LONG TERM METAL PRICES
and factors affecting them

For Alaska-Canada Rail Link
by Raw Materials Group
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REVIEW OF LONG TERM PRICES AND FACTORS AFFECTING THEM FOR IRON ORE, COAL AND BASE METALS.

Introduction

Alaska-Canada Rail Link, Inc. (ACRL) is analysing the possibility to construct a railway that would traverse Alaska, Yukon and British Columbia. The railway could become an affordable transportation corridor for a number of potentially mineable deposits in the corridor region to Pacific tidewaters. This railway would make it possible to export mineral concentrates and coal and hence facilitate exploitation of the deposits and support economic development in the regions affected.

Raw Materials Group (RMG) has been requested to provide a second opinion and undertake a study to discuss long term prices for iron ore, coal and base metals and also factors affecting price levels and how will these relate to the proposed railway. Due to time constraints the study is based, to a large extent, on information currently available to RMG since there is no time or budget to start researching the basic figures.

All units in this report are metric and hence a ton refers to a metric ton which is equal to 0.98415 long ton or 1.1023 short ton.

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Outline

This report is divided into three major parts:

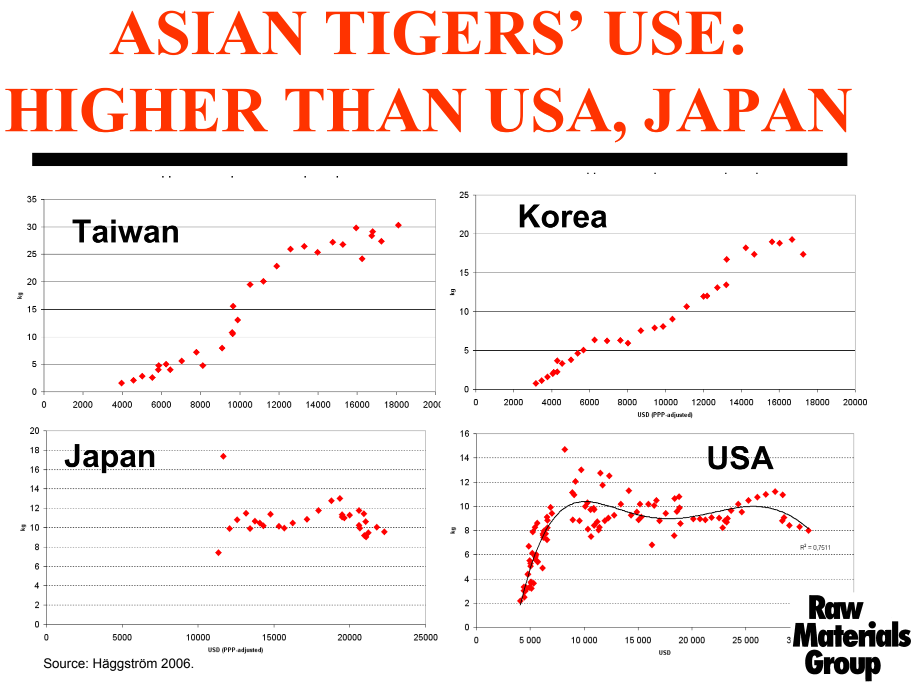
- A qualitative discussion of the demand and supply forces shaping long term metal demand.
- A quantitative model based on the first section and described in detail in the appendix.
- Finally the results of the first two sections are discussed and conclusions combining the results are drawn.

Global supply and demand

Demand

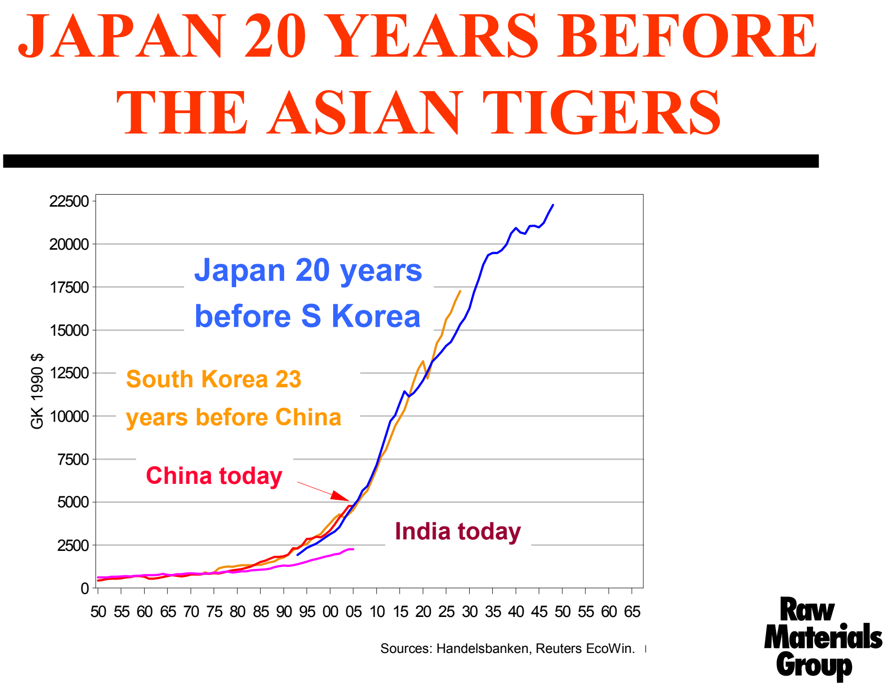
Demand for metals has over the 20th century been closely related to economic development and in particular to industrial growth and investments into infrastructure. Figure 1 gives examples of demand for zinc in four countries, the US, Japan, South Korea and Taiwan over long periods of time since 1900. The demand for metals is increasing dramatically within a fairly narrow band of GDP/capita, when industry and infrastructure is built for a modern economy. At a later stage in economic development the curve flattens but it does not go down to zero again but there is a continued demand for metals even at higher development levels. At what level metal demand stabilizes depends on the economic structure of the specific country. In the case of South Korea for example the metals intensity is higher than in the US because of the more important role played by industry in South Korea compared to the US.

Figure 1.
GDP vs metal use in four countries over a long time period.



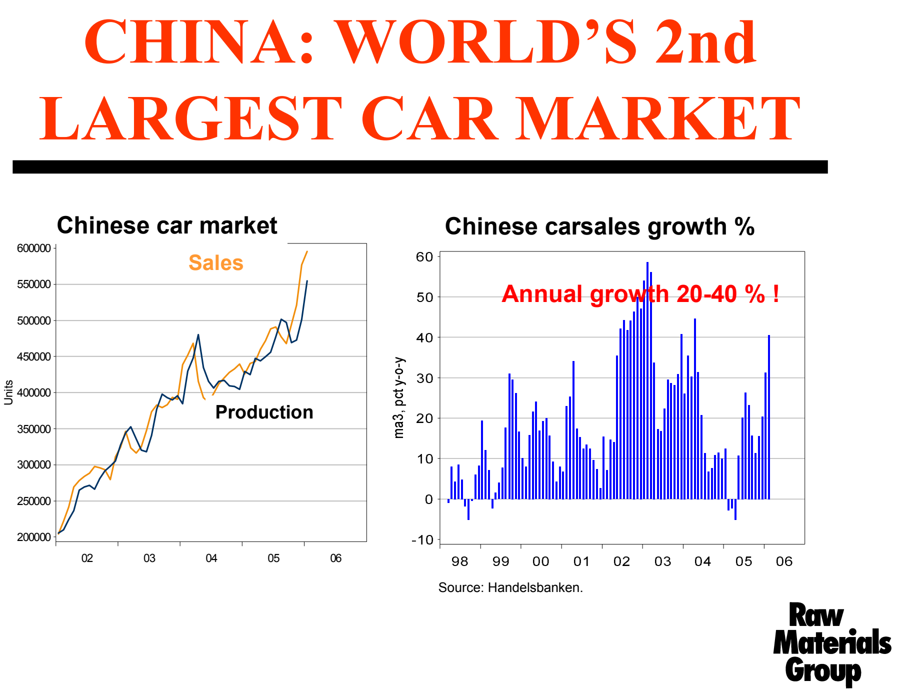
Economic growth globally has been dominated by China in recent years. Chinese development has followed more or less the same economic growth trajectory as did Japan and South Korea 45 and 25 years before China. See figure 2 below. The likelihood that China will follow more or less the same curve can of course be debated but in the absence of a better model it can serve as starting point for a forward looking discussion. Empirical data for the last two decades seems to support the hypothesis that in the present economic growth phase China will continue to demand more metals and to become an important factor in global metals demand. Since 1990 Chinese metal demand has grown on average by 10 % per annum and in the last five years the growth accelerated to over 15 % per annum. In 2005/2006 China has become the single most important user of practically all metals. China has accounted for over 70 % of total global demand growth for metals in recent years.

Figure 2.
Economic growth in Japan, South Korea, Taiwan, China and India



A large part of this phenomenal demand growth has been driven by infrastructure investments: Motorways, railroads, ports, power stations, dams, expansion of the electric grid, houses for a growing population etc and also industrial investments new factories and plants of all types. But one anecdotal evidence of this is the recently announced push to up grade the Chinese railway grid. A US$ 150 billion push to speed up and increase traffic and remove bottlenecks will demand 2 million tons of steel for the rail and another 1-2 million tons for wagons and engines. But it is also important to note that personal demand for metal containing goods increases when standard of living increases. Items such as white goods, washing machines, AC units, refrigerators and not least cars contain considerable volume of metals. Above a level of annual income of roughly US$ 5000 per family the basic demands for housing, clothing and food are covered. In Asia alone, outside Japan, demographic projections estimate that between 250 and 750 million families will pass this level of income in the period between 2000 and 2020. A random example from last week’s daily press is the announcement of the continued high increase of sales of passenger cars in China, in recent years the annual average growth has been between 20-40 % and China has moved up to second place in the world bypassing Japan and lagging only the US in car sales. Figure 3.

Figure 3.
Car sales in China



It is certain that Chinese demand for metals will slow down the question is only when? But even when this happens global demand for metals is not likely to collapse. Firstly even if Chinese demand growth is reduced from the present extremely high levels it is not likely to drop down to zero. Secondly other Asian countries such as India with a large population and an expanding economy and also growing metals demand will be ready to take over. And behind China and India are another billion of people in other poor countries demanding their right to a higher standard of living. Thirdly the demand for metals in developed economies in North America, Europe and Japan is not dropping down as much as expected in the 1980s and 1990s. The use of heavy SUV cars, ever increasing housing demands, and even new high tech IT consumer products that use metals are but a few evidences of this. Figures 4 and 5 give a few examples of the metal content of white goods and cars and it is obvious that steel content is going down but non-ferrous metals are not dropping but increasing depending on for example copper in the many small electric motors driving windows etc.

Figure 4.
Metal use in white goods over time

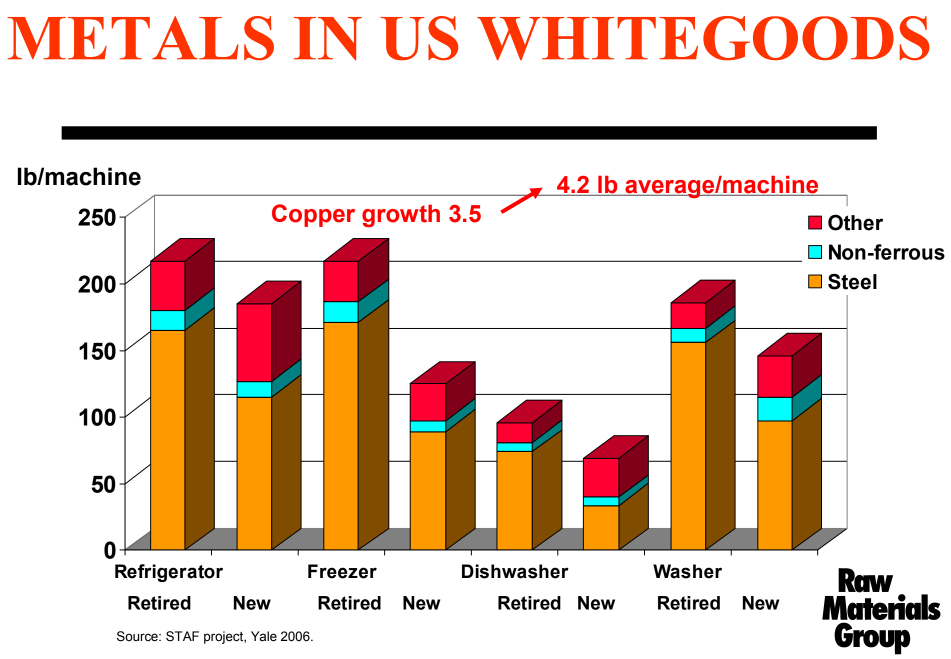
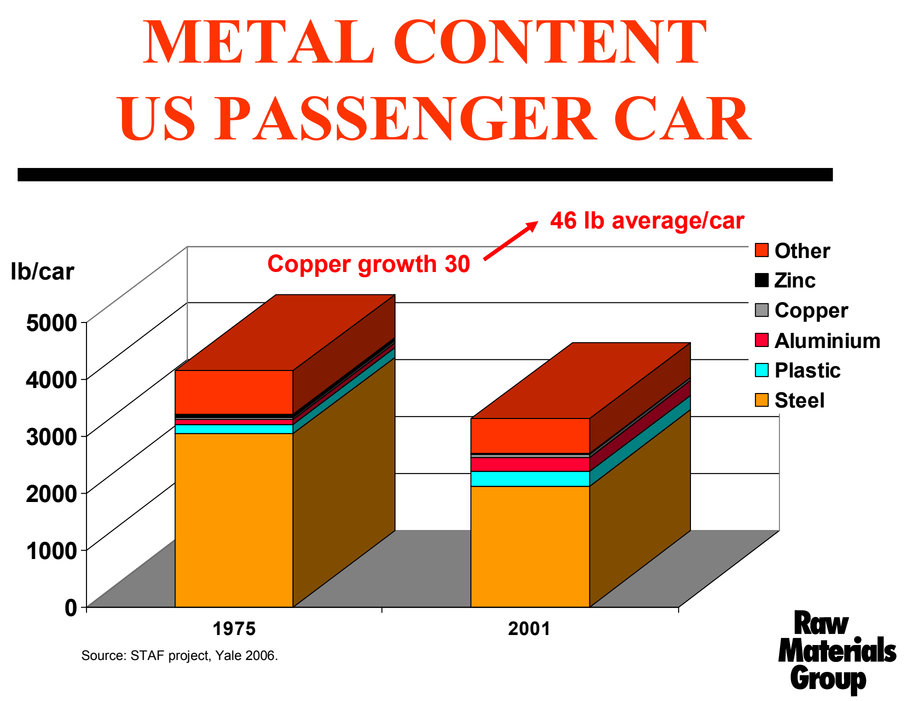


Figure 5.
Metal use in passenger cars over time



Supply

China's ever growing appetite for metals has partly been covered by increased metal production from domestic ores. China is among the top mining countries of the world and is increasing its production fast, it is already the largest mine producer of iron ore, coal and zinc as well as a number of economically less important but nevertheless technically and strategically important metals such as tungsten and rare earths. But the bulk of the additional demand has to be covered by imports. This import dependence is increasing for most metals such as iron ore and zinc in spite of the quick growth of Chinese production. Given the fairly poor grades and small size of many of the deposits that are mined in China it is also often less costly to import high quality ores from overseas. The average iron ore "mine" in Chine is only producing 5 000 tons per year – a new mine in Australia or Brazil has a capacity of at least a one million tons often up to 10-15 million tons or one thousand times bigger. Even the largest Chinese iron ore mines are small in an international comparison.

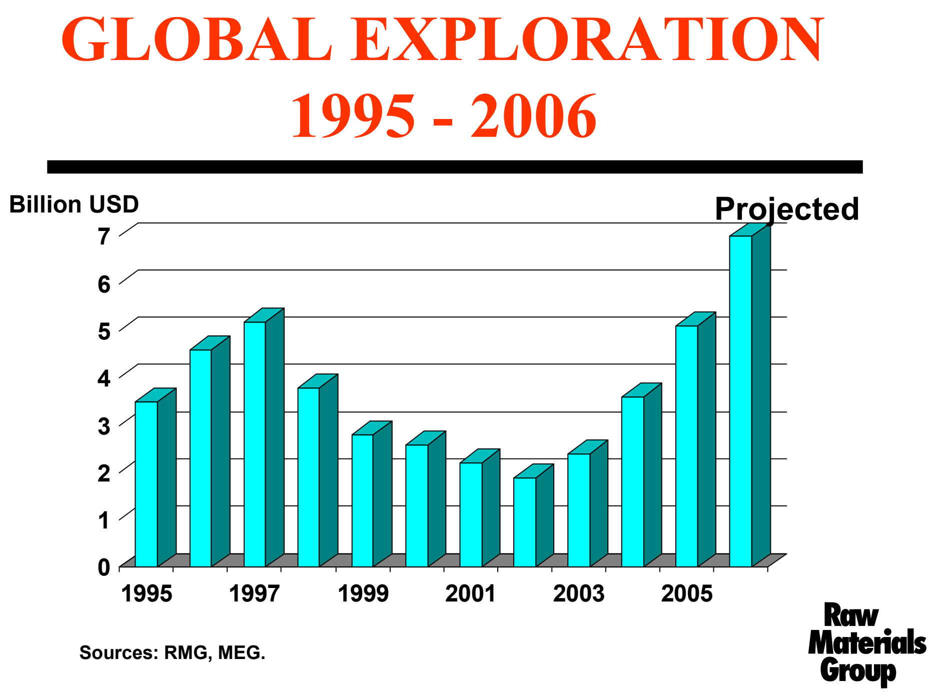
It is partly the high un-employment situation and the poverty in rural China that keeps up domestic production. The safety and environmental conditions in many of the small Chinese mines are appalling simply because they are artisinal mines rather than industrial operations. They have more in common with the garimpeiros of Brazil or the orepailleurs of West Africa and the small scale miners of Tanzania than with the operations over the world run by the major mining transnationals such as Rio Tinto and BHP Billiton. With improvements in transport lines and the increase in size of steel works in China production from these mines cannot compete, due to lower quality and further their use demands higher energy and water inputs than the imported ores. The geology of China is further not as attractive as other areas of the globe. Our conclusion is that even if Chinese mining will increase its production there are serious problems in expanding production at a level that keeps up with demand and hence imports of metal concentrates and ores will have to increase.

The potential of global mining to satisfy the sharply rising demand for metals in China and elsewhere will be determining future metal price levels to a large extent. How will the supply demand balance which has been tight in the last few years develop in the future? A few factors are of key importance in determining supply development:

- Available geological reserves
- Levels of exploration and investments into new mines
- Lead times when expanding production

During the 1970s there was a wide spread worry about the availability of sufficient geological reserves of metals and minerals. When projecting metal demand into the future and comparing it to available reserves a serious metal shortage was looming on the horizon. These calculations proved to be wrong however and today most economists and geologist agree there are enough reserves of metals to cover future demand. It is mostly a matter of at what price metals will be available, with increasing metal prices more deposits can be mined profitably. The tar sands of Alberta are a prime example of deposits which were not reserves but only geological formations at lower oil prices but when prices increase the oil sands can be used for oil production.

Figure 6.
Exploration expenditure



Exploration to find new deposits has been at low levels in the first years of the new millennium and it is only in the past 2 years that exploration expenditure has grown. Figure 6. The amounts given in figure 6 are underestimating the total figures slightly because they include only private exploration and there are important volumes of state funded exploration spent in China, India, Russia but also in market economies such as Finland the state is an important explorer for metals and minerals. When considering these additional amounts invested in exploration by governments around the world the total figure for 2005 did probably not exceed US$ 6 000 million per year. Figure 7.

Figure 7.
Global exploration expenditure

Will this be enough to secure new deposits to cover the increasing demands for the future? Firstly the metal demand is growing so even if the amount of capital necessary to find a new deposit is constant exploration should increase at the same rate as metal demand to replace the deposits depleted over time. Obviously this is not happening. The problem gets more serious when considering that the amount of investment necessary to find a new deposit is not constant but continuously growing for a number of reasons:

- Deposits are to be found in more remote areas with harsh climates.
- The most easily located deposits have already been found and the future ones are at higher depths or are of lower grades.
- The demands for alternative use of the ground have placed many prospective areas out of bounds for exploration activities.

New exploration techniques and improved geological theories and understanding of the processes that form metals can improve the efficiency of exploration. On balance it seems however likely that exploration has been at too low levels for a number of years and that this will make it difficult to find sufficient number and volumes of new ore reserves in the coming years.

Exploration expenditure is proportional to metal prices with roughly one year's lag time and hence with the present high metal prices it is certain that exploration will continue to increase in 2006 and 2007 as well but it is not at all certain that the quick increase in available capital is sufficient to increase the volume without lowering productivity. There are simply not enough experienced geologists and further the planning of an exploration campaign is often limited due to seasons and the long lead times to complete the formal process to get access to the planned areas. To train new geologist will take years and hence it will be a slow process to increase effective exploration.

The next step in expanding mine production is to construct the mines necessary to extract and process the ores found by exploration. This is also a slow process which is not as simple as when expanding capacity in traditional industry. To build a mine is often a process of 3-5 years depending on similar factors as the ease of exploration:

- Location of the mine.
- Access to infrastructure such as power and water and transport to export harbors.
- Permitting procedure including environmental and socio-economic aspects in particular aboriginal issues.
- Process parameters depending on type of minerals and partly on environmental demands on tailings and other effluent streams.

In all, the time from a discovery of a new potential ore deposit to the mine can be taken into operation is increasing and is normally 7-12 years. Very rarely can a mine become operational in less than 5 years and often it might take up to 15 years to get it going. These start-up times have been increasing in recent years and the situation is worse at present due to a shortage of trained and experienced engineers and all other categories that are needed to implement a mining project. This situation will certainly ease in a few years but lead times will get longer and longer delaying the supply response to an increased demand.

During 2005 a total of 181 new metal mining investment projects, which were together costed at almost 30 billion US dollars (US$) were registered in RMG's databases. This figure is 16

% higher than in 2004 when 180 projects totalling US$ 25 billion were announced. The dollar volume of projects has been increasing since the trough of the mining cycle in 2002 when only 65 projects worth US$ 11 billion were fed into the global mining project pipe line. Further indication of the mining boom investment projects worth over US$ 6 billion were completed in 2005, which is a record figure since 1999 when RMG began monitoring mining investments.

Mine investment project pipeline

The total amount of US dollars in the global mining industry's project pipeline as recorded in RMG Mines/Projects database is 137 billion US dollars ($US) by the end of 2005. The total figure represents a 25- 30 % increase over the figure from the end of 2004. It is a reflection of the continuing boom in the mining industry world wide.

More projects than in earlier periods have been given the green light and the Construction category has continued to grow during 2005 for the third consecutive year. There are at present projects valued at US$ 16 billion under construction world wide. It should be pointed out that many investment projects, in particular brown field ones and those carried out by the major transnational mining companies and by smaller locally owned companies are never announced and do not enter into the RMG Mines/Projects database. The amount of investment into brown field projects is stable. It is difficult to monitor the flow of brown field projects from project studies to construction because they are often carried out internally, without any fanfare. Hence the figure of projects under construction is an underestimate of this category. A project usually takes more than a year to realise (on average 12-18 months) depending on the location, existing infrastructure, financing and many other factors. There will be a continued growth in projects under construction at least in the next 1-2 years.

Copper, gold, iron ore and nickel in that order are the most important investment targets for mining companies. These four metals account for 82 % of the total project pipeline. They also dominate mining in terms of the total value of its output. Iron ore has been under-represented in the project pipe line for many years but in 2004 and 2005 high demand for iron ore and healthy increases in prices paid have made iron ore one of the hottest investment targets. Of the total amount of investments into new projects presented in 2005 more than one third are iron ore projects. Iron ore is now third in the list after copper and gold as the most important investment targets. Both copper and gold decreased their shares of the total pipeline. The category Other increased somewhat including among other uranium, molybdenum and other ferroalloys projects. The interest in diamonds increased with several new big projects fed into the pipeline. The share of lead/zinc of the total proposed investments decreased further and the investments necessary to keep up production seem not to be forthcoming at the necessary rate.

Table 1.
Mine investments by metal 2005

	US$ billion	%	Change share 05/04
1. Copper	39	28	-
2. Gold	30	22	-
3. Iron ore	25	18	+
4. Nickel	24	17	+/-
5. PGMs	6	4	+
6. Diamonds	5	4	+/-
7. Lead/zinc	4	3	+/-
8. Other	4	3	+/-
TOTAL	137	100	na

Source: Raw Materials Data, Stockholm, Sweden January 2006.

Gold projects are often smaller than copper projects, and although the average gold project has grown to almost US$ 100 million compared to 70 millions only a year ago, they are still much smaller than the US$ +240 million average project size for copper. This is due to the fact that it is still possible to find small but high grade gold deposits which can be mined profitably by junior or mid-sized companies, while most new copper projects are often huge low grade open pit operations. The average iron ore project is even bigger than a copper project, well above US$ 300 million. Zinc/lead and PGMs projects have an average size somewhere between those of copper and gold projects.

Projects listed by RMG during 2005 involve a total expenditure of over US$ 29 billion. In this period iron ore dominates completely accounting for over 38 % of the value of all new projects. Copper follows with 18 % and gold at 14 % of the newly announced projects. The nickel figure is only 6 % indicating the early fall of nickel prices and demand compared to other metal price cycles. The ratio between total volume of proposed projects and projects new in 2005 is lowest for nickel, (0.35) and highest for iron ore, (2.2) of all the major metals indicating the most important changes in investment patterns and future new capacity coming on stream.

A third of listed investments are located in the Latin American region. Latin America has been in focus for mining investors of the world for several years. Compared to the figures for 2004 the Latin American share of global investments has however decreased. Oceania with mainly Australia and Papua New Guinea is the second most important region decreasing slightly to 20 % of the investment pipeline. Africa, Asia and North America (USA and Canada) are competing for the third place with 12-16 % of investment each. Their respective shares having increased somewhat since 2004. Europe finally, is the least important region accounting for only some 7 % of total investments, and the growth we have noticed earlier seems to have levelled off. The decrease in Latin America is partly due to that several large copper gold projects have been completed in Latin America such as Alto Chicama in Peru, Escondida Norte in Chile and Veladero in Argentina. Please see Table 2 below.

Table 2.
Mine investments by region 2005

	US$ billion	%	Change share 04/05
Africa	22	16	+/-
Asia	18	13	+/-
Europe	10	7	+/-
Latin America	44	32	-
North America	16	12	+/-
Oceania	27	20	+
TOTAL	137	100	na

Source: Raw Materials Data, Stockholm, Sweden January 2006.

Another way of looking at the mining industry's present boom is to follow the dollar value of the investments in projects that are under construction. The results are given in Table 4 and clearly demonstrate the current strong increase in new mining investments. There is no scale for the absolute dollar values because of methodological problems: There are a number of investment projects in operating mines for example to eliminate bottle necks and increase capacities by a few per cent without undertaking any major investments. These investments are often not announced to the public and hence not included in the statistics we provide. A project that is extended over several years will appear in the table under several years and it will only disappear when it is completed.

From Table 3 it is clear that the investment boom is strongest in Latin America and Oceania where several major iron ore projects have contributed to the quick increase in the last 2-3 years. Europe has seen a steady increase mainly due to Russian projects (some in the Siberian parts of the country), while Africa and North America had a low point in 2003.

Table 3.
Mining metal projects under construction per region 2001-2005

	Africa	**Asia**	**Europe**	**Latin America**	**North America**	**Oceania**
2001	**2560**	**320**	**55**	**690**	**1470**	**800**
2002	**1625**	**1145**	**30**	**770**	**1105**	**815**
2003	**990**	**1390**	**260**	**1410**	**480**	**930**
2004	**1515**	**1655**	**755**	**3600**	**1725**	**4820**
2005	**1615**	**1355**	**965**	**5450**	**2050**	**4800**

Source: RMG 2006.

Forecast

The observations and considerations outlined above have formed the basis for the quantitative forecast made in the following section. To facilitate the interpretation of the data series produced three metal price levels have been used: pessimistic, conservative (in our opinion the most likely or realistic) and optimistic.

Using the methodology outlined in the Appendix forecasts for the base metals (copper, lead and zinc), iron ore (as fines, lump and pellets) and both thermal and coking coal have been made from 2006 to 2025. Table 4 below summarizes these results at key periods along this timeline. Supply and demand factors have determined the values up to 2010 (see text) while beyond this point a more statistical approach has been used due to the exceptionally long term nature of the forecasts.

Table 4.
Real price forecasts

		Real (2005 terms) (assuming 2-3% inflation)									
			Pessimistic			Conservative			Optimistic		
Commodity	Units	2006	2010	2020	2025	2010	2020	2025	2010	2020	2025
Thermal Coal	US$/t	51	34	33	33	45	43	43	56	53	53
Coking Coal	US$/t	111	57	55	56	77	73	73	96	91	90
Iron Ore Fines	USc/mtu	71	45	43	44	54	52	52	63	60	59
Iron Ore Lump	USc/mtu	91	57	55	56	69	66	66	80	76	75
Iron Ore Pellets	USc/mtu	113	94	91	89	104	92	88	119	106	103
Copper	US$/t	7379	2027	1875	1885	2703	2500	2490	4793	4549	4490
Lead	US$/t	1383	507	485	488	676	647	644	898	853	842
Zinc	US$/t	3261	1014	970	975	1351	1293	1289	2118	2011	1984

The figures above in table 4 are in 2005 dollar terms having been deflated from the nominal values generated by the forecasting process. These deflated forecasts assume that the developed world economies and the now industrialising economies (China, India and Brazil) will maintain their successful low inflation stance at 2-3% annual inflation. Table 5 summaries the cumulative inflation for each forecasting period for the assumed 2-3% and a model with a rate of inflation increasing to 5% by 2020 and maintaining this level to 2025 for comparison.

Table 5.
Cumulative inflation

	Cumulative Inflation (%)	
Period	2-3%	Increasing to 5%
2006-2010	8%	8%
2010-2020	24%	33%
2020-2025	9%	17%

The following series of figures (8,9,19) illustrates the conservative price trends for each commodity group. These forecasts represented as approximate straight lines average the future commodity cycles over the time period.

Figure 8.

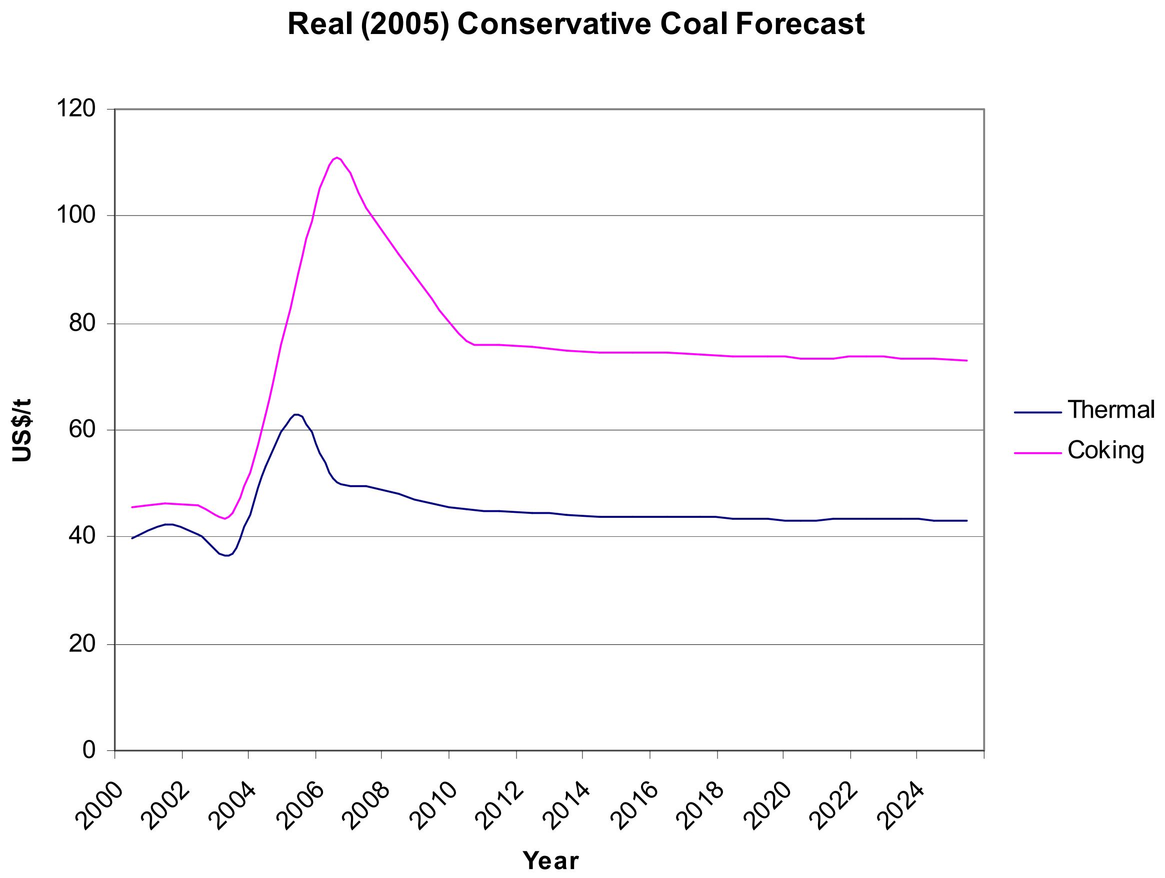


Figure 9.

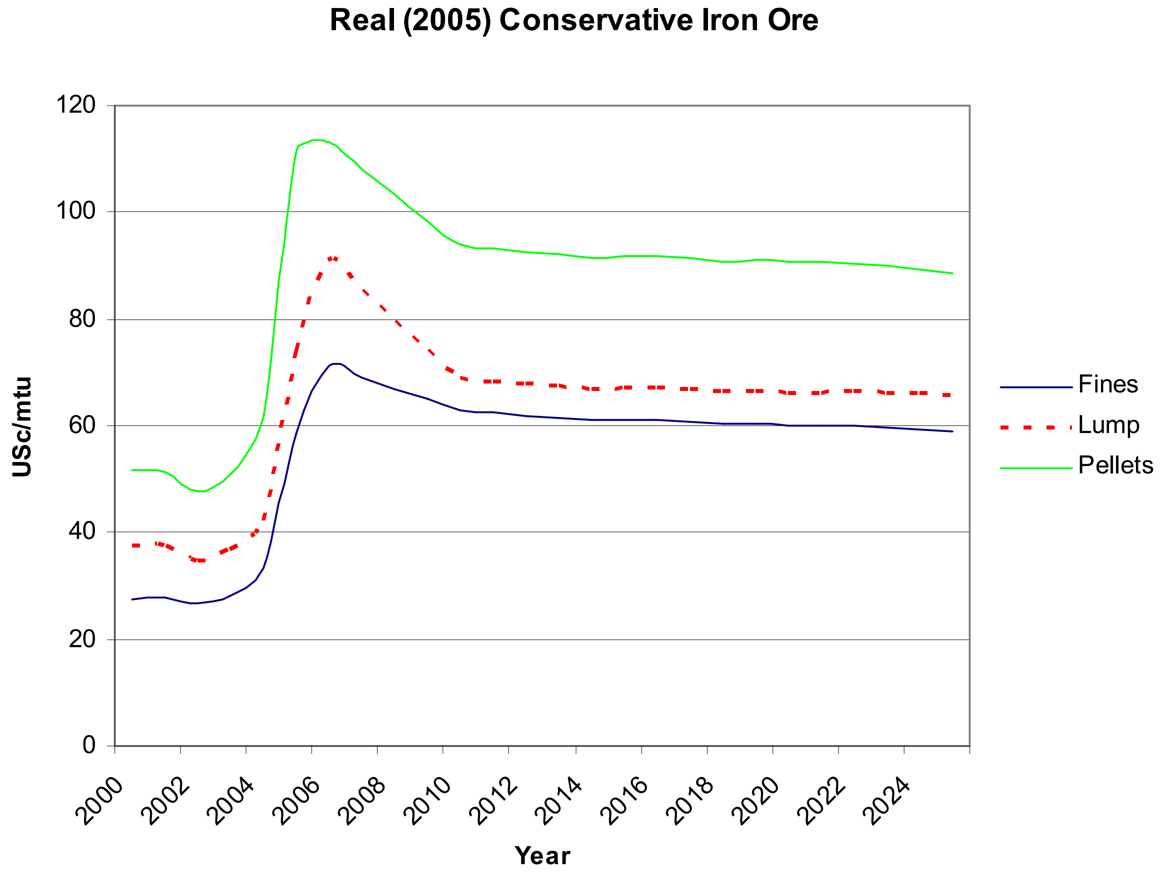
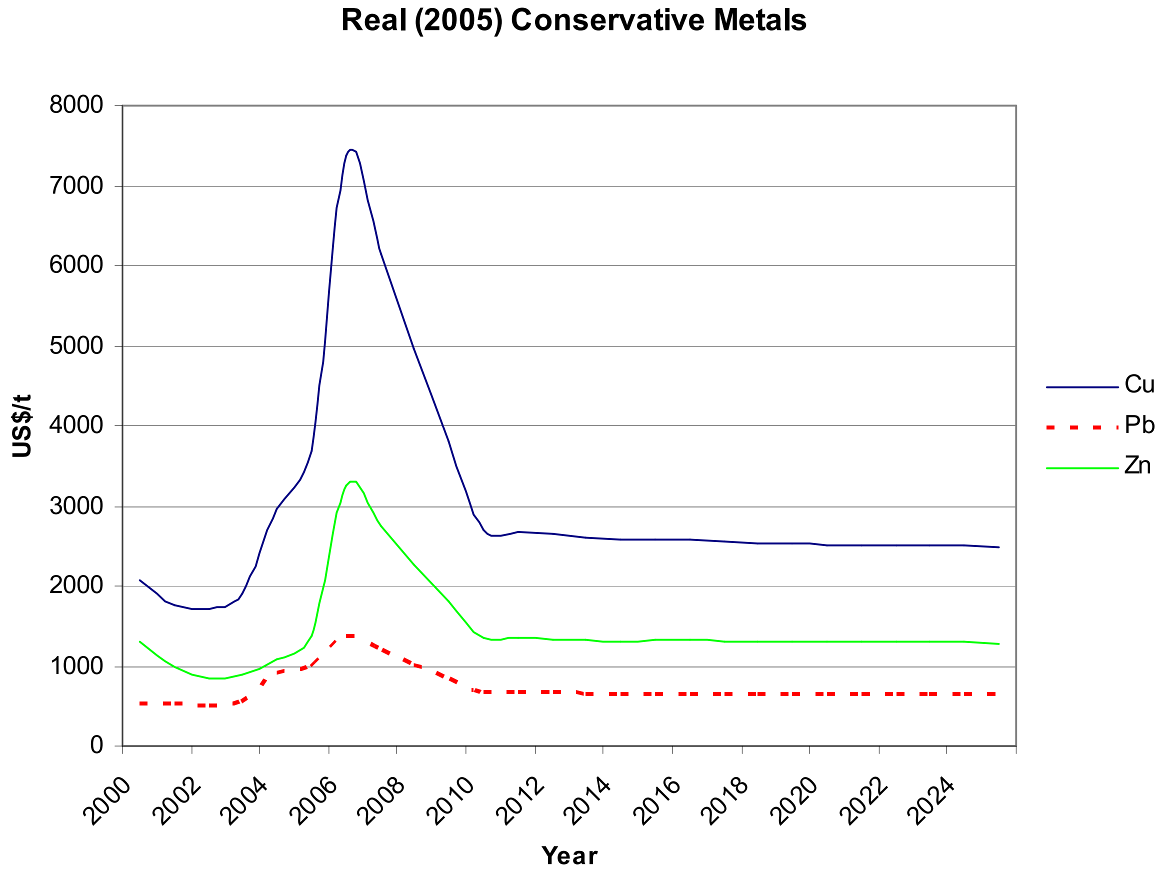

Real (2005) Conservative Iron Ore
120
100
80
60
40
20
0
USc/mtu
2000
2002
2004
2006
2008
2010
2012
2014
2016
2018
2020
2022
2024
Year
Fines
Lump
Pellets

Figure 10.



In the short term the forecasts predict that increases in supply will cause a significant price decrease until 2010. The continuing but much slighter real price decrease beyond 2010 can be attributed to continuing production costs decreases. This increasing efficiency would make currently uneconomical mineral deposits economical and therefore continue to provide the world with the above mentioned commodities.

Discussion

Demand

When analyzing the recent years of quick growth in Chinese and Indian demand for metals it gets more and more difficult to find indicators of a decrease in growth. All evidence point in the direction of a continued growth. Certainly the growth might slow down but given that China alone is the largest metal user the absolute volumes are so huge that even a half the growth rate of today the amounts of additional metal necessary are staggering and will support prices at a higher level than what has been the case in the late 1990s and early 2000s.

Figure 11.
Chinese absolute use of metals

GLOBAL USE

	CHINA	USA
COPPER	20 %	15 %
ALUMINIUM	21	23
LEAD	20	20
ZINC	23	12
NICKEL	11	10

Source: Handelsbanken, RMG.

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Figure 12.
Chinese per capita use of metals

PER CAPITA CONSUMPTION

	OIL	COPPER	ALUMINIUM
	Barrel/person	kg/person	kg/person
USA	25.5	7.5	23.3
JAPAN	15.2	9.1	17.1
KOREA	17.3	17.7	22.8
CHINA	1.9	2.3	4.7

Source: Handelsbanken, RMG.

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Chinese demand is not likely to drop off dramatically but of course it might happen if there are some revolutionary changes in the Chinese political system. The growing tensions between the poor rural areas and the booming cities on the east coast could be one source of serious frictions. If the grip over Chinese society by the Communist Party should become less tight could this result in lowered economic growth rates and resulting lowered demand for metals? If there is a serious conflict over North Korea how could this affect the Chinese economy and politics? It is almost only catastrophic scenarios like these that could rock the Chinese boat enough to create a drop in metal demand sufficiently deep to seriously affect the global consumption. It is of course impossible to determine the likelihood of anything like this happening and these extreme developments will not be further considered in this report.

At the same time it is clear that prices cannot remain at today's extreme levels for much longer, because new deposits will be found and additional mines will get started, even if it takes a long time to take them into operation, and substitution will occur and increase.

Substitution has already started at present price levels. It has for example been estimated by industry sources that in 2006 roughly 1 % of copper will be substituted for other metals, mainly aluminium and alloys with less copper. In this short time frame substitution is difficult but it will increase in a mid term perspective of 2-3 years. At the same time there are physical limits to substitution and copper has such outstanding conductivity of both electricity and heat that the opportunities for substitution are limited. Zinc is mostly used for galvanizing i.e. it protects steel from corrosion. Alternatives are covering steel with a protective layer of paint or to use stainless steel with a high content of nickel, chrome and other alloying metals. This will certainly happen but it is a slow process and there are many applications where substitution is not a realistic and cost effective alternative. Iron is much more difficult to substitute partly because of the massive scale it is used partly because of the relatively low price of steel compared to alternative material such as wood for construction and other more exotic metals and materials. Iron and steel will remain the main construction material for a long period of time. There will be pressures on metal demand through minituriasation and through more effective engineering and construction methods for example by making a building less heavy there will be lower demand for steel in its frames etc.

The situation for coal is slightly different in that it is a non-renewable resource at least when its energy content, rather than its carbon content, is used. At present coal is one of the key alternatives both for generation of electricity and liquid fuels to oil and gas. Except for nuclear power coal is the only alternative to petroleum which is available in sufficient quantities to at least theoretically replace dwindling oil and gas supplies. Renewable resources have yet to be developed on a scale sufficient to have any significant impact on global energy supply. Coal is hence the substitute that might replace oil if oil prices remain high. On the other hand the threat of global warming is a strong deterrent to greatly expanded use of fossil fuels. In the mid term demand for coal will greatly increase but in the long term substitution by uranium and renewables might well occur.

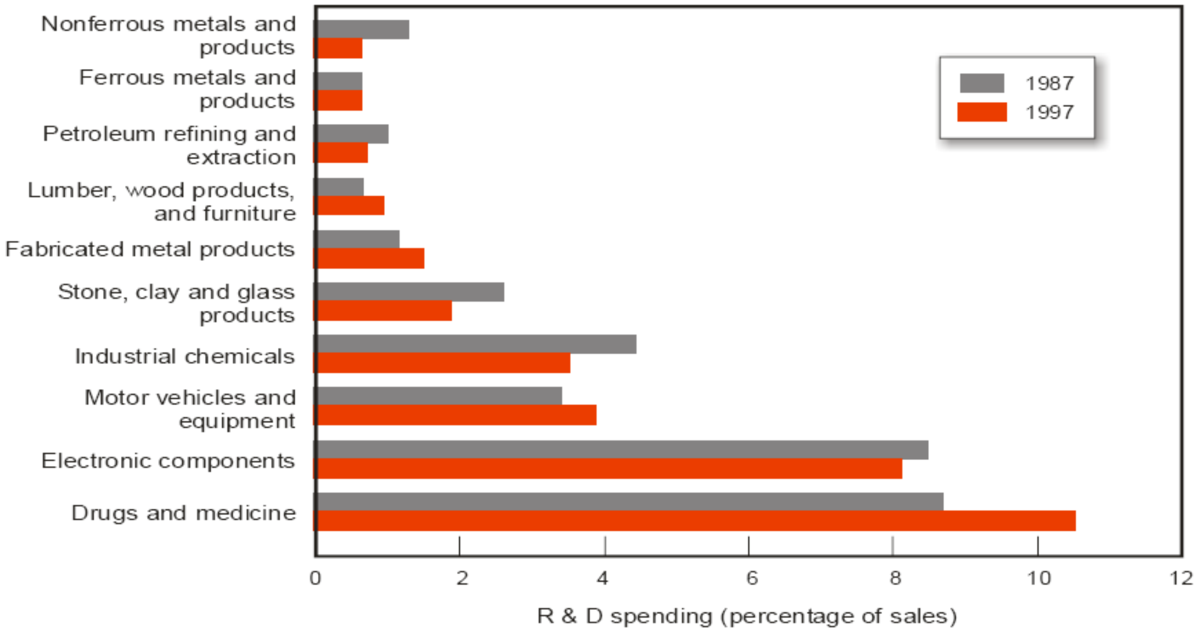
In summary in a longer time perspective substitution will set in with greater force if prices remain at a high level. The likelihood that substitution will cause a dramatic drop in demand is not high but substitution will put a stronger pressure on metal and energy prices after 2015.

Supply

Supply will respond slowly as out lined above and it is this imbalance between a quickly growing demand and a slow supply response that is the fundamental reason for the present boom. It is difficult to find any good reasons why supply growth will be greatly facilitated in the future. On the one hand it will get more and more difficult to find new deposits but on the other hand technological developments could facilitate the whole process. It can be argued that during the last quarter of the 20th century the mining industry did survive and managed to produce metals demanded in spite of falling prices. This feat was to a large extent due to technological progress. But the industry lost most of its profitability in the same period and also got a poor reputation and tainted image as a smoke stack industry and sunset sector.

Research and development (R&D) in mining is at very low levels compared to other industries. See figure 13. For the future it is not likely that the R&D resources of the industry which have been scaled down to a minimum during the difficult years, both in industry itself and in the academic world, will be sufficient to continue to improve productivity at the pace needed. At least the lead time to educate a new generation of researchers and to find funding for new projects and start producing relevant results will be not less than 10 years and the success will not be guaranteed.

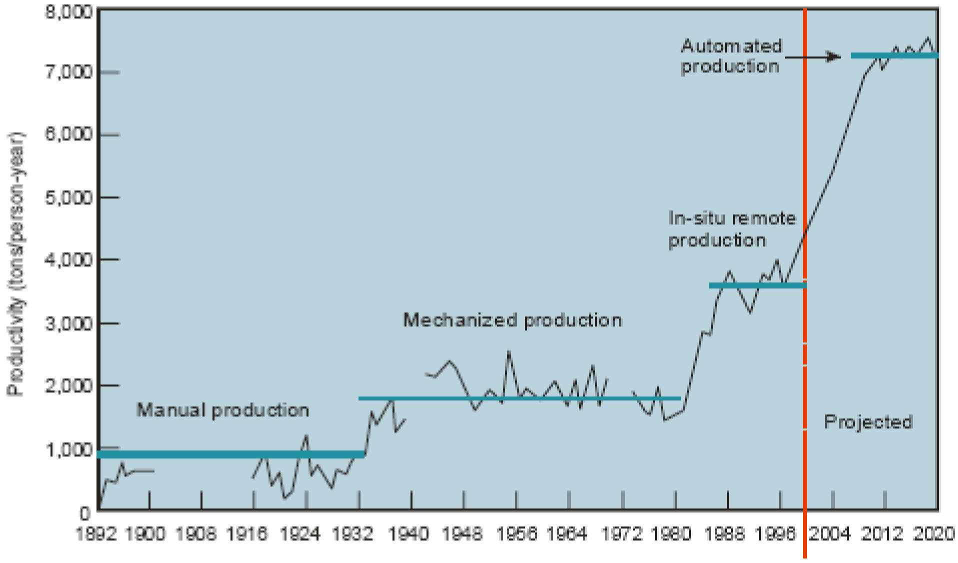
Figure 13.
R&D in the mining industry
(RTD as a percentage of sales)



Source: Chris Cross, Rio Tinto at Bergforsk Seminar June 8th 2006. Based on National Science Foundation, Science and Engineering Indicators 2000, Arlington VA; 2000 (NBS-00-1).

In particular the issues of increasing energy costs and high water demands will be of prime interest to the industry. Mining and metal processing are energy intensive industries and even if some breakthroughs have been made in metal smelting with the introduction of hydrometallurgical methods in recent decades mining itself is done in more or less the same fashion as during all the last century. Operations have been made bigger and more automated but the same unit operations have been used: drilling, blasting, mucking, crushing and milling and then processing. These typical batch wise processes should be replaced with some kind of continuous operation which is better suited to the mineral processing circuit which is already today running in continuous mode. Further the demand for lower emissions to the environment means that greater emphasis must be placed on how to dewater, transport and store all types of wastes, which will also affect the choice of equipment used. Energy demand in the various process steps is shown in figure 14 indicating the importance and possibly also the potential to reduce energy consumption. The effects of new production technologies are illustrated in figure 14 which gives a peep into the future as it is perceived by Rio Tinto. This figure is certainly highly speculative and without a considerable increase in R&D by the industry it will not be realised in the time frame indicated. For this study our conclusion is that without a dramatic and quick increase in R&D expenditure in the mining industry it will be difficult to maintain the necessary increase in productivity to off set the effects of lower ore grades and more remote locations of most new ore deposits. This will mean that the lack of research will also have a pushing effect on metal prices.

Figure 14.
Productivity in mining



Source: Chris Cross, Rio Tinto.

Environmental demands have been touched upon above. Legal requirements on mining companies concerning the environment will most probably increase in industrialized countries and a gap will remain when comparing environmental demands in emerging economies whether among the former centrally planned economies or among the developing countries. It is however anticipated that these differences will not play a major role in decisions concerning localization because most major transnational companies use the same environmental criteria irrespective of in which country they operate. Certainly some companies for example from the CIS countries or from China might take advantage of a more lax legislation in certain countries but it is our view that such examples will be the exception that proves the rule rather than the general case. Perhaps later in the forecast period when some Chinese, Indian or Russian companies have become global players their behavior could upset competition and decisions about location of new capacity but in the next couple of years the impact of various national views of environmental and sustainability issues are not likely to have any larger impact at all on the sector. In a recent World Bank study the recommendations to governments is to reduce all types of state regulations and influence over the sector and this seems to be the case in most countries.

Competitive forces

In addition to the general discussion above in supply/demand terms it is useful to briefly look at the competitive situation of the mining sector. Our discussion will touch on the most important aspects of Porter's basic factors shaping the competitive situation.

The barriers of entry to the mining sector are high mainly because of the capital intensity of the industry and the long lead times between investment and profits. During the recent boom new entrants have however been able to battle their way into the industry showing that when the potential profits are large enough it is possible to overcome these barriers. In iron ore where the "Big Three", CVRD, Rio Tinto and BHP Billiton, have been dominating newcomers have been able to create partnerships with steel works to finance new projects. It is clear that one of the reasons for steel works to do this is their fear of too much domination over the market by the "Big Three". It should be noted that the market dominance of 60-70 % of these companies is measured on seaborne traded iron ore. These figures overstate the dominance of the "Big Three", which control less than 40 % of total world production (see figures 16, 17). Seaborne trade excludes all exports by railway (for example from Russia to East Europe) and by barges between Canada and the US. The quick growth of a number of new companies mainly from the emerging countries on to the global scenes of basic industries such as Mittal Steel, Vedanta and most likely also soon Chinese major companies is another example of how it is possible to break into the market in spite of the high barriers of entry.

These new companies and also other mining and exploration companies representing a new breed of miners such as Lundin Mining, Boliden, Xstrata and other companies with less of a mining industry "heritage" will increase the competitive situation in the mining sector in the next decade. The junior exploration companies, which are the mining industry's equivalent of high tech companies in IT and pharmaceutical industry, will be more successful in finding new deposits than the slow moving, less flexible mining giants. The juniors could form the nucleus of a continued supply of new mining companies that will counteract the tendencies of increased corporate concentration that is at present visible in the mining industry.

At the same time it is important to note that the overall corporate concentration in the mining sector has been declining over the last 25-30 years and that the present increase starts at a low level. Our overall conclusion is hence that the competitive situation in the mining sector will be more or less at the level of today during the next 2-3 decades.

Substitution is discussed above.

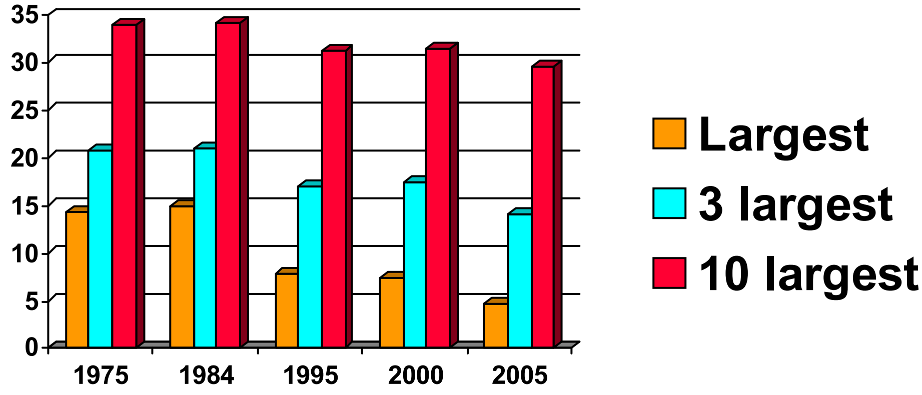
The bargaining power of the suppliers of the mining industry is strong. The level of concentration among the manufacturers of equipment and providers of process technologies is high. Just a few companies dominate almost all sectors of mining equipment from drill rigs and explosives to truck and mills and furnaces. In the recent year there is anecdotal evidence that lack of tires and other critical components has increased the price of crucial pieces of mining equipment and delayed new projects. Delivery times of up to 18 months for products which a few years ago were almost taken off the shelf are reported. The suppliers are however increasing their capacity and their capability to reach a balanced market situation that is critical to avoid a costly and damaging over capacity.

There are signs that the major mining companies are coordinating their purchasing procedures using the auto and aero industries as models. This will put additional pressure on the manufacturers to increase competition.

Prices of metal concentrates produced by most miners are set on metal exchanges such as LME, NYMEX and others. All these markets function well. In iron ore, where prices are negotiated, the influence of a fragmented buyer's side is obvious. It is only in the recent couple of years when the miners have managed to merge and the influence of the "Big Three" has increased - while the level of concentration among the steel works is still at a much lower level - that prices have shot up. The level of concentration among the steel producers is now increasing but it will take years to catch up given the fragmented structure of the industry in China and elsewhere.

The concentration level of the metal mining industry of the world has not increased dramatically over the last 25 years indicating that neither M&A nor organic growth has affected corporate concentration decisively. The corporate structure has changed considerably with companies disappearing and new one emerging but the market shares have not changed much – if anything the level has sunk slightly, coinciding with the growth of gold production outside South Africa and the spin off by Anglo American of its less profitable mines. See Figure 15.

Figure 15.
Concentration of world mining industry
(per cent of total value of global non-fuel minerals)

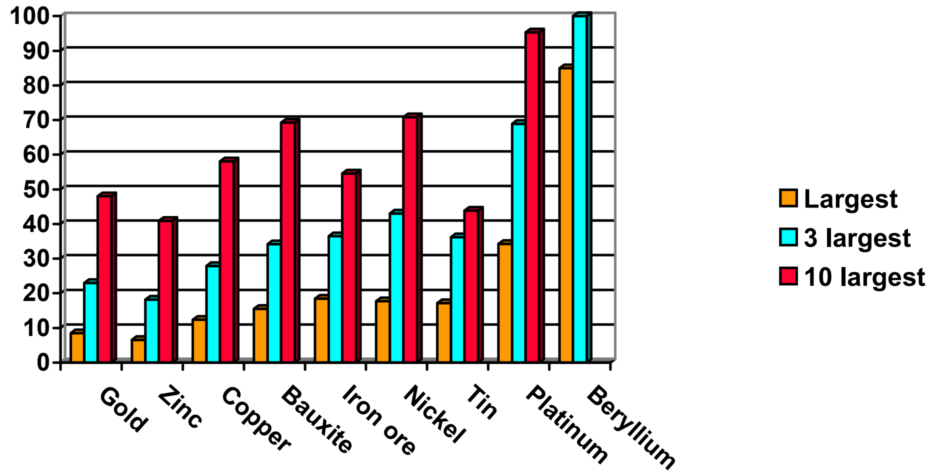


Source: Raw Materials Data Metals, 2006.

Metal by metal

On a metal-by-metal level the picture is more diverse. Figure 16. The platinum group metals (PGMs) industry is an oligopoly with the 4 largest companies controlling over 80 percent of total world production. At the other end of the spectrum is zinc with the largest company, Canadian Teck-Cominco, controlling less than 10 percent of total world production.

Figure 16.
Concentration by metal
(per cent of total world production)

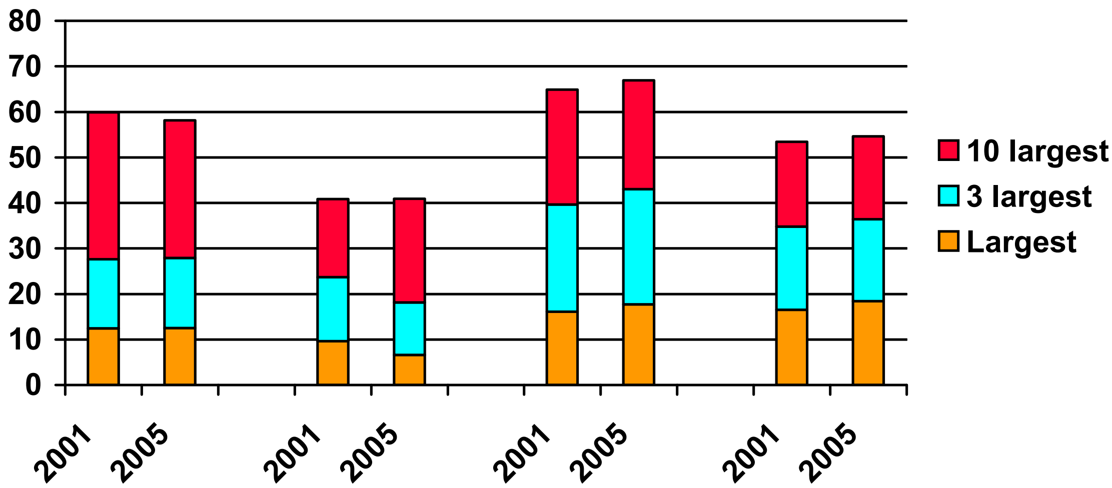


Source: Raw Materials Data Metals, Stockholm 2006.

The level of concentration in the gold industry has decreased since 25 years ago due mainly to the growth of non-South African gold production but in recent years the sector has started consolidating again but it is still the least concentrated of the economically important metals.

The iron ore industry has consolidated during the last few years when Brazilian CVRD has strengthened its position and gripped global leadership firmly. But even here the change in corporate concentration is not that dramatic. Between 1990 and 2005 CVRD's market share has only increased from 15 to 18 per cent. The growth in concentration for copper, zinc, nickel and iron ore is given in the figure 17 below. For copper there is even a marginal decrease in concentration in the period under study.

Figure 17.
Major metals corporate concentration
(% of total production)



Source: Raw Materials Data Metals, Stockholm 2006.

The concentration process has in general not reached such a state where the size of the players could facilitate the cutting down of production in times of over production and low demand in order to try to make price fluctuations less dramatic. Or phrased from the consumers' perspective: The size of the major mining companies has not made it possible for them to influence prices, at least not yet. One exception among the economically most important metals is possibly iron ore in particular if the concentration in the seaborne iron ore trade is considered. This situation is however also changing quickly with the entry of new comers based on attraction of capital in the stock market and by steel companies like Mittal and others trying to build their own captive mines. Further the steel works in the former Soviet Union nowadays controlled by Russian and Kazakh oligarchs are very actively expanding their export lines through Siberia into China. The tight control exerted by the Big Three will be challenged in a serious way in the next 5 years.

Our conclusion is that the competitive situation of the mining industry will intensify slowly but at the same time we see a new trend towards concentration mainly because the high capital demands in the industry will be balancing the underlying tendency of more intensive competition. The overall effect is that the competitive situation in the mining sector will not change dramatically.

Prices

Trying to summarise the forces described qualitatively above one main scenario seems to be the most likely in our view:

Metal demand continues to surge and Chinese demand is keeping up and eventually India gets going. When the pace of growth in India slackens the former Soviet Union and the countries in East Europe gather momentum. They are all in economic developing phases where there is a growth in GDP/capita through the band where metal demand is growing at its highest speed. In short demand keeps increasing but perhaps not at the same pace as today. Even if demand will decrease in one of the regions there is enough absolute demand growth to keep metal prices from sinking like they have done in the late 1900s. It is in short an optimistic scenario for miners and metal producers.

On the supply side this bonanza sooner or later will lead to an increase in capacity and when there is an oversupply situation the price fall could be deep. It must also be underlined that there will be no physical shortage of metals, there is sufficient quantities of all metals in the earth's crust and under the bottom of the seas. The first commercial applications for exploitation permits (except for diamonds) have been made in the seas just north of Papua New Guinea.[1]

The hypothesis that several analyst have been putting forward that a long wave of increasing metal prices, albeit with cyclical swings, is about to start, is difficult to verify or for that matter equally difficult to dismiss. The proponents of this theory point to the period of increased base metal prices from the late 1930s to the mid 1970s followed by a long decline until the early 2000s. They argue that with the present boom already much longer than the peak of earlier commodity highs in the 1970s and earlier in the 1950s this could be something more than a mere cyclical high but the start of a new such extended "super cycle".

A continued demand boom will during a few years generate high metal prices as is already the case, the present boom is longer than the two previous ones in the early 1950s and the late 1970s. The capacity of the mining industry to reinvent itself to find new orebodies and develop new technologies will gradually catch up and prices are bound to drop off again. Past historical experiences show that the industry even during a long period of falling metal prices has had the capacity to supply the metals society has demanded and we see no reason that this will not happen again. In particular new forces such as mining companies from China and India are shaking up the global mining industry.

Given the increased difficulties to locate new orebodies and to extract metals from deposits with lower grades, at higher depths etc the long term equilibrium cost of producing many metals will however increase and will not fall back to the same low level as it had before the present boom started. There will be new higher floor for metal prices. Whether this long term floor will be gradually rising as proposed by the advocates of the "super cycle" we cannot judge at present. There is certainly a lot of merit to these ideas but we are less certain than some analysts about this and assume that there will be a new floor and that this will not be sloping upwards in the very long future towards the end of the period up to 2025.

[1] John E. Tilton On borrowed time? Assessing the threat of mineral depletion, Resources for the Future, Washington D.C. 2003.

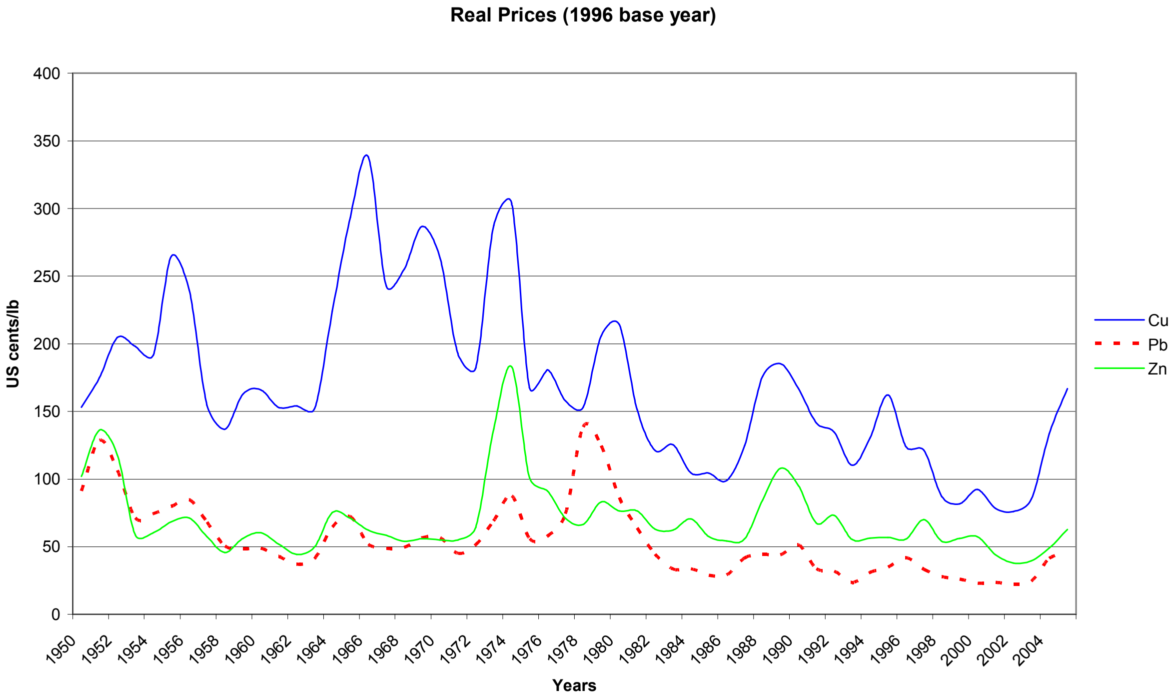
ANNEX

Methodology

Our methodology used to determine the various commodity forecasts for this study is outlined below. After a thorough review of the major financial institutions forecasts and economic outlook for the resource sector a comparison was made with Raw Material Group's historical (from 1950 – 2006) and forecast data (2007 – 2025) including supply and demand in the mid term. Using this combination of information estimates where made for each commodity. This process is outlined below using base metals as an example.

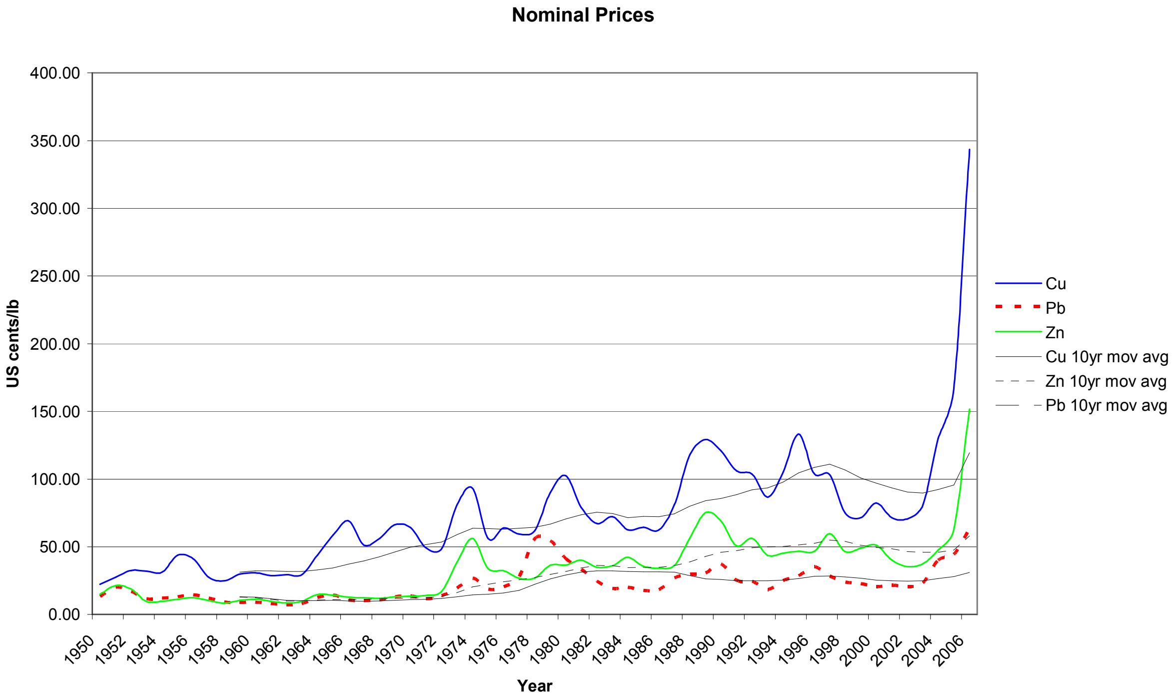
In the case of the base metals (Cu, Pb, Zn) real prices increased from 1950 until the late sixties, but since then have been decreasing until 2003, see figure 1.1. From 2003 until the present prices have been regaining some of this lost ground but are by no means at record real price levels.

Figure 1.1.



The upswing in base metal prices over the past few years is more extreme and sudden when nominal metal prices are considered, see figure1.2. A 10 year moving average trendline has been applied to each of these metals to illustrate the trend in price since 1950 and therefore place a realistic constraint on the forecasts.

Figure 1.2.



From these first two graphs it is clear that base metal prices are cyclical and highly variable making price forecasts in the long term very difficult. Although not as pronounced these trends can also be seen in iron ore and coal. Therefore we have chosen to forecast on three levels pessimistic, conservative and optimistic for the years 2010, 2020 and 2025 for each of the commodities requested, see Table 1.1.

Table 1.1.

			pessimistic			conservative			optimistic		
Commodity	**Units**	**2006**	**2010**	**2020**	**2025**	**2010**	**2020**	**2025**	**2010**	**2020**	**2025**
Thermal Coal	US$/t	53	38	45	50	50	60	65	63	74	80
Coking Coal	US$/t	114	64	77	84	85	101	110	106	125	135
Iron Ore Fines	USc/mtu	73.45	50	60	66	60	71	78	70	83	89
Iron Ore Lump	USc/mtu	93.74	64	77	84	77	91	99	89	105	114
Iron Ore Pellets	USc/mtu	116.70	104	125	134	115	127	133	133	146	156
Copper	US$/t	7600	2250	2588	2846	3000	3450	3761	5320	6278	6780
Lead	US$/t	1425	563	669	736	750	893	973	997	1177	1271
Zinc	US$/t	3359	1125	1339	1473	1500	1785	1946	2351	2775	2996
Copper	US$/lb	3.435	1.021	1.174	1.291	1.361	1.565	1.706	2.413	2.847	3.075
Lead	US$/lb	0.632	0.255	0.304	0.334	0.340	0.405	0.441	0.452	0.534	0.576
Zinc	US$/lb	1.518	0.510	0.607	0.668	0.680	0.810	0.883	1.067	1.259	1.359

Note: Iron ore prices are given in mtu (metric ton units), sometimes also referred to as dmtu - dry metric ton unit since they are calculated on a dry basis. The mtu is normally priced in US cents. To get the actual price for a specific iron ore the mtu value has to be multiplied with the grade of the iron ore concentrate. Normally a high quality iron ore concentrate has 62-64 % iron content. Some iron ores contain as little as 28-30 % iron only. For other metals the price is normally given on a 100 % metal basis although a traded concentrate does not contain 100 % copper or zinc but much less than that.

These values in table 1.1 are in nominal terms and have been determined by forecasting values for 2010 and then using a forecasting factor extrapolated to 2020 and 2025. This extrapolation process uses values dependent on the commodity, time period and the level of optimism. Using conservative Cu as an example the forecast factor from 2010 to 2020 is 1.15.

For this method to be more accurate than using a flat nominal value beyond a certain point in the future as many shorter term forecasts do, an estimate of future inflationary trends must be considered. Here we have assumed that the developed world economies and the now industrialising economies (China, India and Brazil) will maintain their successful low inflation stance at 2-3% annual inflation. This is outlined in Table 1.2.

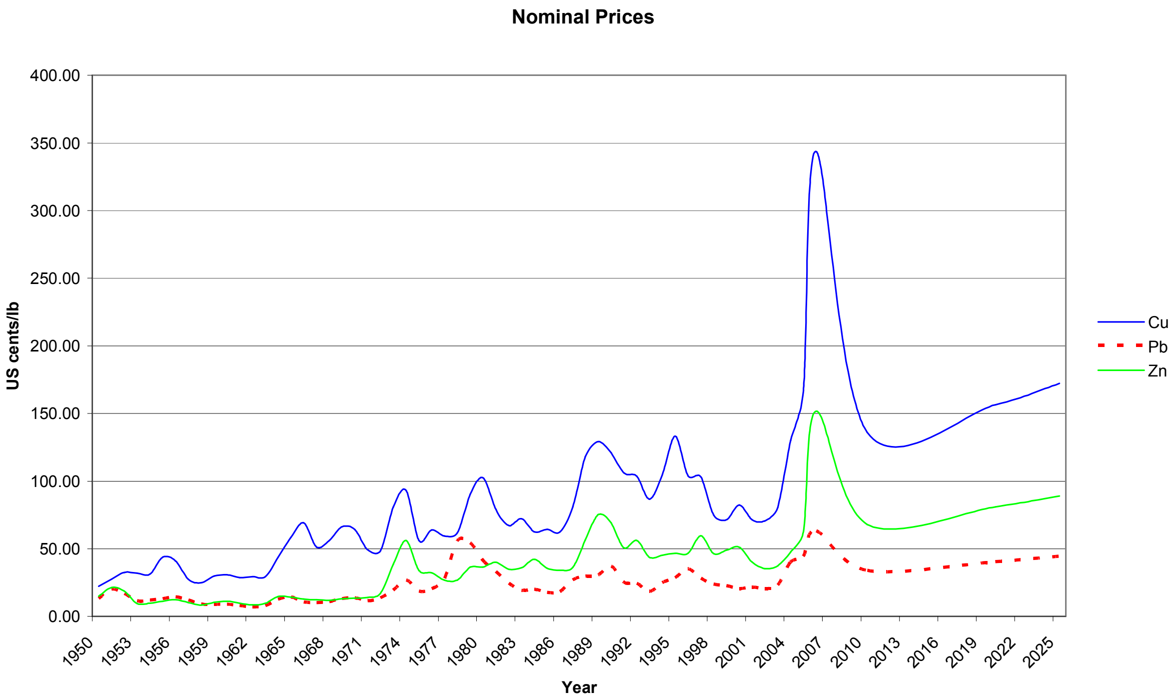
Table 1.2.

	Forecasting Factor	
Period	Government 2-3% CPI	Increasing to 5%
2006-2010	1.08	1.08
2010-2020	1.24	1.33
2020-2025	1.09	1.17

The above table compares our assumption with an increasing rate of inflation to 5% by 2020 and continuing at this rate to 2025. Naturally if the forecasting factor is below the inflation rate over the same forecasting period there will be a decrease in real price for that commodity. Staying with the conservative Cu example we are forecasting that the real price will decrease during this period.

Remaining with the base metal example, figure 1.3 illustrates this forecast factor method produces results from 2010 inline with the overall trend of these metal prices since 1950.

Figure 1.3.



The forecasting methodology outlined above uses historic price trends to predict the long term prices of various commodities and as such is bias towards historical price movements. An alternative method would have been to base forecasts on supply and demand fundamentals for each commodity. In the present study time and resources allocated does not permit a model to be built in this way. Instead we have made a qualitative discussion of the factors affecting demand and supply. We consider the above method the most appropriate (and in effect the only possible) given these constraints as it generates forecasts on a combination of global economics and metal price historical trends.

In summary the forecast for the commodities cover is for a general decrease in price from 2007/2008 until 2010 after which prices will increase in nominal terms but not in real terms.

Coal and Iron Ore

The same method has been employed to coal and iron ore. The following two figures 1.4 and 1.5 illustrate recent price history with the conservative forecast data. Note, in both cases the forecast length is longer than the historical data available. In the case of coal global prices have only been relevant since bulk shipping began in the late 1970's (eg exporting from Australia to Japan).

Although prices of coking and thermal coal show a strong correlation in the past the short term outlook differs significantly due to high demand for coking coal by the steel producers. It is however forecast that a correction would have occurred by 2010 and the price from there onwards would trend towards the 2006 2007 price peak. In 2006 thermal coal began to correct. This correction is forecast to be less drastic than the coking coal correction but a longer cycle is expected before nominal prices begin to increase.

Long term supply and demand forecasts suggest that coking coal will have a widening deficit from 2006 – 2010 while thermal coal will remain in moderate surplus from 2006 – 2010.

Figure 1.4.

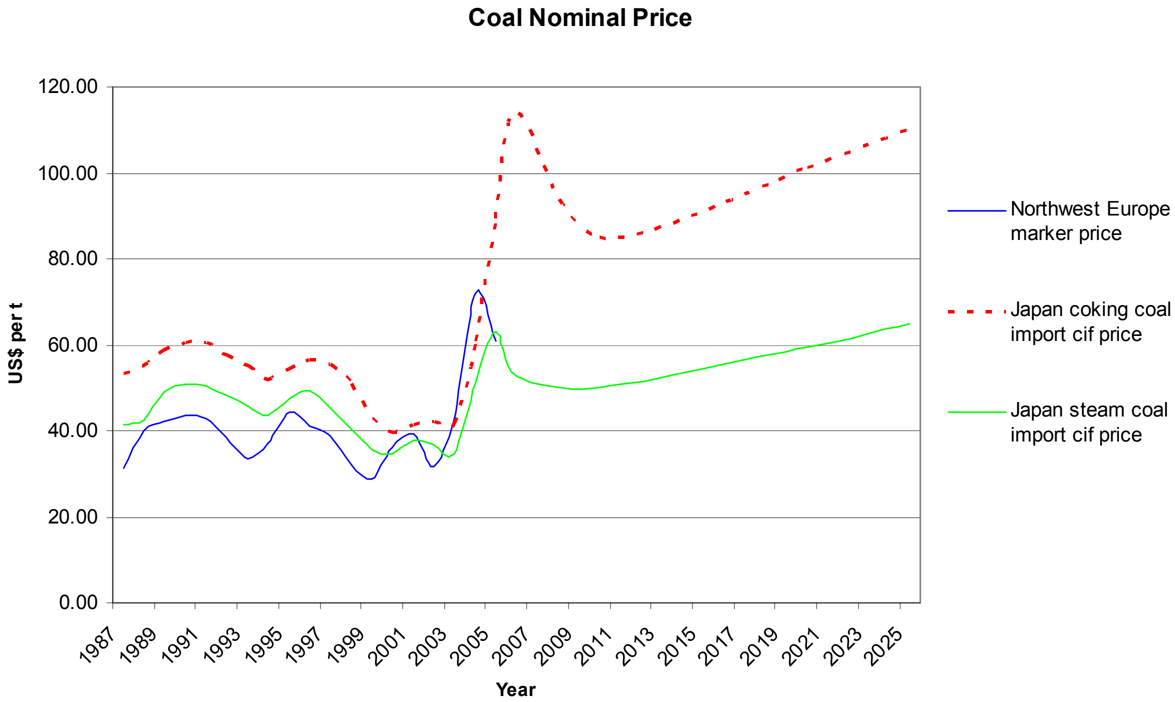
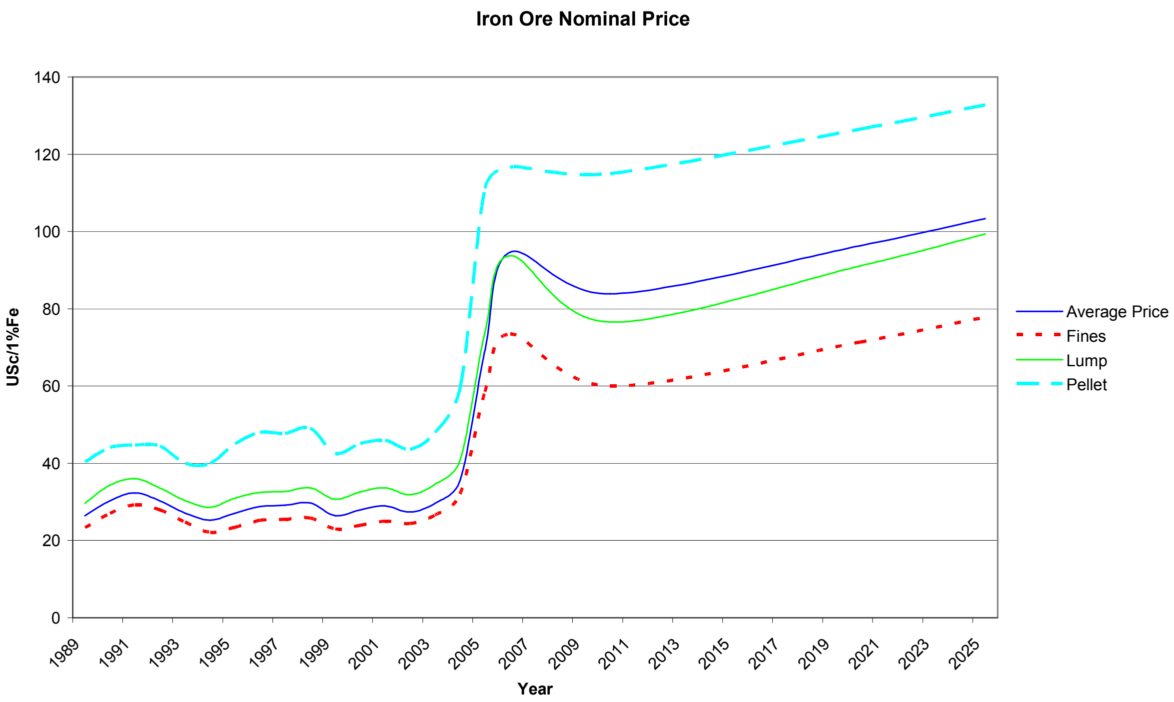


Figure 1.5.



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