier i in the preceding period, and r_i $(0 < r_i < 1)$ is the coefficient of adjustment supplier i. The above equation simply states that in each period only a fixed fraction of the desired change actually takes place. The larger the value of r the faster the adjustment to the desired market share. Since all shares add up to 1, Eq. IV-2 implies that the coefficients of adjustment should be identical for all share equations for one particular importer. The imposition of this condition makes the use of the subscript on r unnecessary in any subsequent notation.

Combining Eq. IV-1 with Eq. IV-2 the market share of supplier i becomes

$$s_{i,t} = \alpha_i * + (1-r)s_{i,t-1} + \sum_j b_{i,j} * \ln P_{j,t} + c_i * \ln Q_t + \varepsilon_{i,t} *$$

Eq. IV-3

where $\alpha_i* = r\alpha_i$, $b_{i,j}* = r\ b_{i,j}$, $c_i* = r\ c_i$, and $\varepsilon_{i,t}* = r\varepsilon_{i,t}$. The regression procedure should give estimates for r, which can then be used to estimate the long-run responses of suppliers' market shares to prices and volume of imports (α_i, $b_{i,j}$, c_i) from the short-run responses (α_i*, $b_{i,j}*$, c_i*). Theoretically, the estimated value of r should lie between zero and one, so that long-run responses can be expected to be greater than short-run ones.

Now, the need to estimate a number of equations simultaneously poses methodological problems. There are numerous other examples where the same problem may occur. Demand equations for a number of commodities; investment functions for a number of firms; consumption functions for subsets of the population; the capital asset pricing model in finance; all are characteristic examples of cases where simultaneous equation estimation creates similar problems. In all cases, the disturbances in these different equations at a given time are likely to reflect some common immeasurable or omitted factors, and hence could be correlated. Such correlation between disturbances from different equations at a given time is called contemporaneous correlation. In such cases it is more efficient to estimate all equations jointly, using what is known as the *seemingly unrelated regressions equation* model.

In a general matrix form, the system of equations for each of the importing countries can be rewritten as

$$y_i = X_i \beta_i + \varepsilon_i, \; i = 1,...,n$$

Eq. IV-4

Where n is the number of supplier that a specific country is procuring its iron ore from and the error terms have a zero mean and a constant variance over time. The generalised regression model can be applied to the following stacked regression:

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} X_1 & 0 & \cdots & 0 \\ 0 & X_2 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & X_n \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_n \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix} = \mathbf{X}\boldsymbol{\beta} + \boldsymbol{\varepsilon}$$

Eq. IV-5

Greene (1993, p. 489) demonstrates that the efficient estimator is generalised least squares (GLS) and he adds that the greater the correlation of the disturbances, the greater the efficiency gain accruing to GLS, vias- -vis other simultaneous equation estimation techniques.

Zellner (1962) and Zellner and Huang (1962) have proposed a feasible generalised least squares estimation methodology that takes into account the fact that the variance-covariance matrix is usually unknown a priori. Their procedures are used in order to increase the efficiency of the estimates. Moreover, since volume shares sum to one, the contemporaneous variance-covariance matrix is singular, and thus the 'rest-of-world' equation has to be deleted before the remaining equations for each importer are jointly estimated.

To estimate consistently all systems of equations by SUR, total imports and unit import costs have to be exogenous to the model. Total imports of iron ore can be considered exogenous because they generally bear a technical relationship with the amount of pig iron to be produced. So their changes are very much driven with the changes in steel demand. Price exogeneity is justified on the ground that contracted prices in a particular year are specified in annual negotiations before actual shipments take place. Although prices and volumes have some relationship they are not completely dependent on each other. This is particularly true in the relationship between prices and 'actual' – as opposed to 'contracted' – shipments, since actual shipments are almost invariably different to contracted volumes.

An additional problem in the estimation process is the inclusion of a lagged variable in all equations. The possible existence of serial correlation creates biasedness and consistency problems to the estimators. Because of this, Durbin's *h*-statistic was used, in addition to the Durbin-Watson statistic produced by the econometric software. Test results are reported in the chapter V, together with the results from the estimation.

IV.3.2 Data

Data used in the model include annual unit import values (in $/tonne) and volumes of iron ore imports (in metric tonnes) of a total of 10 importing countries which collectively account for at least 90% of world imports, throughout the 35 years from 1962 to 1996. In some cases, some importers have emerged in the market at a later stage, so that the time series in these cases begin later than 1962. In the case of China, imports did not begin until the late 1980s. All value and volume data were extracted from the UN International Commodity Trade Statistics (Series D), with unit import values calculated from those data as well. Unit import values were then checked against comparable data obtained from the TEX Report[5] and the Metal Prices Yearbook[6] to ensure consistency. All prices and data are included in the appendix at the end of chapter 5.

The advantage of using unit import values over quoted prices is that quoted prices are usually on an f.o.b. basis (with the exception of Australian ore to Europe which normally quoted on c.i.f. basis). There is no need for any currency or inflationary adjustment, because trade is conducted on the basis of US dollars among all trading partners and any inflationary effects are only relevant to the total number of imports, rather than the allocation of these imports among different suppliers. Ultimately, it is the total landed price in the importing country that determines the competitiveness of each supplier. If a supplier's prices are

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[5] TEX Report Iron Ore Manual (annual issues from 1981 to1997).

uncompetitive in the long-term, importers will chose different trading partners instead. The speed of this change is of importance here and this is one of the parameters this model attempts to estimate.

IV.4 Conclusion

This chapter focused on the economic determination of a model for the behaviour of participants in the iron ore market. The simple model of bilateral monopoly has been suggested by several authors as an attractive analytical framework for many bargaining situations and it has indeed been proposed for the study of iron ore trade.

I believe this model to be rather restrictive, as it assumes that only two participants exist in the market and they will have to agree a price and quantity that maximises their joint profit. Although, this may be true when two negotiating partners are looked at in isolation, this is not true for the market at large. I believe that even on bilateral negotiations, partners take into account the possibility of choosing alternative partners at a later stage, if necessary and they also realise that the opposing partner has similar options open to him as well. Bearing this in mind, I have proposed an alternative profit maximising behaviour which is demonstrated in Figure IV-2. In this case, the importer enters negotiations with complete knowledge of his own minimum acceptable price, a possible idea of his partner's

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[6] The Metal Prices Yearbook is published by Metal Bulletin with prices on all ferrous and non-

maximum acceptable price and also an idea (which can be held with varying degrees of certainty) of what alternative suppliers may be able to offer. This will restrict the range of prices over which negotiations take place and will mitigate the aggressiveness of the seller.

A buyer is likely to act in a similar manner, knowing that the seller has alternative export outlets, but he can also use other bargaining tools to achieve a better deal. A quite common tool is the promise of long term commitment through the signing of contracts, acquisition of equity stakes in mines or provision of financing facilities.

The behaviour of the trading partners in such an oligopoly/oligopsony (or bilateral oligopoly) environment can be studied with a relatively simple and tried econometric technique, borrowed from consumption and investment theory and applied for the first time for all top iron ore importers, who collectively have accounted for at least 90% of world trade in the last 35 years. Chapter V displays and discusses the results of this model.

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ferrous metals.

V. Results, Interpretation and Conclusions

V.1 General Remarks

Following the discussion in chapter IV, this chapter discusses the practical some further considerations regarding the estimation of the partial adjustment model and then proceeds with the presentation of results and comments for nine of the ten top importers of iron ore.

For each of the nine importing countries, I look at its five top suppliers, who usually account for approximately 90% of this country's imports. A system of equations is built as it was described in chapter IV. To give an illustrative example, one may look at the case of Japan whose partners include Australia, Brazil, India, South Africa and Chile. The general form of the equations is given in chapter IV and recreated below for convenience.

$$s_{i,t} = \alpha_i * + (1-r)s_{i,t-1} + \sum_j b_{i,j} * \ln P_{j,t} + c_i * \ln Q_t + \varepsilon_{i,t} *$$

Eq. V-1

The set of seemingly unrelated regressions that is estimated consists of the following five equations:

$$s_{Aus}=\alpha_1+(1-r)\cdot s_{Aus}+b_{1,1}\cdot\ln P_{Aus}+b_{1,2}\cdot\ln P_{Bra}+b_{1,3}\cdot\ln P_{Ind}+b_{1,4}\cdot\ln P_{Saf}b_{1,5}\cdot\ln P_{Chi}+c_1\cdot\ln Q_{Jap}+\varepsilon_1$$
$$s_{Bra}=\alpha_2+(1-r)\cdot s_{Bra}+b_{2,1}\cdot\ln P_{Aus}+b_{2,2}\cdot\ln P_{Bra}+b_{2,3}\cdot\ln P_{Ind}+b_{2,4}\cdot\ln P_{Saf}b_{2,5}\cdot\ln P_{Chi}+c_2\cdot\ln Q_{Jap}+\varepsilon_2$$
$$s_{Ind}=\alpha_3+(1-r)\cdot s_{Ind}+b_{3,1}\cdot\ln P_{Aus}+b_{3,2}\cdot\ln P_{Bra}+b_{3,3}\cdot\ln P_{Ind}+b_{3,4}\cdot\ln P_{Saf}b_{3,5}\cdot\ln P_{Chi}+c_3\cdot\ln Q_{Jap}+\varepsilon_3$$
$$s_{Saf}=\alpha_4+(1-r)\cdot s_{Saf}+b_{4,1}\cdot\ln P_{Aus}+b_{4,2}\cdot\ln P_{Bra}+b_{4,3}\cdot\ln P_{Ind}+b_{4,4}\cdot\ln P_{Saf}b_{4,5}\cdot\ln P_{Chi}+c_4\cdot\ln Q_{Jap}+\varepsilon_4$$
$$s_{Chi}=\alpha_5+(1-r)\cdot s_{Chi}+b_{5,1}\cdot\ln P_{Aus}+b_{5,2}\cdot\ln P_{Bra}+b_{5,3}\cdot\ln P_{Ind}+b_{5,4}\cdot\ln P_{Saf}b_{5,5}\cdot\ln P_{Chi}+c_5\cdot\ln Q_{Jap}+\varepsilon_5$$

The subscripts for countries are: *Aus* for Australia; *Bra* for Brazil; *Ind* for India; *Saf* for South Africa; *Chi* for Chile; and *Jap* for Japan. In short, the share for each supplier is regressed against the first-order lag for that share, the logarithms of the prices of all suppliers (including its own price) and the logarithm of the total volume of the iron ore imported by the buyer.

In all cases, Zellner's feasible generalised least square estimation (FGLS) procedure is used. Given that the main problem is that the variance-covariance matrix (Σ) of the disturbance terms is unknown, Zellner proposes the following:

1. Apply OLS separately to each of the above equations, obtaining the vectors of the sample residuals $\varepsilon_1, \varepsilon_2, \ldots, \varepsilon_n$.
2. The diagonal elements of the unknown matrix Σ are estimated and the estimated Σ matrix is substituted to produce a feasible estimator.

V.1.1 Estimation Results

Overall, the partial adjustment model is found to represent quite well the market share determination by the majority of importers. The goodness of fit tests (measured by R^2 adjusted for degrees of freedom) are reported in detail on a country-by-country basis, but overall they varied between 65-98% with very few cases where the results were quite low. In all cases the estimates for the adjustment factor *r* were found to be statistically significant and a summary of the results is given in Table V-1, below.

Table V-1

Partial Adjustment Factors for all Estimated Import Equations

Importer	Estimated *1-r*	Calculated *r*
Japan	0.57	0.43
Germany	0.73	0.27
Belgium	0.78	0.22
France	0.81	0.19
Italy	0.32	0.68
UK	0.69	0.31
Netherlands	0.48	0.52
USA	0.60	0.40
S. Korea	0.45	0.55

The actual regressions yielded an estimated for *1-r*, from which *r* can be trivially computed. The *r* factor in the partial adjustment process is interpreted as the part of desired changes effectuated by actual changes in import shares. As a result, the higher *r* is, the more flexible the importer is and, hence, more capable (and willing) to switch quickly between different suppliers.

It is quite interesting to observe the diversity in the partial adjustment factors among different importers. Japan, for example, is estimated to be able to realise 43% of its desired changes of import shares from one period to the next. Taking into consideration Japan's inherent weakness due to its lack of domestic natural resources, its flexibility can be attributed to its very wise procuring policy that was discussed in chapter III. Revisiting the bilateral oligopoly exposition of chapter IV, I could argue that Japan has two major credible 'threats': firstly, its recourse to third buyers when it negotiates with each individual supplier, so that each negotiation is not done in isolation, as it would in a bilateral monopoly situation; and secondly, its use of long-term contracts as a negotiating tool in order to extract better price terms from its suppliers.

Germany, in comparison, seems rather inflexible with the *r* factor only at 27%. Although published information on German long-term contracts is largely unavailable, the country does have several equity stakes in Brazilian mines, which may restrict its flexibility. A similar situation seems to prevail for most West European importers, with the exception of Italy. France seems to be the least flexible, possibly owed to the fact that its own iron ore industry is still 'artificially' kept alive, and also because of its substantial equity investment in iron ore mines Liberia and Mauritania.

The United States' flexibility is not surprising, given its close relationships with Canadian mines. South Korea, on the other hand, seems to be following the Japanese model. It, too, depends on 3-4 suppliers, which it can 'play' against one another and thus improve its relatively weak bargaining position (no domestic ore reserves).

V.2 Japan

Table V-2

	Australia	Brazil	India	S. Africa	Chile
Import share (1996)	49.94%	22.35%	13.33%	3.88%	2.96%
Data sample	1962-1996	1962-1996	1962-1996	1962-1996	1962-1996
Lagged own import share	**0.57** **(14.20)**	**0.57** **(14.20)**	**0.57** **(14.20)**	**0.57** **(14.20)**	**0.57** **(14.20)**
ln P – Australia	-0.02 (-0.38)	0.01 (0.70)	**0.16** **(4.09)**	**0.03** **(2.27)**	-0.01 (-0.48)
ln P – Brazil	**-0.23** **(-2.46)**	-0.0006 (0.01)	0.09 (1.23)	-0.01 (-0.58)	0.03 (0.54)
ln P – India	0.09 (1.26)	**0.08** **(2.52)**	-0.07 (-1.32)	-0.04 (-1.82)	0.03 (0.64)
ln P – S. Africa	0.09 (0.97)	-0.02 (-0.48)	-0.07 (-0.93)	0.02 (0.66)	-0.006 (-0.12)
ln P – Chile	0.07 (1.26)	-0.003 (-0.12)	-0.08 (-1.92)	0.007 (0.41)	-0.04 (-1.10)
ln P – Total imports	**0.09** **(5.11)**	**0.02** **(3.54)**	**-0.05** **(-4.32)**	**-0.013** **(-2.56)**	**-0.03** **(-3.56)**
Constant	**-1.56** **(-5.60)**	**-0.60** **(-5.44)**	**1.04** **(5.73)**	**0.24** **(3.44)**	**0.68** **(4.47)**
Adjusted R^2	0.97	0.98	0.80	0.67	0.95
Durbin's *h*-statistic Breusch-Godfrey (*p*)	1.36	0.24	1.56	n.a. p=0.1334	-2.17

Notes:

1. Numbers is brackets indicate calculated *t*-statistics.
2. The estimated coefficients reported here were based on Zellner's SUR methodology, run on RATS. The goodness of fit and Durbin's *h*-statistics were obtained from the single equation OLS regressions.
3. Durbin's *h*-statistic is used to test for first-order autocorrelation in the presence of a lagged dependent variable. The *h*-statistics are asymptotically normally distributed as *N*(0,1). The 95% critical value is 1.96. Any calculated *h*-statistic below this value (in absolute terms) indicates that there is no autocorrelation problem in the equation. Where the *h*-statistic cannot be calculated the Breusch-Godfrey test is used instead. *P*-values in excess of 0.05 indicates that there is no autocorrelation problem.

The biggest and most influential player in the iron ore market is Japan. The reasons for its dominance of the Pacific and – indirectly – the world market have already been given in earlier discussion. The results from the partial adjustment model are given in the table below. All *r*'s estimated are statistically significant and the model performs quite well for four out of the five suppliers. Japan's relative flexibility ($r = 0.43$) was discussed earlier in this chapter and the estimate is somewhat larger that that reported by Chang (1994), where r is estimated at 0.29.

Interesting to note are also the coefficients for some of the price variables. Australia's share, for example, has a negative elasticity of –0.23 to changes in Brazilian prices, implying that Australia benefits from decreases (rather than increases) in Brazilian prices. The sign of the coefficient is not the expected one, but similar results on this issue are also reported by Chang. Brazil's share is more sensitive on India's prices, while India's share is dependent on Australia's. Also significant are the coefficients of the variable Q, representing total Japanese imports. The results show a tendency for Japan to resort directly to Australia and Japan for any increased needs in imports, at the expense of other countries. This is not surprising as these two countries have the largest capacity and flexibility to swiftly satisfy increased demand.

V.3 Germany

As discussed earlier, Germany shows a relative inflexibility in switching between suppliers, as it is estimated to realise some 27% (= 1 – 0.73) of its desired changed every year. Reasons for this relative inflexibility were discussed at the beginning of this chapter. Of the other coefficients, it is only Brazilian shares that seem to be affected by price changes in Sweden and the total imports. The coefficient for total imports is negative, implying that swift increases in import demand are satisfied by shorter-haul sources, like Canada and Sweden.

Overall, with the exception of Norway, there is a reasonably good fit to the model, with adjusted R^2's for Brazil and Sweden at 97% and 90%, respectively. The case of Norway has more problems (presence serial correlation) and overall it does not perform well. This may be partly due to the fact that Norway has few own resources and some of its exports actually come from Sweden (through the port of Narvik, near the Arctic circle).

Table V-3

	Brazil	**Canada**	**Sweden**	**Australia**	**Norway**
Import share (1996)	55.22%	14.01%	13.11%	9.06%	2.69%
Data sample	1962-1996	1962-1996	1962-1996	1962-1996	1962-1996
Lagged own import share	**0.73** **(17.35)**	**0.73** **(17.35)**	**0.73** **(17.35)**	**0.73** **(17.35)**	**0.73** **(17.35)**
ln P – Brazil	-0.03 (-0.32)	-0.17 (-1.59)	0.06 (0.58)	0.03 (0.32)	-0.02 (-0.37)
ln P – Canada	0.03 (0.41)	0.56 (0.70)	0.08 (1.00)	-0.01 (-0.14)	-0.0006 (-0.02)
ln P – Sweden	**0.18** **(3.51)**	0.05 (1.00)	0.06 (1.12)	-0.02 (-0.41)	-0.0001 (-0.003)
ln P – Australia	-0.06 (-0.59)	0.10 (1.05)	-0.08 (-0.81)	-0.07 (-0.77)	0.02 (0.40)
ln P – Norway	-0.05 (-1.32)	-0.006 (-0.15)	-0.14 (-3.47)	0.06 (1.49)	0.0002 (0.009)
ln P – Total imports	**-0.10** **(-4.42)**	0.03 (1.12)	0.009 (0.35)	0.013 (0.60)	-0.014 (-1.06)
Constant	**1.68** **(4.12)**	-0.56 (-1.28)	-0.06 (-0.13)	-0.19 (-0.47)	0.26 (1.12)
Adjusted R^2	0.97	0.64	0.90	0.77	0.20
Durbin's *h*-statistic	-0.31	-1.28	0.92	0.37	5.15

Notes:

1. Numbers is brackets indicate calculated *t*-statistics.
2. The estimated coefficients reported here were based on Zellner's SUR methodology, run on RATS.
3. The goodness of fit and Durbin's *h*-statistics were obtained from the single equation OLS regressions. Durbin's *h*-statistic is used to test for first-order autocorrelation in the presence of a lagged dependent variable. The *h*-statistics are asymptotically normally distributed as $N(0,1)$. The 95% critical value is 1.96. Any calculated *h*-statistic below this value (in absolute terms) indicates that there is no autocorrelation problem in the equation.

V.4 Belgium

Belgium's case is quite similar to that of Germany's. It also seems to be able to realise only a small part of its desired changes every year. The implied *r* of 0.22 is relatively. Of the price coefficients, that of French import shares and Mauritanian prices, as well as Brazilian import shares and Swedish prices. Still, however, the coefficients are quite low and, hence, inelastic. Overall, the model achieves good fit results of between 82-98% in terms of adjusted R^2.

Table V-4

	Brazil	Mauritania	France	Canada	Sweden
Import share (1996)	48.47%	11.97%	10.94%	10.43%	6.01%
Data sample	1962-1996	1962-1996	1962-1996	1962-1996	1962-1996
Lagged own import share	**0.78** **(17.54)**	**0.78** **(17.54)**	**0.78** **(17.54)**	**0.78** **(17.54)**	**0.78** **(17.54)**
ln P – Brazil	**0.08** **(2.61)**	0.006 (0.31)	**-0.18** **(-3.13)**	0.003 (0.20)	0.07 (1.52)
ln P – Mauritania	**-0.13** **(-3.09)**	0.003 (0.11)	**0.21** **(2.83)**	-0.04 (-1.41)	-0.09 (-1.59)
ln P – France	-0.01 (-0.56)	-0.02 (-1.04)	-0.05 (-0.99)	**0.06** **(3.73)**	0.05 (1.29)
ln P – Canada	**0.05** **(2.53)**	0.005 (0.48)	-0.04 (-1.15)	0.02 (1.54)	-0.02 (-0.72)
ln P – Sweden	**0.08** **(2.79)**	0.01 (0.55)	-0.0001 (-0.003)	**-0.03** **(-2.00)**	-0.05 (-1.25)
ln P – Total imports	-0.01 (-0.55)	-0.03 (-2.75)	-0.04 (-1.21)	0.02 (1.53)	0.04 (1.63)
Constant	0.03 (0.11)	**0.51** **(2.55)**	0.81 (1.48)	-0.24 (-1.24)	-0.48 (-1.09)
Adjusted R^2	0.98	0.89	0.96	0.85	0.82
Durbin's *h*-statistic	-1.16	-1.69	-1.67	-3.33	0.55

Notes:

1. Numbers is brackets indicate calculated *t*-statistics.
2. The estimated coefficients reported here were based on Zellner's SUR methodology, run on RATS.
3. The goodness of fit and Durbin's *h*-statistics were obtained from the single equation OLS regressions. Durbin's *h*-statistic is used to test for first-order autocorrelation in the presence of a lagged dependent variable. The *h*-statistics are asymptotically normally distributed as $N(0,1)$. The 95% critical value is 1.96. Any calculated *h*-statistic below this value (in absolute terms) indicates that there is no autocorrelation problem in the equation.

V.5 France

Table V-5

	Brazil	Australia	Mauritania	Canada	S. Africa
Import share (1996)	35.89%	27.63%	15.83%	10.27%	2.50%
Data sample	1962-1996	1962-1996	1962-1996	1962-1996	1962-1996
Lagged own import share	**0.81** **(15.97)**	**0.81** **(15.97)**	**0.81** **(15.97)**	**0.81** **(15.97)**	**0.81** **(15.97)**
ln P – Brazil	**-0.16** **(-2.13)**	0.003 (0.03)	0.04 (0.50)	0.08 (1.43)	-0.09* (-1.81)
ln P – Australia	0.09 (1.06)	-0.03 (-0.22)	0.05 (0.65)	-0.05 (-0.78)	0.05 (0.77)
ln P – Mauritania	0.03 (0.39)	0.04 (0.33)	-0.14* (-1.90)	-0.04 (-0.68)	0.08 (1.45)
ln P – Canada	**0.04** **(2.13)**	0.007 (0.06)	0.03 (1.51)	-0.008 (-0.49)	-0.01 (-1.00)
ln P – S. Africa	-0.04 (-0.91)	0.004 (0.06)	0.06 (1.40)	0.02 (0.57)	-0.05* (-1.75)
ln P – Total imports	0.06 (2.82)	-0.009 (-0.28)	0.04* (1.82)	0.01 (0.60)	0.000 (0.003)
Constant	**-0.83** **(-2.60)**	0.11 (0.23)	**-0.68** **(-2.27)**	-0.15 (-0.62)	0.12 (0.56)
Adjusted R^2	0.82	0.73	0.77	0.74	0.31
Durbin's *h*-statistic Breusch-Godfrey (*p*)	-2.52	-2.27	n.a. 0.065	-2.06	n.a. 0.000

* *significant at 90%*

Notes:

1. Numbers is brackets indicate calculated *t*-statistics.
2. The estimated coefficients reported here were based on Zellner's SUR methodology, run on RATS.
3. The goodness of fit and Durbin's *h*-statistics were obtained from the single equation OLS regressions. Durbin's *h*-statistic is used to test for first-order autocorrelation in the presence of a lagged dependent variable. The *h*-statistics are asymptotically normally distributed as *N*(0,1). The 95% critical value is 1.96. Any calculated *h*-statistic below this value (in absolute terms) indicates that there is no autocorrelation problem in the equation. Where the *h*-statistic cannot be calculated the Breusch-Godfrey test is used instead. *P*-values in excess of 0.05 indicates that there is no autocorrelation problem.

V.6 Italy

Italy seems to be quite different from its European counterparts. It has the highest implies *r*, estimated at 68%, which can be interpreted as a wish of the country's steel producers to pursue more actively the diversification f their procurement portfolio. The highest elasticity is observed as the coefficient of Canadian prices and Brazilian shares (0.21), which indicates that it is Canada that takes up any 'slack' in the Italy-Brazil negotiations. A similar relationship exists between Mauritanian shares and Canadian prices.

Table V-6

	Brazil	Mauritania	Australia	Canada	Venezuela
Import share (1996)	50.50%	19.13%	7.94%	7.75%	4.60
Data sample	1962-1996	1962-1996	1962-1996	1962-1996	1962-1996
Lagged own import share	**0.32 (3.95)**	**0.32 (3.95)**	**0.32 (3.95)**	**0.32 (3.95)**	**0.32 (3.95)**
ln P – Brazil	0.03 (0.53)	0.03 (1.03)	-0.03 (-0.88)	0.02 (0.62)	**-0.05 (-2.19)**
ln P – Mauritania	-0.11 (-1.38)	-0.02 (-0.48)	0.08 (1.34)	0.05 (0.98)	**0.08 (2.28)**
ln P – Australia	-0.08 (-0.85)	0.07 (1.15)	0.02 (0.26)	**-0.13 (-2.28)**	-0.02 (-0.35)
ln P – Canada	**0.21 (4.02)**	**0.07 (2.47)**	0.01 (-0.39)	-0.02 (-0.76)	-0.03 (-1.46)
ln P – Venezuela	0.12 (1.44)	-0.07 (-1.44)	-0.02 (-0.32)	0.04 (0.82)	0.01 (0.31)
ln P – Total imports	0.01 (0.38)	-0.03 (-1.39)	-0.02 (0.76)	-0.03 (-1.32)	-0.03 (-1.64)
Constant	-0.55 (-0.95)	0.32 (0.96)	-0.33 (-0.82)	**0.68 (1.99)**	**0.51 (2.04)**
Adjusted R^2	0.90	0.64	0.26	0.50	0.64
Durbin's *h*-statistic Breusch-Godfrey (*p*)	n.a. 0.001	-4.21	n.a. 0.023	n.a. 0.09	n.a. 0.03

Notes:

1. Numbers is brackets indicate calculated *t*-statistics.
2. The estimated coefficients reported here were based on Zellner's SUR methodology, run on RATS.
3. The goodness of fit and Durbin's *h*-statistics were obtained from the single equation OLS regressions. Durbin's *h*-statistic is used to test for first-order autocorrelation in the presence of a lagged dependent variable. The *h*-statistics are asymptotically normally distributed as *N*(0,1). The 95% critical value is 1.96. Any calculated *h*-statistic below this value (in absolute terms) indicates that there is no autocorrelation problem in the equation. Where the *h*-statistic cannot be calculated the Breusch-Godfrey test is used instead. *P*-values in excess of 0.05 indicates that there is no autocorrelation problem.

V.7 UK

The United Kingdom's situation is similar to that of other West European countries, i.e. it seems to have relative inflexibility in changing its import allocation swiftly, as it is implies by its partial adjustment ratio of 0.31. The model does not perform as well as in previous cases, with goodness of fit results ranging between 59-88% and one very poor fit in the case of Venezuela.

Table V-7

	Australia	Canada	Brazil	Venezuela	Mauritania
Import share (1996)	37.88%	21.68%	11.53%	7.49%	4.20%
Data sample	1962-1996	1962-1996	1962-1996	1962-1996	1962-1996
Lagged own import share	**0.69** **(11.70)**	**0.69** **(11.70)**	**0.69** **(11.70)**	**0.69** **(11.70)**	**0.69** **(11.70)**
ln P – Australia	0.03 (0.48)	-0.07 (-0.90)	**-0.10** **(-1.99)**	-0.03 (-1.11)	**-0.10** **(-1.99)**
ln P – Canada	0.10* (1.88)	0.12* (1.82)	-0.01 (-0.31)	0.02 (0.86)	-0.01 (-0.31)
ln P – Brazil	0.02 (0.30)	0.06 (0.74)	-0.008 (-0.14)	0.007 (0.30)	-0.008 (-0.14)
ln P – Venezuela	-0.02 (-0.33)	-0.04 (-0.50)	0.08* (1.73)	-0.01 (-0.46)	-0.08* (1.73)
ln P – Mauritania	-0.06 (1.33)	-0.09* (-1.73)	0.06* (1.66)	0.006 (0.30)	0.05* (1.66)
ln P – Total imports	**0.09** **(2.64)**	-0.03 (-0.78)	0.01 (0.40)	0.02 (1.34)	0.01 (0.40)
Constant	**-1.76** **(-2.84)**	0.61 (0.91)	-0.16 (-0.36)	-0.28 (-1.08)	-0.16 (-0.36)
Adjusted R^2	0.88	0.59	0.62	0.22	0.62
Durbin's *h*-statistic Breusch-Godfrey (*p*)	-2.08	-1.61	n.a. 0.03	0.75	-0.53

* *Significant at 90%.*

Notes:
1. Numbers is brackets indicate calculated *t*-statistics.
2. The estimated coefficients reported here were based on Zellner's SUR methodology, run on RATS.
3. The goodness of fit and Durbin's *h*-statistics were obtained from the single equation OLS regressions. Durbin's *h*-statistic is used to test for first-order autocorrelation in the presence of a lagged dependent variable. The *h*-statistics are asymptotically normally distributed as *N*(0,1). The 95% critical value is 1.96. Any calculated *h*-statistic below this value (in absolute terms) indicates that there is no autocorrelation problem in the equation. Where the *h*-statistic cannot be calculated the Breusch-Godfrey test is used instead. *P*-values in excess of 0.05 indicates that there is no autocorrelation problem.

V.8 Netherlands

Results for Netherlands were initially erratic due to the relatively larger spread across several suppliers. For some meaningful results to be produced, the number of simultaneous regression was limited to just three partners: Brazil, Norway and Venezuela. The estimates for the partial adjustment ration were statistically significant and the implied *r* is set at 0.52, revealing a relatively flexibility in switching between partners.

Table V-8

	Brazil	Norway	Venezuela
Import share (1996)	33.63%	21.41%	12.62%
Data sample	1962-1996	1962-1996	1962-1996
Lagged own import share	**0.48** **(4.27)**	**0.48** **(4.27)**	**0.48** **(4.27)**
ln P – Brazil	-0.02 (-0.14)	-0.17 (-1.09)	-0.08 (-1.05)
ln P – Norway	**0.29** **(2.50)**	0.23* (1.65)	0.04 (0.61)
ln P – Venezuela	**-0.25** **(-2.71)**	-0.10 (-0.86)	-0.01 (-0.23)
ln P – Total imports	**0.05** **(1.99)**	0.07* (1.77)	0.03* (1.71)
Constant	**-0.79** **(-2.27)**	**-0.91** **(-2.07)**	-0.32 (-1.50)
Adjusted R^2	0.76	0.71	0.50
Durbin's *h*-statistic Breusch-Godfrey (*p*)	0.94	n.a. 0.03	n.a. 0.43

* *Significant at 90%.*

Notes:
1. Numbers is brackets indicate calculated *t*-statistics.
2. The estimated coefficients reported here were based on Zellner's SUR methodology, run on RATS.
3. The goodness of fit and Durbin's *h*-statistics were obtained from the single equation OLS regressions. Durbin's *h*-statistic is used to test for first-order autocorrelation in the presence of a lagged dependent variable. The *h*-statistics are asymptotically normally distributed as $N(0,1)$. The 95% critical value is 1.96. Any calculated *h*-statistic below this value (in absolute terms) indicates that there is no autocorrelation problem in the equation. Where the *h*-statistic cannot be calculated the Breusch-Godfrey test is used instead. *P*-values in excess of 0.05 indicates that there is no autocorrelation problem.

Results in the case of Netherlands might be further distorted by the fact that the country (through the port of Rotterdam, which has excellent reception facilities for large ore carriers) acts as a trans-shipment hub for several other West European countries, especially Germany. Because trans-shipped goods are not reported separately in UN commodity statistics, it is not unlikely that some of the volumes of ore appearing as Dutch imports may actually end up in a different country altogether.

V.9 USA

Table V-9

	Canada	Brazil	Venezuela
Import share (1996)	53.29%	28.12%	11.63%
Data sample	1963-1996	1963-1996	1963-1996
Lagged own import share	**0.60** **(7.39)**	**0.60** **(7.39)**	**0.60** **(7.39)**
ln P – Canada	-0.15 (-1.58)	0.11* (1.80)	0.05 (0.77)
ln P – Brazil	**0.17** **(2.16)**	**-0.16** **(-3.08)**	-0.06 (-1.26)
ln P – Venezuela	0.02 (0.23)	0.08 (1.64)	-0.04 (-0.78)
ln P – Total imports	0.02 (0.42)	0.02 (0.79)	-0.01 (-0.40)
Constant	-0.20 (-0.24)	-0.45 (-0.85)	0.43 (0.80)
Adjusted R^2	0.50	0.85	0.77
Durbin's *h*-statistic	-0.95	0.52	-2.71

* *Significant at 90%.*

Notes:

1. Numbers is brackets indicate calculated *t*-statistics.
2. The estimated coefficients reported here were based on Zellner's SUR methodology, run on RATS.
3. The goodness of fit and Durbin's *h*-statistics were obtained from the single equation OLS regressions. Durbin's *h*-statistic is used to test for first-order autocorrelation in the presence of a lagged dependent variable. The *h*-statistics are asymptotically normally distributed as $N(0,1)$. The 95% critical value is 1.96. Any calculated *h*-statistic below this value (in absolute terms) indicates that there is no autocorrelation problem in the equation.

The overall model performance in the case of the USA can be deemed as satisfactory, with quite good fitness statistics of 85% in the case of Brazil and 77% in the case of Venezuela. In the of Canada the reported R^2 is only 50%, but the result is not unexpected in view of the close cross-ownership ties between US steel mills and Canadian mines. The use of just three countries is perfectly justified as between them they supply 93% of USA's needs. Brazil's own demand elasticity has the expected sign and is statistically significant. So is the cross elasticity of Canadian import shares with Brazilian prices. Finally, the implied r of 0.40 reveals relative flexibility on the part of the US, again not an unexpected occurrence, due to USA's bargaining strength, expressed through its ability to gradually depend less on iron ore[1] and the availability of domestic ore production.[2]

V.10 South Korea

The main drawback of the estimation methodology in the case of South Korea is the lack of a long enough time series of data. The data series in the previous cases is not as long anyway (just 35 annual observations), but in the case of South Korea the total number of observations is just 24, starting in 1973. This is simply because it was around that time that South Korea emerged as a potent steel producer, imitating the Japanese growth model which promoted heavy industries

[1] This is due to the introduction or more flexible steel production techniques, like the increased use of electric arc furnaces in mini-mills, which make use of steel scrap of direct reduced iron instead of iron ore.

for export purposes. Suffering from a similar lack of domestic raw materials, South Korea also had to rely on long-term import deals to secure the much needed procurement of raw materials for its industry.

Regressions were run for just two suppliers (Australia and Brazil), as other smaller suppliers came in the picture much later and their inclusion in the model creates estimation problems. From the estimation the implied estimated *r* is 55%, revealing a degree of flexibility similar to that of Japan.

Table V-10

	Australia	Brazil
Import share (1996)	49.07%	27.74%
Data sample	1973-1996	1973-1996
Lagged own import share	**0.45** **(3.77)**	**0.45** **(3.77)**
ln P – Australia	**-0.36** **(-3.73)**	**0.19** **(2.65)**
ln P – Brazil	**0.29** **(3.27)**	-0.14* (-1.91)
ln P – Total imports	0.01 (0.95)	**0.04** **(2.87)**
Constant	0.23 (1.61)	**-0.67** **(-3.15)**
Adjusted R^2	0.68	0.88
Durbin's *h*-statistic	1.32	-1.43

* *Significant at 90%.*

Notes:
1. Numbers is brackets indicate calculated *t*-statistics.
2. The estimated coefficients reported here were based on Zellner's SUR methodology, run on RATS.
3. The goodness of fit and Durbin's *h*-statistics were obtained from the single equation OLS regressions. Durbin's *h*-statistic is used to test for first-order autocorrelation in the presence of a lagged dependent variable. The *h*-statistics are asymptotically normally distributed as *N*(0,1). The 95% critical value is 1.96. Any calculated *h*-statistic below this value (in absolute terms) indicates that there is no autocorrelation problem in the equation.

[2] Indigenous resources of iron are available in the US, but often of rather low quality and

Own elasticities for both Australia and Brazil have the correct signs and are statistically significant. There also seems to be considerable cross price elasticity both between Australian shares and Brazilian prices (0.29) and between Brazilian shares and Australian prices (0.19), with both coefficients being statistically significant. Finally, the overall fit of the model can be deemed satisfactory (66% and 88% for Australia and Brazil, respectively) given the length of the data series.

V.11 China

The case of China was not formally studied using the partial adjustment model. The data series in China's case is even shorter, starting only in 1987. At best there are only ten observations (imports from Australia, Brazil and India) with two more series having only 4 observations (imports from Peru and South Africa). Despite this inability to perform any meaningful econometric testing, however, the case of China as an iron ore importer will certainly attract more attention. China entered the international steel producing community only recently, and this after substantial foreign direct investment by countries such as Japan. In recent years Chinese steel mills, through their government agencies, have sought secure iron ore supplies from a variety of exporters. The first obvious targets were Australia and Brazil, and they have acquired small equity stakes in one or two Australian mine. The Chinese have also looked for additional procurement sources elsewhere, most notably in Peru and South Africa. In the case of Peru they have

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apparently not in large enough volumes, since the country still has to rely on imports.

acquired an equity stake in Hierro Peru, with exports being channelled through the port of St. Nicholas on the Pacific. In the last year with complete UN commodity statistics (1996), China had crept up to third place in the world league of iron ore exporters and has certainly become a force difficult to ignore.

V.12 Conclusions

Iron ore is among the biggest, non-energy extractive industry in the world in terms of value, and the biggest in terms of the volumes of cargo it channels in international trade. On an annual basis it generates close to 400 million metric tonnes of trade and provides employment for an important part of the world's bulk carrier fleet. Iron ore is – and has been in the past – in abundant supply and current production comfortably covers supply needs. However, this supply tends to be concentrated in only a few countries which dominate the world market. Only 10 of these of these countries supply at least 90% of world exports, with just the two market leaders – Australia and Brazil – providing some 60% of them, and dominating the Pacific and Atlantic markets, respectively. Following these two are Canada, South Africa and Sweden, with a few more smaller producers each of which does not control more that 1-2% of world supplies.

Almost in its entirety, iron ore is the input of a single industry: steel manufacturing. Iron ore – whether in the form of sinter, pellets or directly reduced – enters the steel making procedure primarily as feedstock in the basic oxygen converters or in electric arc furnaces. It is not, therefore, surprising that on the demand side, a handful of industrialised countries, which lead the world steel production, absorb most of the world's iron ore imports. Leading force among these countries are Japan, the United States, the EU (led by Germany), and more recently South Korea and China.

Two key characteristics of the iron ore market are central to its study: firstly, there is only a small number of buyers and sellers; and secondly, there is a great degree of interdependence among buyers and sellers and both groups are aware of this interdependence. For buyers, security of supplies is crucial. Although iron ore accounts for only a small portion of the cost of finished steel, its availability is indispensable. For sellers, long-term commitment from importers is essential in order to maintain the long-run viability of mining projects, which are usually very costly both in terms of time and capital terms.

Since the 1960s, long-term contracts have been, and still are, the main vehicle used in international iron ore trade. They have been used extensively by all the major importers and exporters of the commodity, the former wishing to secure continuous supplies of raw material and the latter striving to earn long-term commitment (and revenue) from their customers. Initially used by the Japanese as the most viable solution to procure raw materials for their booming economy, LTCs became popular with other developed economies, especially after the restrictions on foreign participation imposed by host countries and their nationalisation programmes.

In the 1960s and 1970s LTCs served well the international iron ore trade and brought a relative stability in prices, thus maintaining the impetus of world economic growth. In the 1980s, however, many importers found themselves over-committed to LTCs and sought, and achieved, massive renegotiations in contract terms. The main outcome of this readjustment to world economic conditions, has been a tendency towards relatively shorter contracts (5-8 years instead of 15-20 years) with more flexible quantity requirements and annual price renegotiations standard in all markets.

Long-term contracts have evolved over the years, and I believe them to be more of a bargaining tool, rather than a mechanism that determines the optimal quantity of ore that must be traded between partners in order to maximise their joint profits. The experience of the 1980s was one of successive failures on the part of importers to take delivery of their contracted quantities. Increasingly, the reasons for the existence of such contracts remain thin on the ground. Their persistence could be attributable to their qualities as bargaining tools during the annual price negotiations.

I focused on the LTCs Japan has negotiated over the years, due to the – uncharacteristic – availability of relevant data. Most of the general observations made earlier are also valid in the case of Japan, which in fact pioneered the widespread use of LTCs. For a considerable amount of time Japan enjoyed an almost oligopsonistic advantage over its suppliers, especially over Australia, which has been for a long time largely dependent on Japanese imports. This state of affairs, however, has shown evidence of changing towards a more competitive market structure as more prominent steel producers have appeared in the Pacific market and Australia has been systematically trying to diversify its export markets.

Under the light of the above peculiarities of the iron market, the economic analysis within a competitive framework is not an option. Instead, I focused on that part of economic theory that focuses on non-competitive structures – namely, the theory of industrial organisation. Three such non-competitive market structures were discussed: oligopoly, bilateral monopoly and bilateral oligopoly. All structures have partial applications to the case of the iron ore market, but the one that seems to be closest to the international order in the sector is bilateral oligopoly.

Oligopoly itself could be applicable on the production side, especially as just two countries supply 60% of world exports. The existence of relatively few dominant buyers, however, renders the use of this analytical framework problematic. Several authors have tried to look at individual bargaining situations as cases of bilateral monopoly, whereby a single buyer has to deal with a single seller. In most cases, theory predicts that the two parties will prefer to trade the quantity of the commodity that maximises their joint profits. In all but one case, however, does a final price get determined as well. Instead, an indeterminate price range is – rather vaguely – indicated.

I believe this model to also be rather restrictive, as it assumes that only two participants exist in the market and they will have to agree a price and quantity that maximises their joint profit. Although, this may be true when two negotiating partners are looked at in isolation, this is not trues for the market at large. I believe that even on bilateral negotiations, partners take into account the possibility of choosing alternative partners at a later stage, if necessary and they also realise that the opposing partner has similar options open to him as well.

Bearing this in mind, *the contribution of this thesis lies in my proposal for an alternative profit maximising behaviour which is demonstrated in chapter IV.* In this case, the importer enters negotiations with complete knowledge of his own maximum acceptable price, a possible idea of his partner's minimum acceptable price and also an idea (which can be held with varying degrees of certainty) of what alternative suppliers may be able to offer. This will restrict the range of prices over which negotiations take place and will mitigate the aggressiveness of the seller. A buyer is likely to act in a similar manner, knowing that the seller has alternative export outlets, but he can also use other bargaining tools to achieve a better deal. A quite common tool is the promise of long term commitment through the signing of contracts, acquisition of equity stakes in mines or provision of financing facilities.

Building on the theoretical framework proposed in chapter IV, *the behaviour of the trading partners in such an oligopoly/oligopsony (or bilateral oligopoly) environment* was studied with a relatively simple and tried econometric technique, borrowed from consumption and investment theory and *applied for the first time for all top iron ore importers*, who collectively have accounted for approximately 90% of world trade in the last 35 years. The model has performed well in most cases and has revealed substantial differences in the way Far East and West European importers behave.

Japan and South Korea have developed important flexibility in changing their procurement arrangement in relatively shorter time. This flexibility is measured by the *r*, the ratio of partial adjustment, which represents the actual changes in import allocation that an importer achieves in a year as a percentage of his desired change. In the case of Japan this ration was 0.43 or 43%, while for South Korea it was estimated at 0.55 or 55%. Although such a ratio indicates market conditions still far away from perfect competition, it is interesting to contrast it with the estimates for West European countries. Leading these importing countries is Germany with an estimated *r* of 0.27, with all other countries having similar partial adjustment factors, except Italy.

Although not explicitly a demand model for international trade, the partial adjustment models makes a significant contribution to the discussion about the economic structure of the iron ore industry. The cases of Japan and South Korea, in particular, firmly points towards the conclusions of the discussion on the bilateral oligopoly structure of the market. In chapter III it was hypothesised that Japan is largely using long-term contracts as a bargaining tool rather than a mechanism to determine the quantity maximising joint profits with its partners. Its failure to receive contracted quantities of iron ore in the 1990s has contributed to this flexibility and it is not unreasonable to say that it uses the signing (or non-signing) of new contracts as a credible threat in its annual negotiations with – especially – Australia and Brazil.

Germany and its European partners, on the other hand, have demonstrated a relative inflexibility in their ability to reallocate import shares quickly. Although published information on European long-term contracts is not available, some of their inflexibility might be attributed to the fact that several of these countries have considerable equity stakes in several iron ore mining projects in Latin America and Africa.

The most challenging and exciting prospects, both from a commercial and a research point of view, currently is the case of China. A relative new comer in the market, it appears as an iron ore importer only since 1987. Within the space of the last 10 years, China has entered the league of top iron ore importers and the most recent statistics place it in third position. The length of available data series is still restrictive for any meaningful quantitative research to be carried out right now.

The iron ore market is still relatively slow moving and does not benefit from the existence of a fairly transparent pricing mechanism for its finished product (like, for example, copper ore and bauxite). For any quantitative analysis to be meaningful a few decades worth of data are necessary.

Having said this, however, recent trends towards shorter contracts and more frequent use of the spot market may herald a slow but firm move towards a more competitive market structure and a more transparent pricing mechanism.

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V.13 Appendix to Chapter V

Data used for the partial adjustment model

- Imports from partners (in metric tonnes)
- Import shares of partners (%)
- Unit import prices (US$/metric tonne)

The following countries are covered

- Table V-11: Japan (1962-1996)
- Table V-12: Germany (1962-1996)
- Table V-13: Belgium (1962-1996)
- Table V-14: France (1962-1996)
- Table V-15: Italy (1962-1996)
- Table V-16: UK (1962-1996)
- Table V-17: Netherlands (1962-1996)
- Table V-18: USA (1963-1996)
- Table V-19: South Korea (1973-1996)

Table V-11(a): JAPAN - Imports by Origin (Metric tonnes)

Year	AUSTRALIA	BRAZIL	CANADA	CHILE	INDIA	NEW ZEALAND	PERU	PHILIPPINES	SAFRICA	VENEZUELA	ROW	WORLD
1962	135739	463781	1574297	3010688	2199932	0	2495242	1481905	627301	0	1265968	13254853
1963	179729	497749	1885535	3317901	2886447	0	2915184	1429455	591131	17324	2436011	16156466
1964	101539	438648	1764701	5417108	3547908	0	3493886	1500729	1025425	0	3256088	20546032
1965	230912	915163	1950468	6929097	7912866	0	4532179	1482003	1651617	128898	4675752	30408955
1966	2043491	1704461	1818358	7628578	10194503	0	5062617	1605420	2792834	0	5928925	38779187
1967	8313833	2430664	1680117	8098830	10828547	0	6823164	1452516	4348548	0	6122874	50099093
1968	13813940	2198482	1977228	8706909	12771756	0	7363401	1535932	4897523	0	7234975	60500146
1969	23234523	4185450	2044304	7768902	13633377	4368	8622915	1614361	4669665	0	8528148	74306013
1970	36596955	6779361	2301011	7986398	16522345	52514	7753413	1871929	4817660	92491	9092328	93866405
1971	46287396	8996651	2684807	9036158	16795451	354633	7415340	2333955	6125183	0	9068063	109097637
1972	48294755	9334542	2074721	6683831	17901020	1080210	6939935	2473449	4578779	0	7377752	106738994
1973	64238641	12821283	3357038	8492829	19112277	1988305	6132755	2312305	4769330	0	6836440	130061203
1974	67880987	19522809	4503522	8571156	17369020	2408926	5959933	1636426	4238602	0	5656453	137747834
1975	63253080	23459583	3899669	8056814	16812324	2503256	2732028	1516817	3427271	0	3293629	128954471
1976	64094316	25380371	5635573	7604065	17593276	2335727	2477181	893450	3932043	0	3458745	133404747
1977	63103364	23742697	3638923	6717755	17877999	2545735	2975767	2052825	6595258	0	2820048	132070371
1978	52626268	20815439	2475924	6105614	14355153	3331510	2610413	3622575	6609331	0	1803792	114356019
1979	55297480	26136093	4649023	6711754	17088183	3485820	2949954	4044543	8153954	0	1665951	130182755
1980	60040060	28522932	3428674	7071442	16506568	3008840	2549191	4060454	6832650	0	1614443	133635254
1981	54860965	27164735	4409286	6172637	15635813	2732642	1978113	3639374	5764929	0	1003352	123361846
1982	54139956	27346237	2930706	5628020	15738754	2563506	2074540	3860964	6528120	0	914107	121724910
1983	49772804	23509201	3225341	5040447	14653314	2422873	1548414	3060712	5142615	0	777231	109152952
1984	58357452	29017413	3107327	4976730	15839987	2438071	1539258	3990428	5471859	0	633974	125372499
1985	54321348	29064068	2790899	4750156	18854936	2347332	1469010	3918467	6586285	0	410200	124512701
1986	46893889	26633279	2261862	4574391	20750506	2321056	1403918	3596554	5507801	123268	1167309	115233833
1987	43413754	26831270	2255126	4526926	20255127	1960508	1128518	4201748	5583602	339850	1537987	112034416
1988	52415696	27931730	2081978	4925306	21761645	1542445	1048549	4764452	4900424	443502	1561364	123377091
1989	56275433	29520127	2146843	4652456	21219380	1387042	961025	4507224	4852591	540492	1646624	127709237
1990	53852628	30198492	1923104	3950169	20752612	1274758	863581	4849456	4804779	1798060	1001764	125269403
1991	58353791	28470416	1680710	4128662	20972731	1292745	540871	4864255	4993303	1407405	386665	127091554
1992	104137622	53514070	2461418	7994576	16573064	3096340	1567430	7784918	9689162	3366806	17281478	227466884
1993	106946248	55644356	2317666	7114934	16617477	2464536	1144660	8262038	8272864	3007682	17174543	228967004
1994	55409205	27873986	1374528	3402279	15714024	1226188	686529	4328930	4579463	1090837	403668	116089637
1995	58727456	27627593	1063578	2418369	18324992	1317973	397372	4744337	4700331	981434	131460	120434895
1996	59527894	26645608	978612	3523113	15891856	1382136	751639	4546109	4628261	1066201	263538	119204967

Table V-11(b): JAPAN - Shares by Origin

Year	AUSTRALIA	BRAZIL	CANADA	CHILE	INDIA	NEW ZEALAND	PERU	PHILIPPINES	SAFRICA	VENEZUELA	ROW
1962	1.02%	3.50%	11.88%	22.71%	16.60%	0.00%	18.83%	11.18%	4.73%	0.00%	9.55%
1963	1.11%	3.08%	11.67%	20.54%	17.87%	0.00%	18.04%	8.85%	3.66%	0.11%	15.08%
1964	0.49%	2.13%	8.59%	26.37%	17.27%	0.00%	17.01%	7.30%	4.99%	0.00%	15.85%
1965	0.76%	3.01%	6.41%	22.79%	26.02%	0.00%	14.90%	4.87%	5.43%	0.42%	15.38%
1966	5.27%	4.40%	4.69%	19.67%	26.29%	0.00%	13.05%	4.14%	7.20%	0.00%	15.29%
1967	16.59%	4.85%	3.35%	16.17%	21.61%	0.00%	13.62%	2.90%	8.68%	0.00%	12.22%
1968	22.83%	3.63%	3.27%	14.39%	21.11%	0.00%	12.17%	2.54%	8.10%	0.00%	11.96%
1969	31.27%	5.63%	2.75%	10.46%	18.35%	0.01%	11.60%	2.17%	6.28%	0.00%	11.48%
1970	38.99%	7.22%	2.45%	8.51%	17.60%	0.06%	8.26%	1.99%	5.13%	0.10%	9.69%
1971	42.43%	8.25%	2.46%	8.28%	15.39%	0.33%	6.80%	2.14%	5.61%	0.00%	8.31%
1972	45.25%	8.75%	1.94%	6.26%	16.77%	1.01%	6.50%	2.32%	4.29%	0.00%	6.91%
1973	49.39%	9.86%	2.58%	6.53%	14.69%	1.53%	4.72%	1.78%	3.67%	0.00%	5.26%
1974	49.28%	14.17%	3.27%	6.22%	12.61%	1.75%	4.33%	1.19%	3.08%	0.00%	4.11%
1975	49.05%	18.19%	3.02%	6.25%	13.04%	1.94%	2.12%	1.18%	2.66%	0.00%	2.55%
1976	48.05%	19.03%	4.22%	5.70%	13.19%	1.75%	1.86%	0.67%	2.95%	0.00%	2.59%
1977	47.78%	17.98%	2.76%	5.09%	13.54%	1.93%	2.25%	1.55%	4.99%	0.00%	2.14%
1978	46.02%	18.20%	2.17%	5.34%	12.55%	2.91%	2.28%	3.17%	5.78%	0.00%	1.58%
1979	42.48%	20.08%	3.57%	5.16%	13.13%	2.68%	2.27%	3.11%	6.26%	0.00%	1.28%
1980	44.93%	21.34%	2.57%	5.29%	12.35%	2.25%	1.91%	3.04%	5.11%	0.00%	1.21%
1981	44.47%	22.02%	3.57%	5.00%	12.67%	2.22%	1.60%	2.95%	4.67%	0.00%	0.81%
1982	44.48%	22.47%	2.41%	4.62%	12.93%	2.11%	1.70%	3.17%	5.36%	0.00%	0.75%
1983	45.60%	21.54%	2.95%	4.62%	13.42%	2.22%	1.42%	2.80%	4.71%	0.00%	0.71%
1984	46.55%	23.14%	2.48%	3.97%	12.63%	1.94%	1.23%	3.18%	4.36%	0.00%	0.51%
1985	43.63%	23.34%	2.24%	3.81%	15.14%	1.89%	1.18%	3.15%	5.29%	0.00%	0.33%
1986	40.69%	23.11%	1.96%	3.97%	18.01%	2.01%	1.22%	3.12%	4.78%	0.11%	1.01%
1987	38.75%	23.95%	2.01%	4.04%	18.08%	1.75%	1.01%	3.75%	4.98%	0.30%	1.37%
1988	42.48%	22.64%	1.69%	3.99%	17.64%	1.25%	0.85%	3.86%	3.97%	0.36%	1.27%
1989	44.07%	23.12%	1.68%	3.64%	16.62%	1.09%	0.75%	3.53%	3.80%	0.42%	1.29%
1990	42.99%	24.11%	1.54%	3.15%	16.57%	1.02%	0.69%	3.87%	3.84%	1.44%	0.80%
1991	45.91%	22.40%	1.32%	3.25%	16.50%	1.02%	0.43%	3.83%	3.93%	1.11%	0.30%
1992	45.78%	23.53%	1.08%	3.51%	7.29%	1.36%	0.69%	3.42%	4.26%	1.48%	7.60%
1993	46.71%	24.30%	1.01%	3.11%	7.26%	1.08%	0.50%	3.61%	3.61%	1.31%	7.50%
1994	47.73%	24.01%	1.18%	2.93%	13.54%	1.06%	0.59%	3.73%	3.94%	0.94%	0.35%
1995	48.76%	22.94%	0.88%	2.01%	15.22%	1.09%	0.33%	3.94%	3.90%	0.81%	0.11%
1996	49.94%	22.35%	0.82%	2.96%	13.33%	1.16%	0.63%	3.81%	3.88%	0.89%	0.22%

Table V-11: JAPAN - Import Prices (US$/tonne)

Year	AUSTRALIA	BRAZIL	CANADA	CHILE	INDIA	NEW ZEALAND	PERU	PHILIPPINES	SAFRICA	VENEZUELA
1962	9.098	18.459	15.068	16.004	17.004	#N/A	13.714	11.788	18.176	#N/A
1963	7.194	16.804	14.409	15.573	15.796	#N/A	13.104	11.558	16.206	15.412
1964	8.883	16.070	14.248	15.200	15.154	#N/A	13.033	11.390	16.106	#N/A
1965	12.962	15.932	14.224	14.890	13.195	#N/A	12.995	11.823	15.785	14.306
1966	12.101	13.537	13.621	14.511	12.775	#N/A	12.597	12.103	15.073	#N/A
1967	11.753	12.357	12.968	13.860	12.165	#N/A	13.132	12.193	14.222	#N/A
1968	11.863	11.681	12.475	13.368	11.716	#N/A	12.489	13.316	14.031	#N/A
1969	11.770	11.016	12.078	12.973	11.703	7.784	10.894	12.770	13.084	#N/A
1970	11.522	11.266	13.355	13.061	12.041	10.683	11.941	12.305	12.764	18.737
1971	11.139	11.044	11.951	12.456	12.227	7.518	10.945	11.246	13.368	#N/A
1972	11.106	10.716	12.159	12.456	12.223	8.302	11.390	11.091	13.058	#N/A
1973	12.133	11.623	13.580	13.064	13.137	9.034	11.974	11.761	14.501	#N/A
1974	14.359	13.644	15.147	15.233	16.919	10.006	15.444	13.222	16.623	#N/A
1975	15.839	16.791	17.714	16.845	19.583	11.697	18.263	13.589	19.846	#N/A
1976	16.670	17.606	18.542	18.183	19.347	11.468	18.565	14.886	21.089	#N/A
1977	18.254	19.654	22.123	20.716	19.742	11.894	20.688	33.625	21.266	#N/A
1978	20.250	21.313	24.448	25.621	20.569	14.023	25.320	35.681	22.622	#N/A
1979	21.136	24.303	24.769	30.327	21.200	16.141	26.717	38.093	23.148	#N/A
1980	22.891	28.053	26.752	34.956	25.717	19.304	29.910	39.793	25.745	#N/A
1981	25.114	31.004	28.269	39.090	27.604	20.655	33.455	45.836	29.750	#N/A
1982	27.268	31.631	30.403	41.784	27.781	21.544	35.200	43.560	31.288	#N/A
1983	26.574	30.544	27.951	38.579	27.599	21.007	31.696	43.661	31.372	#N/A
1984	23.236	27.082	25.654	34.450	24.276	18.972	28.279	40.026	28.559	#N/A
1985	22.610	25.871	24.599	31.213	22.728	18.548	26.352	38.455	26.763	#N/A
1986	22.696	25.264	25.188	29.903	21.606	17.107	23.209	38.457	25.349	19.024
1987	21.862	24.400	24.619	31.309	21.050	16.163	24.770	36.607	24.401	16.969
1988	21.332	24.554	24.140	28.509	21.719	16.451	23.038	36.692	23.724	18.595
1989	22.462	26.670	27.133	28.825	23.542	17.966	29.203	38.828	24.974	19.847
1990	24.424	29.554	27.933	32.126	25.610	20.449	31.501	39.911	26.599	27.279
1991	26.135	31.601	32.031	34.196	27.238	21.209	29.763	41.676	29.248	28.339
1992	25.261	31.085	29.749	33.744	26.569	20.511	29.310	43.268	30.866	29.034
1993	23.798	29.420	28.283	32.727	24.688	18.818	24.683	42.273	29.712	25.539
1994	22.187	28.270	28.697	29.367	22.902	17.935	23.344	41.716	28.072	22.753
1995	23.096	29.255	28.101	33.399	24.094	18.981	25.208	43.137	30.178	24.102
1996	23.240	29.296	28.865	31.899	24.962	20.457	24.798	41.940	30.782	25.528

Table V-12(a): GERMANY - Imports by Origin (Metric tonnes)

Year	AUSTRALIA	BRAZIL	CANADA	FRANCE	LIBERIA	MAURITANIA	NORWAY	SAFRICA	SPAIN	SWEDEN	VENEZUELA	ROW	WORLD
1962	0	2834141	1019257	9339475	1065656	0	869768	20288	1148977	8098774	1101576	4110351	29608263
1963	0	2586628	930731	7022218	1655009	254231	788099	18988	1110409	8147695	1069587	4231599	27815194
1964	0	3280057	758380	6619839	4294448	1145222	886635	20477	1291464	9706705	2043420	5215490	35262137
1965	0	3357817	1000555	6133863	5776369	1239921	690255	44719	1111237	10146565	1944151	4724049	36169501
1966	0	2891594	800161	5052830	6251153	1177291	598245	4651	808984	9588860	1606032	3328279	32108080
1967	182882	4404162	1017897	4456291	6160078	1252687	1100563	0	813169	10265446	1328211	1742500	32723886
1968	562321	4730084	2199071	4644619	6980121	1304520	1596852	58207	1217919	12916652	1664370	1700607	39575343
1969	823794	6382369	2124738	5364869	6665958	1236752	1457251	8490	1465569	13618395	1734369	1447783	42330337
1970	1010104	6365440	3710166	5220243	8190810	1342251	1675803	586525	1486184	11517322	3010118	2718018	46832984
1971	1785508	6912955	2126936	4356859	6880503	1093937	2218327	115940	1324785	9632481	2301779	1073439	39823449
1972	1662446	8329745	2222352	4012028	6757762	724758	2760080	192	1517388	8714995	2604785	982270	40288801
1973	2777261	11042760	3885710	3515608	8543179	1007578	1884933	155776	1042702	10893676	2550656	1690966	48990805
1974	4779826	11980395	3975956	3676723	9744582	1515820	1462619	659491	1571257	10586306	2711170	3761525	56425670
1975	6412092	11023422	4065132	2623412	6196186	603476	1160921	297083	1465805	5761749	1873163	2465512	43947953
1976	7004641	12075097	6354941	2807170	6600373	960534	1139946	523818	1344355	5267299	2111855	1420627	47610656
1977	5225471	10184084	4452068	1603456	6805208	914387	1404992	2265854	1065267	4322913	1250413	1015206	40509319
1978	5581137	11132384	3451926	1545423	7044638	555499	1371150	3524356	893354	5759267	801746	1004702	42665582
1979	6131731	11984614	6802034	1860724	7591093	769424	2449525	4431039	924201	6854006	1714576	816062	52329029
1980	4663726	13284306	7932065	1851804	6818232	549656	1912700	4410194	956914	5902714	1748578	363818	50394707
1981	3441548	14543398	5951722	1229227	7414275	560772	1525696	4155231	828453	3555796	1394516	227904	44828538
1982	3543160	13870163	6104167	352535	6104589	466941	1331046	3087729	673005	2696026	911583	198951	39339895
1983	4206712	13219804	4078248	4066	6530129	349018	2100713	2329236	537316	1606938	317450	123851	35403481
1984	5620208	15206316	5837420	2909	6272613	406643	3000491	3188472	404888	2044511	484627	183099	42652197
1985	6959341	16500158	6670100	8868	6475637	599336	1667195	999241	243630	4157947	557868	244228	45083549
1986	5416639	15639539	6414624	149	5929649	532421	1122806	861074	159291	4517216	665679	451364	41710451
1987	5617324	17102680	3810138	617	5355812	425851	522293	452711	48126	4982093	924986	390367	39632998
1988	7453828	19512384	4113108	0	5441239	195806	548442	879175	0	5682219	618581	827018	45271800
1989	6409640	19997476	4894747	0	5301712	26175	669088	1845197	0	6310242	638341	1190277	47282895
1990	5255604	19676675	6011406	0	3157532	126030	543295	1166260	42	5734830	743291	1474239	43889204
1991	5668701	20009527	8057450	0	11763	408008	967414	493986	0	5718044	667425	1437319	43439637
1992	11428620	36597016	13804050	0	448366	691230	2749444	1317942	6	12003706	1124428	2562682	82727490
1993	3234353	17561058	5418910	0	36438	280402	1594210	331511	0	5983976	73089	990828	35504775
1994	4727177	22839389	5976930	0	0	475757	1529761	475034	0	5205587	0	1543219	42772854
1995	5358534	22754371	6418738	0	0	802645	1448240	480119	0	4881954	0	975684	43120285
1996	3566870	21741914	5515379	0	0	734207	1060797	691536	0	5160768	0	904826	39376297

Table V-12(b): GERMANY - Shares by Origin

Year	AUSTRALIA	BRAZIL	CANADA	FRANCE	LIBERIA	MAURITANIA	NORWAY	SAFRICA	SPAIN	SWEDEN	VENEZUELA	ROW
1962	0.00%	9.57%	3.44%	31.54%	3.60%	0.00%	2.94%	0.07%	3.88%	27.35%	3.72%	13.88%
1963	0.00%	9.30%	3.35%	25.25%	5.95%	0.91%	2.83%	0.07%	3.99%	29.29%	3.85%	15.21%
1964	0.00%	9.30%	2.15%	18.77%	12.18%	3.25%	2.51%	0.06%	3.66%	27.53%	5.79%	14.79%
1965	0.00%	9.28%	2.77%	16.96%	15.97%	3.43%	1.91%	0.12%	3.07%	28.05%	5.38%	13.06%
1966	0.00%	9.01%	2.49%	15.74%	19.47%	3.67%	1.86%	0.01%	2.52%	29.86%	5.00%	10.37%
1967	0.56%	13.46%	3.11%	13.62%	18.82%	3.83%	3.36%	0.00%	2.48%	31.37%	4.06%	5.32%
1968	1.42%	11.95%	5.56%	11.74%	17.64%	3.30%	4.03%	0.15%	3.08%	32.64%	4.21%	4.30%
1969	1.95%	15.08%	5.02%	12.67%	15.75%	2.92%	3.44%	0.02%	3.46%	32.17%	4.10%	3.42%
1970	2.16%	13.59%	7.92%	11.15%	17.49%	2.87%	3.58%	1.25%	3.17%	24.59%	6.43%	5.80%
1971	4.48%	17.36%	5.34%	10.94%	17.28%	2.75%	5.57%	0.29%	3.33%	24.19%	5.78%	2.70%
1972	4.13%	20.68%	5.52%	9.96%	16.77%	1.80%	6.85%	0.00%	3.77%	21.63%	6.47%	2.44%
1973	5.67%	22.54%	7.93%	7.18%	17.44%	2.06%	3.85%	0.32%	2.13%	22.24%	5.21%	3.45%
1974	8.47%	21.23%	7.05%	6.52%	17.27%	2.69%	2.59%	1.17%	2.78%	18.76%	4.80%	6.67%
1975	14.59%	25.08%	9.25%	5.97%	14.10%	1.37%	2.64%	0.68%	3.34%	13.11%	4.26%	5.61%
1976	14.71%	25.36%	13.35%	5.90%	13.86%	2.02%	2.39%	1.10%	2.82%	11.06%	4.44%	2.98%
1977	12.90%	25.14%	10.99%	3.96%	16.80%	2.26%	3.47%	5.59%	2.63%	10.67%	3.09%	2.51%
1978	13.08%	26.09%	8.09%	3.62%	16.51%	1.30%	3.21%	8.26%	2.09%	13.50%	1.88%	2.35%
1979	11.72%	22.90%	13.00%	3.56%	14.51%	1.47%	4.68%	8.47%	1.77%	13.10%	3.28%	1.56%
1980	9.25%	26.36%	15.74%	3.67%	13.53%	1.09%	3.80%	8.75%	1.90%	11.71%	3.47%	0.72%
1981	7.68%	32.44%	13.28%	2.74%	16.54%	1.25%	3.40%	9.27%	1.85%	7.93%	3.11%	0.51%
1982	9.01%	35.26%	15.52%	0.90%	15.52%	1.19%	3.38%	7.85%	1.71%	6.85%	2.32%	0.51%
1983	11.88%	37.34%	11.52%	0.01%	18.44%	0.99%	5.93%	6.58%	1.52%	4.54%	0.90%	0.35%
1984	13.18%	35.65%	13.69%	0.01%	14.71%	0.95%	7.03%	7.48%	0.95%	4.79%	1.14%	0.43%
1985	15.44%	36.60%	14.79%	0.02%	14.36%	1.33%	3.70%	2.22%	0.54%	9.22%	1.24%	0.54%
1986	12.99%	37.50%	15.38%	0.00%	14.22%	1.28%	2.69%	2.06%	0.38%	10.83%	1.60%	1.08%
1987	14.17%	43.15%	9.61%	0.00%	13.51%	1.07%	1.32%	1.14%	0.12%	12.57%	2.33%	0.98%
1988	16.46%	43.10%	9.09%	0.00%	12.02%	0.43%	1.21%	1.94%	0.00%	12.55%	1.37%	1.83%
1989	13.56%	42.29%	10.35%	0.00%	11.21%	0.06%	1.42%	3.90%	0.00%	13.35%	1.35%	2.52%
1990	11.97%	44.83%	13.70%	0.00%	7.19%	0.29%	1.24%	2.66%	0.00%	13.07%	1.69%	3.36%
1991	13.05%	46.06%	18.55%	0.00%	0.03%	0.94%	2.23%	1.14%	0.00%	13.16%	1.54%	3.31%
1992	13.81%	44.24%	16.69%	0.00%	0.54%	0.84%	3.32%	1.59%	0.00%	14.51%	1.36%	3.10%
1993	9.11%	49.46%	15.26%	0.00%	0.10%	0.79%	4.49%	0.93%	0.00%	16.85%	0.21%	2.79%
1994	11.05%	53.40%	13.97%	0.00%	0.00%	1.11%	3.58%	1.11%	0.00%	12.17%	0.00%	3.61%
1995	12.43%	52.77%	14.89%	0.00%	0.00%	1.86%	3.36%	1.11%	0.00%	11.32%	0.00%	2.26%
1996	9.06%	55.22%	14.01%	0.00%	0.00%	1.86%	2.69%	1.76%	0.00%	13.11%	0.00%	2.30%

Table V-12(c): GERMANY - Import Prices (US$/tonne)

Year	AUSTRALIA	BRAZIL	CANADA	FRANCE	LIBERIA	MAURITANIA	NORWAY	SAFRICA	SPAIN	SWEDEN	VENEZUELA
1962	#N/A	13.918	12.490	4.477	11.924	#N/A	11.474	18.188	10.119	12.904	15.318
1963	#N/A	13.104	12.359	4.357	10.774	11.773	10.327	14.588	9.104	11.471	14.155
1964	#N/A	13.012	11.739	4.311	10.674	12.387	9.739	15.823	8.241	10.741	11.760
1965	#N/A	12.534	10.324	4.251	10.583	12.239	9.940	17.979	8.534	10.843	11.180
1966	#N/A	11.403	10.590	4.341	10.710	13.056	9.411	18.491	9.261	10.710	11.211
1967	12.828	11.581	14.076	4.145	10.438	13.197	8.418	#N/A	9.382	9.776	10.439
1968	12.744	10.933	12.190	3.929	9.605	11.472	8.130	11.287	8.464	9.270	9.452
1969	12.638	11.110	10.951	3.847	10.019	10.860	8.646	15.783	8.407	9.813	9.173
1970	12.829	12.730	12.912	4.056	10.365	11.086	11.514	16.570	9.872	10.321	10.674
1971	12.902	13.110	12.862	4.399	12.177	12.215	13.638	14.784	11.146	12.132	12.569
1972	13.702	12.700	12.474	4.671	13.001	13.115	12.824	10.417	11.172	12.875	13.157
1973	14.421	15.110	14.784	5.193	14.885	14.209	14.538	19.721	13.344	15.533	13.937
1974	16.228	17.357	17.455	5.686	17.681	17.796	18.386	23.142	17.616	16.884	17.042
1975	19.004	19.228	20.841	8.749	19.625	18.536	25.604	23.451	17.042	21.251	19.678
1976	20.981	21.045	22.336	8.230	20.367	21.147	24.326	23.537	17.096	21.269	20.959
1977	23.975	23.037	23.611	7.893	22.998	23.615	25.209	25.831	19.425	20.541	22.541
1978	22.931	24.153	24.650	8.179	24.211	23.383	25.603	26.206	19.187	20.938	22.078
1979	23.750	25.151	24.996	9.993	23.758	25.620	28.850	26.385	17.822	22.859	22.866
1980	28.209	28.402	28.453	10.641	27.710	29.189	32.315	30.610	21.200	27.243	26.849
1981	26.341	26.261	26.389	10.005	24.081	26.868	28.558	27.988	17.509	23.915	25.329
1982	26.838	27.448	28.741	9.108	26.103	27.325	27.956	28.408	14.893	26.106	25.331
1983	25.851	28.784	27.208	19.675	26.833	27.623	27.045	27.183	14.208	24.528	25.569
1984	23.478	25.314	24.450	23.376	23.875	22.226	23.807	22.897	11.381	23.339	23.484
1985	24.488	25.664	25.052	14.772	24.796	23.299	26.428	25.358	12.732	22.912	24.379
1986	29.757	32.396	29.748	73.826	31.976	23.767	27.267	31.760	15.833	27.022	20.319
1987	26.460	29.507	28.507	34.036	29.463	25.077	29.646	31.629	21.236	26.289	20.008
1988	22.896	26.471	24.909	#N/A	25.123	23.079	30.683	22.382	#N/A	28.524	19.655
1989	24.983	28.375	27.217	#N/A	28.266	22.617	31.180	23.770	#N/A	30.921	23.227
1990	29.685	33.621	34.091	#N/A	34.338	26.716	37.319	27.726	#N/A	35.160	29.007
1991	29.875	33.358	33.591	#N/A	2.295	28.120	36.979	29.760	#N/A	36.385	30.673
1992	31.314	34.338	35.145	#N/A	23.695	31.396	35.940	25.010	#N/A	36.384	30.166
1993	24.867	28.094	28.814	#N/A	19.650	27.104	29.956	19.933	#N/A	31.296	27.090
1994	25.936	28.425	29.677	#N/A	#N/A	26.976	32.339	22.272	#N/A	32.922	#N/A
1995	29.078	32.551	34.596	#N/A	#N/A	29.181	36.384	23.902	#N/A	30.884	#N/A
1996	26.686	30.420	32.621	#N/A	#N/A	30.219	34.769	24.172	#N/A	29.536	#N/A

Tebla V-13(a): BELGIUM - Imports by Origin (Metric tonnes)

Year	AUSTRALIA	BRAZIL	CANADA	FRANCE	MAURITANIA	NORWAY	SWEDEN	VENEZUELA	ROW	WORLD
1962	0	80994	253060	16503180	0	46727	4191335	0	127940	21203236
1963	0	62931	158673	14312030	30704	49833	4901604	0	244880	19760655
1964	0	466045	196720	15251193	105647	62110	5742328	0	1157819	22981862
1965	0	562058	506118	14868742	623161	47063	5721546	0	1528670	23857358
1966	2496	459388	48724	13120417	787427	81702	5207237	0	1811267	21518658
1967	203923	195371	0	12417365	1023617	62359	6336595	0	1741637	21980867
1968	353989	561802	161555	13917009	1208147	31382	8059066	0	1991002	26283952
1969	579398	1344324	7300	13378328	1092973	79427	9043970	49212	1989374	27564306
1970	512613	1653426	511386	13731364	1129050	22452	8491860	808415	2368189	29228755
1971	1087532	1455171	0	13950714	1291244	98416	8017394	424788	1843985	28169244
1972	854846	1476584	52636	14525279	1210536	8717	7691327	427670	1914459	28162054
1973	1764854	1295627	276277	14645101	1102978	1124248	8799500	1288941	2250578	32548104
1974	2211672	1661647	387388	14892537	1316017	63689	8907056	873187	3576209	33889402
1975	2279069	1974360	116863	13166570	920684	114147	4967554	284948	1863664	25687859
1976	2276255	2261063	271858	12656090	941675	165244	4451332	618096	3570443	27212056
1977	1585222	1388815	231703	10380769	1047006	478850	4071750	512689	2075874	21772678
1978	1025242	2443012	713250	9276545	560944	912791	5826345	1084175	2615308	24457612
1979	783110	3664268	866036	8028571	1143769	139863	6950681	1208031	3542435	26326764
1980	830540	3319923	668495	6843130	882445	232854	5865659	949973	2690463	22283482
1981	1287208	3785904	837054	4661112	1471347	138683	4396929	1696794	2968997	21244028
1982	1378689	3583216	681062	5082696	1431967	70049	2581327	1341669	2522435	18673110
1983	1541194	3083309	356706	4990173	1503559	180664	2758671	949930	2195939	17560145
1984	1260344	3908950	399701	4386710	1828330	232088	3704323	1665613	2305303	19691362
1985	1181172	4847649	373948	4615076	2282538	368663	3110933	2073580	1718538	20572097
1986	789182	4251747	579740	4236898	2079881	295321	2774369	1471856	1581734	18060728
1987	1307566	4687552	610069	3748714	2302808	299282	2346824	1684250	1458214	18445279
1988	1824956	4852431	667828	3424556	2896938	476501	2824849	1786628	1946395	20701082
1989	1416089	5619487	760533	3180067	2554769	368373	2873522	1527152	1470603	19770595
1990	1485860	6446257	616310	3337088	2563277	612582	2940516	1541426	805146	20348462
1991	1511088	6750197	838875	2862356	2111189	489516	2527305	1632650	765953	19489129
1992	2292776	13406308	2676962	5736104	3017526	876438	4605654	2028730	1343442	35983940
1993	880993	5986082	1100262	2993620	1023573	533669	2097798	703776	446270	15766043
1994	932131	6274231	2161103	2042187	1565682	432061	2548315	486249	568923	17010882
1995	868963	7028179	1792550	1471801	1641788	382336	1035765	470496	638844	15330722
1996	553151	6299258	1355535	1421345	1555878	138013	781242	497148	394528	12996098

Table V-13(b): BELGIUM - Shares by Origin

Year	AUSTRALIA	BRAZIL	CANADA	FRANCE	MAURITANIA	NORWAY	SWEDEN	VENEZUELA	ROW
1962	0.00%	0.38%	1.19%	77.83%	0.00%	0.22%	19.77%	0.00%	0.60%
1963	0.00%	0.32%	0.80%	72.43%	0.16%	0.25%	24.80%	0.00%	1.24%
1964	0.00%	2.03%	0.86%	66.36%	0.46%	0.27%	24.99%	0.00%	5.04%
1965	0.00%	2.36%	2.12%	62.32%	2.61%	0.20%	23.98%	0.00%	6.41%
1966	0.01%	2.13%	0.23%	60.97%	3.66%	0.38%	24.20%	0.00%	8.42%
1967	0.93%	0.89%	0.00%	56.49%	4.66%	0.28%	28.83%	0.00%	7.92%
1968	1.35%	2.14%	0.61%	52.95%	4.60%	0.12%	30.66%	0.00%	7.57%
1969	2.10%	4.88%	0.03%	48.53%	3.97%	0.29%	32.81%	0.18%	7.22%
1970	1.75%	5.66%	1.75%	46.98%	3.86%	0.08%	29.05%	2.77%	8.10%
1971	3.86%	5.17%	0.00%	49.52%	4.58%	0.35%	28.46%	1.51%	6.55%
1972	3.04%	5.24%	0.19%	51.58%	4.30%	0.03%	27.31%	1.52%	6.80%
1973	5.42%	3.98%	0.85%	45.00%	3.39%	3.45%	27.04%	3.96%	6.91%
1974	6.53%	4.90%	1.14%	43.94%	3.88%	0.19%	26.28%	2.58%	10.55%
1975	8.87%	7.69%	0.45%	51.26%	3.58%	0.44%	19.34%	1.11%	7.26%
1976	8.36%	8.31%	1.00%	46.51%	3.46%	0.61%	16.36%	2.27%	13.12%
1977	7.28%	6.38%	1.06%	47.68%	4.81%	2.20%	18.70%	2.35%	9.53%
1978	4.19%	9.99%	2.92%	37.93%	2.29%	3.73%	23.82%	4.43%	10.69%
1979	2.97%	13.92%	3.29%	30.50%	4.34%	0.53%	26.40%	4.59%	13.46%
1980	3.73%	14.90%	3.00%	30.71%	3.96%	1.04%	26.32%	4.26%	12.07%
1981	6.06%	17.82%	3.94%	21.94%	6.93%	0.65%	20.70%	7.99%	13.98%
1982	7.38%	19.19%	3.65%	27.22%	7.67%	0.38%	13.82%	7.19%	13.51%
1983	8.78%	17.56%	2.03%	28.42%	8.56%	1.03%	15.71%	5.41%	12.51%
1984	6.40%	19.85%	2.03%	22.28%	9.28%	1.18%	18.81%	8.46%	11.71%
1985	5.74%	23.56%	1.82%	22.43%	11.10%	1.79%	15.12%	10.08%	8.35%
1986	4.37%	23.54%	3.21%	23.46%	11.52%	1.64%	15.36%	8.15%	8.76%
1987	7.09%	25.41%	3.31%	20.32%	12.48%	1.62%	12.72%	9.13%	7.91%
1988	8.82%	23.44%	3.23%	16.54%	13.99%	2.30%	13.65%	8.63%	9.40%
1989	7.16%	28.42%	3.85%	16.08%	12.92%	1.86%	14.53%	7.72%	7.44%
1990	7.30%	31.68%	3.03%	16.40%	12.60%	3.01%	14.45%	7.58%	3.96%
1991	7.75%	34.64%	4.30%	14.69%	10.83%	2.51%	12.97%	8.38%	3.93%
1992	6.37%	37.26%	7.44%	15.94%	8.39%	2.44%	12.80%	5.64%	3.73%
1993	5.59%	37.97%	6.98%	18.99%	6.49%	3.38%	13.31%	4.46%	2.83%
1994	5.48%	36.88%	12.70%	12.01%	9.20%	2.54%	14.98%	2.86%	3.34%
1995	5.67%	45.84%	11.69%	9.60%	10.71%	2.49%	6.76%	3.07%	4.17%
1996	4.26%	48.47%	10.43%	10.94%	11.97%	1.06%	6.01%	3.83%	3.04%

Table V-13(c):BELGIUM - Import Prices (US$/tonne)

Year	AUSTRALIA	BRAZIL	CANADA	FRANCE	MAURITANIA	NORWAY	SWEDEN	VENEZUELA
1962	#N/A	14.162	8.433	3.425	#N/A	11.107	10.778	#N/A
1963	#N/A	12.696	8.237	3.408	10.845	9.311	9.635	#N/A
1964	#N/A	11.999	8.042	3.337	10.658	9.741	9.566	#N/A
1965	#N/A	10.305	8.304	3.335	11.057	10.263	9.765	#N/A
1966	10.417	10.192	8.127	3.268	10.572	10.306	9.658	#N/A
1967	12.877	9.679	#N/A	2.996	9.966	8.948	8.434	#N/A
1968	13.368	9.421	11.544	2.812	10.102	8.954	8.031	#N/A
1969	12.389	9.696	15.342	2.604	9.727	12.452	8.057	9.876
1970	12.118	9.850	14.408	2.558	9.946	10.823	8.792	10.210
1971	12.767	11.181	#N/A	2.759	11.295	13.463	10.651	10.568
1972	12.341	9.084	18.333	3.044	11.033	16.061	11.364	9.245
1973	10.612	9.833	13.751	3.707	12.036	11.431	11.555	9.800
1974	12.691	12.530	13.619	4.326	15.095	19.061	14.980	13.376
1975	16.776	14.616	20.289	5.321	19.613	26.851	18.022	18.744
1976	20.018	17.898	22.188	5.602	20.888	18.917	17.540	18.997
1977	19.160	15.446	19.508	5.870	19.877	16.178	15.537	17.551
1978	18.051	19.245	17.910	6.534	18.874	16.383	17.158	16.793
1979	17.208	26.249	25.634	6.785	21.540	19.998	17.953	19.718
1980	24.641	30.322	27.465	6.974	27.144	26.390	17.655	25.470
1981	24.942	27.087	25.442	5.945	24.752	27.718	16.212	24.458
1982	24.605	25.246	25.111	5.995	23.082	28.394	14.124	22.614
1983	20.522	23.574	21.264	4.977	21.720	20.425	17.015	20.729
1984	18.881	21.137	20.010	4.460	20.199	19.057	16.908	18.334
1985	19.426	22.241	23.402	4.706	21.755	21.955	16.667	19.748
1986	22.025	23.966	25.696	6.248	22.161	22.372	19.843	21.664
1987	20.068	22.444	24.671	7.303	20.753	21.348	22.177	19.660
1988	18.752	22.422	23.576	8.086	19.940	15.891	22.924	19.106
1989	20.914	24.970	26.666	7.849	23.138	13.250	21.686	22.727
1990	24.541	28.104	34.330	9.421	26.988	16.603	26.019	25.684
1991	24.615	28.953	36.513	10.295	27.607	18.580	29.827	27.167
1992	26.208	28.960	36.643	9.969	28.591	23.034	30.368	27.256
1993	22.544	23.893	31.085	9.338	23.012	22.439	23.780	24.960
1994	23.368	23.556	33.275	11.230	23.488	23.314	22.978	20.891
1995	21.812	26.209	37.244	10.948	24.269	19.773	34.523	22.330
1996	21.171	25.937	38.074	10.672	23.855	16.151	39.437	23.144

Table V-14(a): FRANCE - Imports by Origin (Metric tonnes)

Year	AUSTRALIA	BRAZIL	CANADA	LIBERIA	MAURITANIA	SAFRICA	SPAIN	SWEDEN	ROW	WORLD
1962	0	210840	83352	0	0	30351	164779	611993	739867	1841182
1963	0	674290	3574	750725	433646	15741	150570	626684	768517	3423747
1964	0	393835	25400	814745	996355	473	141705	478012	755821	3606346
1965	0	632558	30298	957949	1133985	78270	75458	493495	578630	3980643
1966	0	716472	64770	945587	1422222	63930	85856	395712	580841	4275390
1967	163114	1039358	127	953799	1643534	643	125878	355613	528076	4810142
1968	244065	1313139	2298	1173528	1346120	0	175274	284085	462974	5001483
1969	443040	1464829	32431	1221910	1757367	0	254654	1082911	445120	6702262
1970	755639	2194897	264318	1616547	1950703	33009	481856	1437897	561112	9295978
1971	803346	2221279	84541	1296869	1936513	0	470643	1322379	555278	8690848
1972	700499	3181171	74533	1613257	2363861	0	511384	1732524	617846	10795075
1973	831076	3109175	319989	1707245	1880951	114671	437224	1965781	905281	11271393
1974	1613040	4089771	655371	2077489	2451909	19909	491689	2663740	1314116	15377034
1975	1676003	3490781	529096	1994006	2163029	528	315278	1645770	1019287	12833778
1976	1686597	4206294	872147	1885501	2245425	1392	617738	1803333	812452	14130879
1977	2172734	4271196	915829	2102131	2543020	573015	85874	1724819	1028875	15417493
1978	2197431	4301394	439892	1886835	2139969	1087631	97743	1870588	573549	14595032
1979	1678630	4397782	1270578	1821769	2868377	992134	216573	3000104	1186844	17432791
1980	2085549	4639565	1186395	2297940	2934190	1092905	242968	3175278	1061694	18716484
1981	2232863	4080799	1033749	2099008	2511305	791767	212827	2751431	859997	16573746
1982	1791485	3889147	955141	1595622	2192758	777973	226539	2688870	877179	14994714
1983	1776729	3280465	980662	1041942	1671084	382911	325704	2352814	737354	12549665
1984	2751598	3600945	1325280	1340863	2032325	410074	660133	2779462	1125539	16026219
1985	1798402	3974562	1987099	1119265	2306361	159604	406289	2891409	1626131	16269122
1986	2355893	4031508	2209517	589483	2293992	564	553419	2470266	1717306	16221948
1987	3373956	3656275	2263100	991759	1845687	1052	632128	810067	1502384	15076408
1988	4684542	5495423	2830198	1113202	1694185	151491	428912	645704	1696864	18740521
1989	4038663	5589740	2294397	999223	2853107	986743	334125	625955	2330983	20052936
1990	4041935	6053208	2070008	504389	2492905	778166	274677	471871	2216999	18904158
1991	4151007	5791942	1918541	709802	1721372	501119	448245	598880	2401811	18242719
1992	7594812	13404868	4344262	401198	3443172	667166	373920	827870	3746071	34803339
1993	6292606	13048266	3466876	220380	5138294	890704	348200	1152526	2539422	33097274
1994	4689134	8217430	2452152	0	3026045	325168	93620	566435	736799	20106783
1995	5761045	7652660	2146678	0	2858884	581820	210165	569109	455679	20236040
1996	5063076	6576078	1882573	0	2900697	458376	210325	169760	1062430	18323315

Table V-14(b): FRANCE - Shares by Origin

Year	AUSTRALIA	BRAZIL	CANADA	LIBERIA	MAURITANIA	SAFRICA	SPAIN	SWEDEN	ROW
1962	0.00%	11.45%	4.53%	0.00%	0.00%	1.65%	8.95%	33.24%	40.18%
1963	0.00%	19.69%	0.10%	21.93%	12.67%	0.46%	4.40%	18.30%	22.45%
1964	0.00%	10.92%	0.70%	22.59%	27.63%	0.01%	3.93%	13.25%	20.96%
1965	0.00%	15.89%	0.76%	24.07%	28.49%	1.97%	1.90%	12.40%	14.54%
1966	0.00%	16.76%	1.51%	22.12%	33.27%	1.50%	2.01%	9.26%	13.59%
1967	3.39%	21.61%	0.00%	19.83%	34.17%	0.01%	2.62%	7.39%	10.98%
1968	4.88%	26.25%	0.05%	23.46%	26.91%	0.00%	3.50%	5.68%	9.26%
1969	6.61%	21.86%	0.48%	18.23%	26.22%	0.00%	3.80%	16.16%	6.64%
1970	8.13%	23.61%	2.84%	17.39%	20.98%	0.36%	5.18%	15.47%	6.04%
1971	9.24%	25.56%	0.97%	14.92%	22.28%	0.00%	5.42%	15.22%	6.39%
1972	6.49%	29.47%	0.69%	14.94%	21.90%	0.00%	4.74%	16.05%	5.72%
1973	7.37%	27.58%	2.84%	15.15%	16.69%	1.02%	3.88%	17.44%	8.03%
1974	10.49%	26.60%	4.26%	13.51%	15.95%	0.13%	3.20%	17.32%	8.55%
1975	13.06%	27.20%	4.12%	15.54%	16.85%	0.00%	2.46%	12.82%	7.94%
1976	11.94%	29.77%	6.17%	13.34%	15.89%	0.01%	4.37%	12.76%	5.75%
1977	14.09%	27.70%	5.94%	13.63%	16.49%	3.72%	0.56%	11.19%	6.67%
1978	15.06%	29.47%	3.01%	12.93%	14.66%	7.45%	0.67%	12.82%	3.93%
1979	9.63%	25.23%	7.29%	10.45%	16.45%	5.69%	1.24%	17.21%	6.81%
1980	11.14%	24.79%	6.34%	12.28%	15.68%	5.84%	1.30%	16.97%	5.67%
1981	13.47%	24.62%	6.24%	12.66%	15.15%	4.78%	1.28%	16.60%	5.19%
1982	11.95%	25.94%	6.37%	10.64%	14.62%	5.19%	1.51%	17.93%	5.85%
1983	14.16%	26.14%	7.81%	8.30%	13.32%	3.05%	2.60%	18.75%	5.88%
1984	17.17%	22.47%	8.27%	8.37%	12.68%	2.56%	4.12%	17.34%	7.02%
1985	11.05%	24.43%	12.21%	6.88%	14.18%	0.98%	2.50%	17.77%	10.00%
1986	14.52%	24.85%	13.62%	3.63%	14.14%	0.00%	3.41%	15.23%	10.59%
1987	22.38%	24.25%	15.01%	6.58%	12.24%	0.01%	4.19%	5.37%	9.97%
1988	25.00%	29.32%	15.10%	5.94%	9.04%	0.81%	2.29%	3.45%	9.05%
1989	20.14%	27.87%	11.44%	4.98%	14.23%	4.92%	1.67%	3.12%	11.62%
1990	21.38%	32.02%	10.95%	2.67%	13.19%	4.12%	1.45%	2.50%	11.73%
1991	22.75%	31.75%	10.52%	3.89%	9.44%	2.75%	2.46%	3.28%	13.17%
1992	21.82%	38.52%	12.48%	1.15%	9.89%	1.92%	1.07%	2.38%	10.76%
1993	19.01%	39.42%	10.47%	0.67%	15.52%	2.69%	1.05%	3.48%	7.67%
1994	23.32%	40.87%	12.20%	0.00%	15.05%	1.62%	0.47%	2.82%	3.66%
1995	28.47%	37.82%	10.61%	0.00%	14.13%	2.88%	1.04%	2.81%	2.25%
1996	27.63%	35.89%	10.27%	0.00%	15.83%	2.50%	1.15%	0.93%	5.80%

Table V-14(c): FRANCE - Import *Prices* (US$/tonne)

Year	AUSTRALIA	BRAZIL	CANADA	LIBERIA	MAURITANIA	SAFRICA	SPAIN	SWEDEN
1962	#N/A	13.242	10.846	#N/A	#N/A	15.914	11.531	12.289
1963	#N/A	12.321	10.632	9.248	10.712	15.056	10.932	10.489
1964	#N/A	12.586	10.433	9.426	11.757	21.142	10.670	10.885
1965	#N/A	12.309	14.423	9.768	11.466	14.488	9.873	10.878
1966	#N/A	12.162	14.729	9.353	11.201	15.845	9.667	12.638
1967	12.789	10.130	62.992	9.293	9.656	23.328	7.666	10.455
1968	11.427	9.676	18.712	8.981	9.657	#N/A	6.966	10.423
1969	11.640	9.944	16.682	8.533	9.299	#N/A	8.643	10.137
1970	11.778	10.953	13.102	9.353	9.962	19.116	8.382	11.001
1971	13.306	11.922	16.312	10.287	10.498	#N/A	8.918	12.456
1972	11.265	11.485	10.854	9.509	11.129	#N/A	9.529	12.900
1973	10.347	12.308	12.025	10.608	11.316	14.249	10.070	14.129
1974	13.998	14.505	14.598	12.963	15.253	26.671	11.635	17.632
1975	17.928	17.139	17.655	18.348	22.113	#N/A	17.159	23.583
1976	20.191	20.069	18.311	16.607	20.536	#N/A	10.375	24.797
1977	19.695	20.462	17.380	14.936	20.748	24.102	13.636	20.639
1978	18.169	19.242	17.461	14.385	18.730	19.708	11.029	18.458
1979	19.213	21.812	20.240	17.215	20.412	23.721	10.943	21.304
1980	23.690	25.500	26.872	21.046	24.774	27.763	12.751	26.389
1981	25.651	25.936	26.115	22.103	26.035	30.264	13.589	25.639
1982	25.711	25.614	26.743	21.702	26.490	29.816	14.704	25.997
1983	23.587	25.235	25.672	19.806	23.898	26.964	13.070	27.170
1984	21.168	22.007	20.877	17.940	19.883	21.350	12.616	24.139
1985	20.454	22.653	22.319	21.317	20.674	25.870	11.487	25.824
1986	20.461	20.422	22.013	20.219	22.334	#N/A	12.345	25.340
1987	19.478	19.558	21.053	17.724	21.182	#N/A	11.985	29.317
1988	18.923	18.718	21.845	18.492	22.352	26.523	12.721	22.749
1989	23.262	22.282	26.532	21.215	24.709	25.987	14.016	20.589
1990	28.062	25.848	29.228	24.124	26.456	25.901	14.985	31.723
1991	26.986	28.483	33.435	23.543	30.260	29.474	16.136	28.669
1992	27.551	27.407	30.060	25.803	29.083	29.303	17.720	28.942
1993	23.880	25.509	26.998	21.821	25.111	30.328	24.819	24.408
1994	20.852	23.946	24.675	#N/A	21.732	22.936	13.427	25.025
1995	24.007	27.509	27.680	#N/A	25.171	30.195	15.055	29.093
1996	24.287	24.603	22.492	#N/A	24.492	31.175	15.742	51.219

Table V-15(a): ITALY - Imports by Origin (Metric tonnes)

Year	AUSTRALIA	BRAZIL	CANADA	INDIA	LIBERIA	MAURITANIA	VENEZUELA	ROW	WORLD
1962	0	607049	111400	434959	536423	0	637933	1487387	3815151
1963	0	757286	68873	562516	554691	236498	650576	2340724	5171164
1964	0	918975	31148	300187	644122	739553	764285	1587602	4985872
1965	0	1276614	278001	292525	1836580	1074861	814556	2095539	7668676
1966	0	1022018	1241496	66260	1618067	1236156	931541	1675228	7790766
1967	169299	943890	1472047	17260	2553927	1197137	1063598	2272505	9689663
1968	420004	1247810	1272469	52422	2153649	937500	967951	2813318	9865123
1969	733568	1255030	1185322	1049	2196715	1157240	1210901	3028187	10768012
1970	740390	1145539	1360886	16010	2816814	1131943	1111661	2367898	10691141
1971	1519147	1024857	1256893	35953	2780821	949828	1385169	2162987	11115655
1972	1315967	2076794	951022	657	4130227	1182164	1492978	2158042	13307851
1973	1779818	1932937	1942958	0	3764004	1192918	1525751	1884580	14022966
1974	2269188	3259516	1998170	0	3811716	1197882	1836329	3759840	18132641
1975	2083909	3093899	1991508	0	2830679	1313447	2160715	2117286	15591443
1976	2547920	3195522	2097989	199482	2879519	1133933	1997434	2881078	16932877
1977	1522423	3157019	1807063	0	3100200	1223497	1758250	2693001	15261453
1978	1533351	3790344	1496326	563538	3317584	1253091	1667769	2674444	16296447
1979	1196046	4005599	2731395	183743	3154935	1790842	1606037	2652016	17320613
1980	1793264	4989185	1790929	125692	3116336	1957997	1526460	1613082	16912945
1981	1045600	4683689	1679516	0	3224258	1738497	1472953	1255438	15099951
1982	1523487	4596868	1648183	338008	3416034	1822306	1832928	802018	15979832
1983	1825150	3542183	1070947	403362	3304933	2038139	928410	345675	13458799
1984	1835242	6746279	1634007	590462	3558625	2779064	1151870	948516	19244065
1985	2180642	5280492	1391205	1046516	3231085	2906541	989020	1268753	18294254
1986	1879039	5938934	1555945	960132	3322070	2252628	1060429	631418	17600595
1987	1665284	5221892	1600240	1023189	3701794	1594560	946953	768919	16522831
1988	1604871	5407521	1381034	908698	2778072	2211860	1003023	1118111	16413190
1989	1626444	5905126	1246328	968097	1950833	2293422	1058548	1639767	16688566
1990	1648018	6402731	1111622	1027497	1123594	2374984	1114073	2161423	16963942
1991	1928438	6887738	922676	1004635	61010	3170424	1662979	2040400	17678300
1992	4403112	12956588	1924212	859816	1152576	3077070	1477332	4109399	29960105
1993	3561528	12833708	1783080	2257115	0	4884036	2107832	5966633	33393932
1994	1911958	7161925	535955	1525746	0	2715815	950166	1601468	16403033
1995	1927718	7854139	975858	1216365	120850	3460644	994798	1755239	18305611
1996	1274147	8103970	1244136	630283	0	3069554	737465	988138	16047693

Table V-15(b): ITALY - Shares by Origin

Year	AUSTRALIA	BRAZIL	CANADA	INDIA	LIBERIA	MAURITANIA	VENEZUELA	ROW
1962	0.00%	15.91%	2.92%	11.40%	14.06%	0.00%	16.72%	38.99%
1963	0.00%	14.64%	1.33%	10.88%	10.73%	4.57%	12.58%	45.26%
1964	0.00%	18.43%	0.62%	6.02%	12.92%	14.83%	15.33%	31.84%
1965	0.00%	16.65%	3.63%	3.81%	23.95%	14.02%	10.62%	27.33%
1966	0.00%	13.12%	15.94%	0.85%	20.77%	15.87%	11.96%	21.50%
1967	1.75%	9.74%	15.19%	0.18%	26.36%	12.35%	10.98%	23.45%
1968	4.26%	12.65%	12.90%	0.53%	21.83%	9.50%	9.81%	28.52%
1969	6.81%	11.66%	11.01%	0.01%	20.40%	10.75%	11.25%	28.12%
1970	6.93%	10.71%	12.73%	0.15%	26.35%	10.59%	10.40%	22.15%
1971	13.67%	9.22%	11.31%	0.32%	25.02%	8.54%	12.46%	19.46%
1972	9.89%	15.61%	7.15%	0.00%	31.04%	8.88%	11.22%	16.22%
1973	12.69%	13.78%	13.86%	0.00%	26.84%	8.51%	10.88%	13.44%
1974	12.51%	17.98%	11.02%	0.00%	21.02%	6.61%	10.13%	20.74%
1975	13.37%	19.84%	12.77%	0.00%	18.16%	8.42%	13.86%	13.58%
1976	15.05%	18.87%	12.39%	1.18%	17.01%	6.70%	11.80%	17.01%
1977	9.98%	20.69%	11.84%	0.00%	20.31%	8.02%	11.52%	17.65%
1978	9.41%	23.26%	9.18%	3.46%	20.36%	7.69%	10.23%	16.41%
1979	6.91%	23.13%	15.77%	1.06%	18.21%	10.34%	9.27%	15.31%
1980	10.60%	29.50%	10.59%	0.74%	18.43%	11.58%	9.03%	9.54%
1981	6.92%	31.02%	11.12%	0.00%	21.35%	11.51%	9.75%	8.31%
1982	9.53%	28.77%	10.31%	2.12%	21.38%	11.40%	11.47%	5.02%
1983	13.56%	26.32%	7.96%	3.00%	24.56%	15.14%	6.90%	2.57%
1984	9.54%	35.06%	8.49%	3.07%	18.49%	14.44%	5.99%	4.93%
1985	11.92%	28.86%	7.60%	5.72%	17.66%	15.89%	5.41%	6.94%
1986	10.68%	33.74%	8.84%	5.46%	18.87%	12.80%	6.02%	3.59%
1987	10.08%	31.60%	9.69%	6.19%	22.40%	9.65%	5.73%	4.65%
1988	9.78%	32.95%	8.41%	5.54%	16.93%	13.48%	6.11%	6.81%
1989	9.75%	35.38%	7.47%	5.80%	11.69%	13.74%	6.34%	9.83%
1990	9.71%	37.74%	6.55%	6.06%	6.62%	14.00%	6.57%	12.74%
1991	10.91%	38.96%	5.22%	5.68%	0.35%	17.93%	9.41%	11.54%
1992	14.70%	43.25%	6.42%	2.87%	3.85%	10.27%	4.93%	13.72%
1993	10.67%	38.43%	5.34%	6.76%	0.00%	14.63%	6.31%	17.87%
1994	11.66%	43.66%	3.27%	9.30%	0.00%	16.56%	5.79%	9.76%
1995	10.53%	42.91%	5.33%	6.64%	0.66%	18.90%	5.43%	9.59%
1996	7.94%	50.50%	7.75%	3.93%	0.00%	19.13%	4.60%	6.16%

Table V-15(c): ITALY - Import Prices (US$/tonne)

Year	AUSTRALIA	BRAZIL	CANADA	INDIA	LIBERIA	MAURITANIA	VENEZUELA
1962	#N/A	12.442	8.806	#N/A	13.167	#N/A	12.360
1963	#N/A	12.739	8.900	#N/A	9.982	11.146	11.433
1964	#N/A	12.919	8.251	#N/A	9.706	10.327	10.093
1965	#N/A	11.639	7.838	#N/A	8.983	10.496	9.784
1966	#N/A	9.159	11.545	#N/A	8.991	10.619	9.901
1967	11.831	9.698	13.089	#N/A	8.889	9.927	9.131
1968	11.809	9.754	13.002	#N/A	9.224	9.986	8.892
1969	11.998	9.530	13.729	#N/A	8.526	9.862	8.261
1970	11.249	10.284	14.806	#N/A	10.151	11.071	8.772
1971	11.945	11.638	16.803	#N/A	11.166	12.260	9.966
1972	11.686	9.066	12.970	#N/A	11.235	12.398	9.539
1973	11.131	12.695	16.118	#N/A	13.148	12.008	9.606
1974	14.699	15.573	17.877	#N/A	15.665	14.118	14.977
1975	19.245	15.206	21.515	#N/A	19.400	19.932	20.633
1976	18.010	16.652	18.214	#N/A	20.337	19.524	18.282
1977	17.491	18.886	21.331	#N/A	20.529	17.781	17.244
1978	15.915	18.474	20.731	#N/A	17.886	16.847	16.187
1979	15.179	20.671	20.282	#N/A	22.610	19.836	15.800
1980	19.379	26.265	23.201	#N/A	26.782	21.860	20.181
1981	22.721	28.776	25.797	#N/A	25.213	22.212	23.734
1982	24.632	29.004	25.113	#N/A	24.995	22.050	24.012
1983	24.885	28.266	25.700	#N/A	25.993	21.763	22.320
1984	19.803	24.156	24.266	#N/A	24.793	18.894	20.918
1985	20.148	24.596	26.191	#N/A	23.427	19.771	20.244
1986	20.010	22.997	24.140	#N/A	23.481	18.945	25.855
1987	19.313	23.033	24.778	#N/A	23.151	17.712	18.273
1988	19.929	23.617	24.647	#N/A	23.562	16.805	18.615
1989	26.870	26.893	31.463	#N/A	35.825	23.458	26.689
1990	23.620	30.334	33.914	#N/A	29.096	24.665	25.779
1991	26.074	31.642	36.365	#N/A	21.964	25.814	26.599
1992	26.114	30.400	37.779	27.092	24.070	26.839	28.178
1993	23.013	26.996	32.695	20.469	#N/A	22.700	23.737
1994	21.166	25.504	28.064	19.506	#N/A	20.933	21.620
1995	23.956	29.195	42.189	20.167	19.876	23.095	23.557
1996	23.497	30.041	44.488	20.676	#N/A	22.721	23.551

Table V-16(a): UK - Imports by Origin (Metric tonnes)

Year	AUSTRALIA	BRAZIL	CANADA	MAURITANIA	SWEDEN	VENEZUELA	ROW	WORLD
1962	0	454765	1718705	0	4177647	1247075	4829205	12427397
1963	0	762965	2397448	209167	4706530	1240232	4528301	13844643
1964	0	546833	3323509	1409995	5680503	1714091	5469025	18143956
1965	14396	623996	3054753	1539295	6162125	1733044	5295839	18423448
1966	0	690651	2187615	1569794	4990338	1312595	5014605	15765598
1967	93343	752776	3131500	1657626	3647020	1390701	5427370	16100336
1968	267519	565043	3346521	1874996	4706154	1695413	5092912	17548558
1969	307953	1037782	2941714	1987925	3565598	1553068	6334997	17729037
1970	607423	1241052	4644272	1731384	1710453	1698515	7898239	19531338
1971	637292	1560103	4980160	1601963	2312455	1752413	4483096	17327482
1972	1265859	1957559	3762058	1719658	3948688	1555047	3058128	17266997
1973	1234550	2437061	5476000	2230583	4851187	1715511	4306331	22251223
1974	791789	3141192	4397969	1584088	4205331	1766735	4088789	19975893
1975	858040	2203733	3060940	1598143	2525417	1802642	3984150	16033065
1976	1305268	3185932	3820769	1447189	3399151	1005499	4626145	18789953
1977	986623	2956726	3193664	1141955	3199570	320349	3894198	15693085
1978	1721927	3573638	3122101	813604	1024722	776365	4521614	15553971
1979	1555943	4103106	6054378	875160	254788	1265002	3885556	17993933
1980	1101882	1587053	3684480	479288	346602	556066	990974	8746345
1981	1093326	1845464	5433586	460945	2037075	599861	3361129	14831386
1982	1498709	1903223	3816564	371323	437225	369286	2385369	10781699
1983	2513465	1640149	5267973	453876	816745	854544	1804097	13350849
1984	3098154	2325762	3532784	834241	771251	934898	2812093	14309183
1985	2929263	2278307	5458196	408029	424493	1327049	2724536	15549873
1986	2974565	2420964	5096067	156856	414091	982373	2761940	14806856
1987	3574011	3550498	6416826	414997	306567	776681	3156548	18196128
1988	4778861	2014412	5552289	414063	418383	943125	3714642	17835775
1989	4894421	3265726	5002608	678970	575338	1166006	3879983	19463052
1990	3276045	2391713	2943641	665644	588298	1071055	3999480	14935876
1991	2838329	2273296	2800570	874753	345227	512099	3948262	13592536
1992	10439008	5357976	5152878	1892724	571092	1891184	6399256	31704118
1993	11346604	4220952	5399214	1894692	224760	2019536	6748149	31853907
1994	9519061	3331810	4709696	1453685	144385	1896611	5284240	26339489
1995	7691519	2442669	4020178	1012678	64010	1773686	3820332	20825072
1996	7692669	2341585	4403647	853863	77170	1520924	3418034	20307892

Table V-16(b): UK - Shares by Origin

Year	AUSTRALIA	BRAZIL	CANADA	MAURITANIA	SWEDEN	VENEZUELA	ROW
1962	0.00%	3.66%	13.83%	0.00%	33.62%	10.03%	38.86%
1963	0.00%	5.51%	17.32%	1.51%	34.00%	8.96%	32.71%
1964	0.00%	3.01%	18.32%	7.77%	31.31%	9.45%	30.14%
1965	0.08%	3.39%	16.58%	8.36%	33.45%	9.41%	28.75%
1966	0.00%	4.38%	13.88%	9.96%	31.65%	8.33%	31.81%
1967	0.58%	4.68%	19.45%	10.30%	22.65%	8.64%	33.71%
1968	1.52%	3.22%	19.07%	10.68%	26.82%	9.66%	29.02%
1969	1.74%	5.85%	16.59%	11.21%	20.11%	8.76%	35.73%
1970	3.11%	6.35%	23.78%	8.86%	8.76%	8.70%	40.44%
1971	3.68%	9.00%	28.74%	9.25%	13.35%	10.11%	25.87%
1972	7.33%	11.34%	21.79%	9.96%	22.87%	9.01%	17.71%
1973	5.55%	10.95%	24.61%	10.02%	21.80%	7.71%	19.35%
1974	3.96%	15.72%	22.02%	7.93%	21.05%	8.84%	20.47%
1975	5.35%	13.74%	19.09%	9.97%	15.75%	11.24%	24.85%
1976	6.95%	16.96%	20.33%	7.70%	18.09%	5.35%	24.62%
1977	6.29%	18.84%	20.35%	7.28%	20.39%	2.04%	24.81%
1978	11.07%	22.98%	20.07%	5.23%	6.59%	4.99%	29.07%
1979	8.65%	22.80%	33.65%	4.86%	1.42%	7.03%	21.59%
1980	12.60%	18.15%	42.13%	5.48%	3.96%	6.36%	11.33%
1981	7.37%	12.44%	36.64%	3.11%	13.73%	4.04%	22.66%
1982	13.90%	17.65%	35.40%	3.44%	4.06%	3.43%	22.12%
1983	18.83%	12.28%	39.46%	3.40%	6.12%	6.40%	13.51%
1984	21.65%	16.25%	24.69%	5.83%	5.39%	6.53%	19.65%
1985	18.84%	14.65%	35.10%	2.62%	2.73%	8.53%	17.52%
1986	20.09%	16.35%	34.42%	1.06%	2.80%	6.63%	18.65%
1987	19.64%	19.51%	35.26%	2.28%	1.68%	4.27%	17.35%
1988	26.79%	11.29%	31.13%	2.32%	2.35%	5.29%	20.83%
1989	25.15%	16.78%	25.70%	3.49%	2.96%	5.99%	19.94%
1990	21.93%	16.01%	19.71%	4.46%	3.94%	7.17%	26.78%
1991	20.88%	16.72%	20.60%	6.44%	2.54%	3.77%	29.05%
1992	32.93%	16.90%	16.25%	5.97%	1.80%	5.97%	20.18%
1993	35.62%	13.25%	16.95%	5.95%	0.71%	6.34%	21.18%
1994	36.14%	12.65%	17.88%	5.52%	0.55%	7.20%	20.06%
1995	36.93%	11.73%	19.30%	4.86%	0.31%	8.52%	18.34%
1996	37.88%	11.53%	21.68%	4.20%	0.38%	7.49%	16.83%

Table V-16(c): UK - Import Prices (US$/tonne)

Year	AUSTRALIA	BRAZIL	CANADA	MAURITANIA	SWEDEN	VENEZUELA
1962	#N/A	16.677	13.895	#N/A	13.792	15.167
1963	#N/A	15.089	13.942	11.355	12.345	14.074
1964	#N/A	14.906	14.660	11.584	12.094	13.243
1965	13.337	13.335	14.994	11.996	12.154	13.831
1966	#N/A	13.186	13.889	11.683	12.539	13.338
1967	13.381	11.760	14.408	11.519	11.908	11.829
1968	13.184	11.896	14.355	11.450	10.702	11.040
1969	14.200	11.435	14.145	11.259	10.580	11.153
1970	13.319	14.917	14.055	11.880	12.371	11.159
1971	13.575	17.225	15.947	14.520	15.323	14.040
1972	12.776	16.748	16.086	16.082	16.326	11.894
1973	15.848	16.701	16.172	15.492	17.538	12.576
1974	17.809	19.013	19.705	17.440	21.008	19.179
1975	18.781	22.339	20.599	20.092	28.478	24.085
1976	22.618	20.459	19.705	18.383	30.694	21.567
1977	19.740	24.295	21.406	17.872	28.650	22.444
1978	16.437	21.837	22.567	17.126	22.120	19.921
1979	19.286	25.309	31.745	15.930	19.067	21.111
1980	23.524	29.513	38.371	20.205	34.178	26.925
1981	20.106	23.508	30.422	19.840	12.839	21.973
1982	19.297	22.787	34.146	21.146	25.582	23.380
1983	20.209	21.839	33.122	19.153	18.182	21.010
1984	18.622	21.155	24.237	15.679	16.382	18.742
1985	20.181	24.290	27.717	18.883	16.436	21.662
1986	20.641	23.860	25.628	17.851	20.056	20.253
1987	19.803	22.940	27.302	17.812	23.202	19.556
1988	23.143	27.655	30.272	17.333	20.990	21.303
1989	21.578	23.723	30.594	31.446	19.524	20.661
1990	42.777	43.599	42.355	37.601	25.203	32.227
1991	39.826	41.203	40.395	29.430	27.347	48.830
1992	29.381	35.220	32.137	22.690	34.723	28.415
1993	27.066	32.328	26.352	24.305	37.022	25.528
1994	16.969	14.849	16.963	9.262	31.430	16.938
1995	23.289	22.615	21.029	21.089	48.617	20.066
1996	24.107	23.575	26.294	20.995	51.587	21.694

Table V-17(a): NETHERLANDS - Imports by Origin (Met. tonnes)

Year	AUSTRALIA	BRAZIL	CANADA	NORWAY	SWEDEN	VENEZUELA	ROW	WORLD
1962	0	59701	119153	16839	742817	0	566400	1504910
1963	0	19779	59297	3355	673707	0	962430	1718568
1964	0	204445	91012	5836	696431	34541	1230609	2262874
1965	0	264208	337427	6980	561227	52218	1571537	2793597
1966	0	144793	530901	2672	303841	0	1557136	2539343
1967	0	937680	618986	1929	68712	0	1074972	2702279
1968	0	708770	429285	403683	498553	0	1397194	3437485
1969	159883	514963	1010060	523529	561621	0	1610353	4380409
1970	172903	298524	1519842	452942	609268	0	1669674	4723153
1971	74382	593152	1180809	666947	944881	0	1892725	5352896
1972	0	1064291	454169	697418	883735	0	1903804	5003417
1973	220346	1219042	169022	365211	1571244	0	2793800	6338665
1974	0	1613114	599599	0	1855558	197468	2201630	6467369
1975	687531	1769293	929575	0	1536597	323767	2009604	7256367
1976	539084	1672194	1183829	0	1710592	57767	1369315	6532781
1977	601035	1110322	2134658	0	1492211	0	1583168	6921394
1978	539801	1767547	773308	15318	721861	0	1759999	5577834
1979	409112	2391113	1180241	0	1711449	0	1651523	7343438
1980	416492	2565478	1194626	0	1899768	195785	1313487	7585636
1981	326024	2181056	856238	0	1684767	135303	1476211	6659599
1982	461621	1381497	1171992	101223	1566234	174201	1304133	6160901
1983	199339	1106276	592477	396650	889671	116206	1679273	4979892
1984	542197	2355162	733476	90527	1450954	389916	1676470	7238702
1985	1379515	2012813	1485005	0	1543192	387273	1700392	8508190
1986	1025548	1999966	859292	111600	1342968	285256	1441874	7066504
1987	1032806	2741249	686908	1194072	366396	129001	898934	7049366
1988	1531535	2521454	720449	1085797	377898	186047	1140520	7563700
1989	1366137	2379213	811588	1212458	301608	461217	1634519	8166740
1990	1394960	2443248	829464	1461013	0	426998	1757698	8313439
1991	1656203	2327277	800268	1456161	0	431517	1233041	7904490
1992	2754710	4930056	1124224	3150928	0	1211356	1892970	15064284
1993	1956628	5737814	1070862	4312956	0	1162944	2883062	17124266
1994	1383929	2812267	965172	2068495	0	615131	723163	8568204
1995	1248734	3203102	770548	1589567	12702	1133359	793192	8751204
1996	937830	2878451	623236	1832090	295165	1080128	911155	8558055

Table V-17(b): NETHERLANDS - Shares by Origin

Year	AUSTRALIA	BRAZIL	CANADA	NORWAY	SWEDEN	VENEZUELA	ROW
1962	0.00%	3.97%	7.92%	1.12%	49.36%	0.00%	37.64%
1963	0.00%	1.15%	3.45%	0.20%	39.20%	0.00%	56.00%
1964	0.00%	9.03%	4.02%	0.26%	30.78%	1.53%	54.38%
1965	0.00%	9.46%	12.08%	0.25%	20.09%	1.87%	56.25%
1966	0.00%	5.70%	20.91%	0.11%	11.97%	0.00%	61.32%
1967	0.00%	34.70%	22.91%	0.07%	2.54%	0.00%	39.78%
1968	0.00%	20.62%	12.49%	11.74%	14.50%	0.00%	40.65%
1969	3.65%	11.76%	23.06%	11.95%	12.82%	0.00%	36.76%
1970	3.66%	6.32%	32.18%	9.59%	12.90%	0.00%	35.35%
1971	1.39%	11.08%	22.06%	12.46%	17.65%	0.00%	35.36%
1972	0.00%	21.27%	9.08%	13.94%	17.66%	0.00%	38.05%
1973	3.48%	19.23%	2.67%	5.76%	24.79%	0.00%	44.08%
1974	0.00%	24.94%	9.27%	0.00%	28.69%	3.05%	34.04%
1975	9.47%	24.38%	12.81%	0.00%	21.18%	4.46%	27.69%
1976	8.25%	25.60%	18.12%	0.00%	26.18%	0.88%	20.96%
1977	8.68%	16.04%	30.84%	0.00%	21.56%	0.00%	22.87%
1978	9.68%	31.69%	13.86%	0.27%	12.94%	0.00%	31.55%
1979	5.57%	32.56%	16.07%	0.00%	23.31%	0.00%	22.49%
1980	5.49%	33.82%	15.75%	0.00%	25.04%	2.58%	17.32%
1981	4.90%	32.75%	12.86%	0.00%	25.30%	2.03%	22.17%
1982	7.49%	22.42%	19.02%	1.64%	25.42%	2.83%	21.17%
1983	4.00%	22.21%	11.90%	7.97%	17.87%	2.33%	33.72%
1984	7.49%	32.54%	10.13%	1.25%	20.04%	5.39%	23.16%
1985	16.21%	23.66%	17.45%	0.00%	18.14%	4.55%	19.99%
1986	14.51%	28.30%	12.16%	1.58%	19.00%	4.04%	20.40%
1987	14.65%	38.89%	9.74%	16.94%	5.20%	1.83%	12.75%
1988	20.25%	33.34%	9.53%	14.36%	5.00%	2.46%	15.08%
1989	16.73%	29.13%	9.94%	14.85%	3.69%	5.65%	20.01%
1990	16.78%	29.39%	9.98%	17.57%	0.00%	5.14%	21.14%
1991	20.95%	29.44%	10.12%	18.42%	0.00%	5.46%	15.60%
1992	18.29%	32.73%	7.46%	20.92%	0.00%	8.04%	12.57%
1993	11.43%	33.51%	6.25%	25.19%	0.00%	6.79%	16.84%
1994	16.15%	32.82%	11.26%	24.14%	0.00%	7.18%	8.44%
1995	14.27%	36.60%	8.81%	18.16%	0.15%	12.95%	9.06%
1996	10.96%	33.63%	7.28%	21.41%	3.45%	12.62%	10.65%

Table V-17(c): NETHERLANDS - Import Prices (US$/tonne)

Year	AUSTRALIA	BRAZIL	CANADA	NORWAY	SWEDEN	VENEZUELA
1962	#N/A	16.918	8.242	12.352	11.961	#N/A
1963	#N/A	12.791	8.162	13.115	10.515	#N/A
1964	#N/A	11.539	9.746	11.480	10.545	10.278
1965	#N/A	12.626	11.603	10.602	10.917	10.494
1966	#N/A	11.679	9.821	9.731	11.223	#N/A
1967	#N/A	9.179	8.402	9.331	11.177	#N/A
1968	#N/A	11.256	9.476	10.934	9.259	#N/A
1969	8.719	10.972	14.051	10.542	9.417	#N/A
1970	8.091	9.688	12.113	10.271	11.204	#N/A
1971	8.268	9.841	9.904	10.893	10.463	#N/A
1972	#N/A	9.942	9.228	11.264	10.840	#N/A
1973	9.880	12.849	11.111	12.730	12.969	#N/A
1974	#N/A	16.122	18.306	#N/A	15.226	11.597
1975	15.082	16.656	20.862	#N/A	19.912	19.811
1976	13.621	19.037	21.367	#N/A	20.569	24.512
1977	13.831	20.255	24.334	#N/A	19.631	#N/A
1978	14.185	17.716	27.461	24.481	18.096	#N/A
1979	14.852	20.182	27.817	#N/A	19.201	#N/A
1980	20.944	25.479	26.710	#N/A	24.060	23.725
1981	22.290	26.768	27.305	#N/A	25.543	33.887
1982	15.775	24.584	25.227	26.368	27.924	25.195
1983	15.998	20.045	22.921	25.325	21.934	28.019
1984	15.847	19.054	21.803	21.949	21.115	19.466
1985	15.869	20.247	22.554	#N/A	23.384	19.779
1986	18.057	22.009	26.490	20.027	24.133	19.681
1987	15.704	21.770	23.016	25.542	22.315	19.775
1988	13.393	19.587	23.205	24.308	22.024	23.446
1989	12.433	18.064	20.558	21.560	19.665	20.288
1990	16.241	21.549	25.717	25.100	#N/A	23.637
1991	18.679	19.774	25.362	24.492	#N/A	24.129
1992	18.983	23.067	25.901	24.562	#N/A	26.380
1993	16.340	20.175	22.114	24.457	#N/A	22.009
1994	17.231	19.449	24.217	23.199	#N/A	22.707
1995	19.363	20.064	24.734	25.170	54.716	22.602
1996	16.040	20.487	24.641	24.879	23.682	20.320

Table V-18(a): USA - Imports by Origin (Metric tonnes)

Year	BRAZIL	CANADA	CHILE	VENEZUELA	ROW	WORLD
1963	793734	19197954	2722374	9378996	1707099	33800157
1964	1071650	25261698	2755667	10113419	3891192	43093626
1965	2315452	24138592	2702852	12470018	4081650	45708564
1966	2766465	24318970	2304219	12793780	4793194	46976628
1967	1665872	24645954	1387061	13025220	4661706	45385813
1968	1277180	26761182	1464268	10478111	4664840	44645581
1969	1252489	19283936	1811462	13971910	4975776	41295573
1970	2023392	24317399	1606225	13234459	4275688	45457163
1971	1801237	20668408	891956	13161367	4244929	40767897
1972	1132341	18459726	312789	11101395	5327651	36333902
1973	3267622	21974760	207887	13322981	5174884	43948134
1974	6677498	20018340	300888	15624606	5761365	48382697
1975	7638355	19418160	946261	13347446	5804444	47154666
1976	5474584	25362234	617428	9145752	4501819	45101817
1977	2229692	25688837	575030	6277857	3692539	38463955
1978	4043126	19544593	396735	6180475	3990720	34155649
1979	3139058	23031274	249414	4637103	3255462	34312311
1980	2027462	17589099	326728	3660252	1856767	25460308
1981	1771916	19147381	347734	5151873	2369770	28788674
1982	987875	9431296	47993	1848640	2598369	14914173
1983	1296471	8973584	0	1437036	1834672	13541763
1984	2582469	11339931	0	1613259	1899680	17435339
1985	2580455	8693874	166612	2289906	2435116	16165963
1986	3752512	8789750	94561	2386460	1924083	16947366
1987	3698082	7952031	581461	2639892	1996093	16867559
1988	4836055	9155456	138907	3568487	2416947	20115852
1989	5168955	8537959	60796	4232015	1597595	19597320
1990	4275578	9371338	138346	3502946	793419	18081627
1991	2480248	7336602	102570	2762155	670956	13352531
1992	2442320	6833624	107356	2540097	580751	12504148
1993	2872063	7329011	67532	3189335	526491	13984432
1994	3609745	10073221	134465	2874066	870069	17561566
1995	4814005	9047852	56502	2466124	1136466	17520949
1996	5172538	9800179	163980	2139613	1115628	18391938

Table V-18(b): USA - Shares by Origin

Year	BRAZIL	CANADA	CHILE	VENEZUELA	ROW
1963	2.35%	56.80%	8.05%	27.75%	5.05%
1964	2.49%	58.62%	6.39%	23.47%	9.03%
1965	5.07%	52.81%	5.91%	27.28%	8.93%
1966	5.89%	51.77%	4.91%	27.23%	10.20%
1967	3.67%	54.30%	3.06%	28.70%	10.27%
1968	2.86%	59.94%	3.28%	23.47%	10.45%
1969	3.03%	46.70%	4.39%	33.83%	12.05%
1970	4.45%	53.50%	3.53%	29.11%	9.41%
1971	4.42%	50.70%	2.19%	32.28%	10.41%
1972	3.12%	50.81%	0.86%	30.55%	14.66%
1973	7.44%	50.00%	0.47%	30.32%	11.77%
1974	13.80%	41.37%	0.62%	32.29%	11.91%
1975	16.20%	41.18%	2.01%	28.31%	12.31%
1976	12.14%	56.23%	1.37%	20.28%	9.98%
1977	5.80%	66.79%	1.49%	16.32%	9.60%
1978	11.84%	57.22%	1.16%	18.10%	11.68%
1979	9.15%	67.12%	0.73%	13.51%	9.49%
1980	7.96%	69.08%	1.28%	14.38%	7.29%
1981	6.15%	66.51%	1.21%	17.90%	8.23%
1982	6.62%	63.24%	0.32%	12.40%	17.42%
1983	9.57%	66.27%	0.00%	10.61%	13.55%
1984	14.81%	65.04%	0.00%	9.25%	10.90%
1985	15.96%	53.78%	1.03%	14.16%	15.06%
1986	22.14%	51.86%	0.56%	14.08%	11.35%
1987	21.92%	47.14%	3.45%	15.65%	11.83%
1988	24.04%	45.51%	0.69%	17.74%	12.02%
1989	26.38%	43.57%	0.31%	21.59%	8.15%
1990	23.65%	51.83%	0.77%	19.37%	4.39%
1991	18.58%	54.95%	0.77%	20.69%	5.02%
1992	19.53%	54.65%	0.86%	20.31%	4.64%
1993	20.54%	52.41%	0.48%	22.81%	3.76%
1994	20.55%	57.36%	0.77%	16.37%	4.95%
1995	27.48%	51.64%	0.32%	14.08%	6.49%
1996	28.12%	53.29%	0.89%	11.63%	6.07%

Table V-18(c): USA - Import Prices (US$/tonne)

Year	BRAZIL	CANADA	CHILE	VENEZUELA
1963	9.740	10.390	9.305	8.203
1964	10.880	10.870	8.789	7.832
1965	10.097	10.953	8.603	7.853
1966	9.649	11.235	8.597	7.976
1967	8.947	11.238	8.137	7.963
1968	9.100	11.510	7.864	7.936
1969	9.022	11.375	7.933	7.926
1970	8.829	12.222	7.972	8.198
1971	9.186	12.939	8.018	8.675
1972	10.589	13.421	9.198	9.003
1973	11.217	14.193	8.235	9.594
1974	12.768	17.063	9.582	12.108
1975	15.816	21.635	12.863	15.381
1976	20.421	24.666	12.895	16.580
1977	23.435	26.992	14.514	18.968
1978	29.114	32.079	17.785	22.347
1979	32.490	33.658	23.792	23.976
1980	39.104	38.249	36.902	27.680
1981	40.146	42.636	26.851	32.940
1982	35.619	44.001	20.107	38.600
1983	29.447	43.528	#N/A	41.376
1984	28.254	41.350	#N/A	29.304
1985	25.401	42.574	19.656	29.423
1986	24.831	39.166	34.930	24.635
1987	22.871	34.460	21.725	23.174
1988	20.518	34.887	24.844	25.043
1989	22.628	38.447	21.547	29.720
1990	26.992	40.679	24.330	35.297
1991	28.327	40.805	24.539	36.579
1992	28.198	39.290	26.612	35.299
1993	27.384	36.103	27.291	34.242
1994	25.835	35.354	28.111	39.609
1995	26.780	35.595	27.716	37.449
1996	29.754	37.204	31.766	39.389

Table V-19(a): S. KOREA - Imports by Origin (Met. tonnes)

Year	AUSTRALIA	BRAZIL	CANADA	CHILE	INDIA	PERU	ROW	WORLD
1973	205311	0	0	0	241057	0	21200	467568
1974	768107	0	0	0	411936	174678	40070	1394791
1975	608687	0	0	0	609988	244626	30405	1493706
1976	936355	95556	0	0	737481	141370	237021	2147783
1977	1992253	204183	0	0	948374	499033	78578	3722421
1978	1678278	104064	50599	0	987554	445855	356695	3623045
1979	3192340	599145	10604	0	2025562	1347590	341857	7517098
1980	3882786	1166019	0	0	2160238	1680304	252146	9141493
1981	3973512	1599986	0	0	2605894	2057718	361588	10598698
1982	4233561	2248801	0	0	2807481	1971194	248903	11509940
1983	3949272	2195252	0	0	2512854	1463782	49394	10170554
1984	4464534	2000405	107173	0	2137072	1578208	104	10287496
1985	4751803	2859786	0	0	3201931	1604724	0	12418244
1986	4512602	2295348	130440	0	2581869	2057305	363643	11941207
1987	6527407	4884392	133565	0	3578078	2624981	272511	18020934
1988	7502675	5524945	374798	33148	3742717	2538529	136260	19853072
1989	8477943	6165499	616032	66297	3907356	2452077	10	21685214
1990	8223856	6547265	612949	550451	3289801	1771744	163541	21159607
1991	12878589	8246363	1009611	970455	3782761	1686802	374684	28949265
1992	30420770	15540894	1897544	2005364	4120940	3908152	5673745	63567409
1993	17364164	9430951	916838	703227	4799416	1544162	790359	35549117
1994	18538481	8112450	1093858	995547	3695714	977540	836419	34250009
1995	18997122	8481426	527121	1567473	3228660	1208821	1064669	35075292
1996	17088745	9659545	939056	1983042	3580931	561257	1011388	34823964

Table V-19(b): S.KOREA - Shares by Origin

Year	AUSTRALIA	BRAZIL	CANADA	CHILE	INDIA	PERU	ROW
1973	43.91%	0.00%	0.00%	0.00%	51.56%	0.00%	4.53%
1974	55.07%	0.00%	0.00%	0.00%	29.53%	12.52%	2.87%
1975	40.75%	0.00%	0.00%	0.00%	40.84%	16.38%	2.04%
1976	43.60%	4.45%	0.00%	0.00%	34.34%	6.58%	11.04%
1977	53.52%	5.49%	0.00%	0.00%	25.48%	13.41%	2.11%
1978	46.32%	2.87%	1.40%	0.00%	27.26%	12.31%	9.85%
1979	42.47%	7.97%	0.14%	0.00%	26.95%	17.93%	4.55%
1980	42.47%	12.76%	0.00%	0.00%	23.63%	18.38%	2.76%
1981	37.49%	15.10%	0.00%	0.00%	24.59%	19.41%	3.41%
1982	36.78%	19.54%	0.00%	0.00%	24.39%	17.13%	2.16%
1983	38.83%	21.58%	0.00%	0.00%	24.71%	14.39%	0.49%
1984	43.40%	19.45%	1.04%	0.00%	20.77%	15.34%	0.00%
1985	38.26%	23.03%	0.00%	0.00%	25.78%	12.92%	0.00%
1986	37.79%	19.22%	1.09%	0.00%	21.62%	17.23%	3.05%
1987	36.22%	27.10%	0.74%	0.00%	19.86%	14.57%	1.51%
1988	37.79%	27.83%	1.89%	0.17%	18.85%	12.79%	0.69%
1989	39.10%	28.43%	2.84%	0.31%	18.02%	11.31%	0.00%
1990	38.87%	30.94%	2.90%	2.60%	15.55%	8.37%	0.77%
1991	44.49%	28.49%	3.49%	3.35%	13.07%	5.83%	1.29%
1992	47.86%	24.45%	2.99%	3.15%	6.48%	6.15%	8.93%
1993	48.85%	26.53%	2.58%	1.98%	13.50%	4.34%	2.22%
1994	54.13%	23.69%	3.19%	2.91%	10.79%	2.85%	2.44%
1995	54.16%	24.18%	1.50%	4.47%	9.20%	3.45%	3.04%
1996	49.07%	27.74%	2.70%	5.69%	10.28%	1.61%	2.90%

Table V-19(c): S.KOREA - Import Prices (US$/tonne)

Year	AUSTRALIA	BRAZIL	CANADA	CHILE	INDIA	PERU
1973	14.237	#N/A	#N/A	#N/A	#N/A	#N/A
1974	14.775	#N/A	#N/A	#N/A	#N/A	21.491
1975	15.162	#N/A	#N/A	#N/A	#N/A	19.843
1976	15.642	14.295	#N/A	#N/A	#N/A	19.523
1977	14.431	18.958	#N/A	#N/A	#N/A	15.588
1978	15.957	17.701	13.143	#N/A	#N/A	13.287
1979	16.010	17.542	43.003	#N/A	#N/A	15.891
1980	18.768	19.481	#N/A	#N/A	#N/A	18.216
1981	21.566	21.242	#N/A	#N/A	#N/A	22.570
1982	24.052	23.012	#N/A	#N/A	#N/A	28.567
1983	25.417	24.995	#N/A	#N/A	#N/A	24.744
1984	26.964	30.141	25.893	#N/A	#N/A	25.644
1985	25.263	26.932	#N/A	#N/A	#N/A	24.492
1986	24.683	25.709	23.321	#N/A	#N/A	23.973
1987	22.131	21.599	21.765	#N/A	#N/A	21.205
1988	21.693	20.281	35.987	25.703	#N/A	24.966
1989	22.259	23.369	23.765	29.187	#N/A	22.946
1990	25.356	28.001	26.707	29.187	#N/A	25.518
1991	27.468	29.735	31.197	33.914	#N/A	28.962
1992	26.686	29.764	29.581	31.082	26.503	26.792
1993	23.899	26.685	26.707	28.142	24.251	24.828
1994	21.817	25.487	25.637	26.465	22.885	25.977
1995	22.554	26.752	27.003	29.802	22.805	25.984
1996	23.868	28.770	32.700	33.421	24.929	28.630

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