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The China Resources Boom

By

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This paper draws heavily on my joint work with Ligang Song of The Australian National University on the implications of Chinese growth for global resource markets. Material from that work was presented by Dr Song at a conference in Shanghai late in 2005, and will be expanded in a paper to the Australian National University's annual China Update conference economy in August this year. The final product of this work will be a book with the current working title, "Resources for the China Boom". This work is supported by the ANU-Rio Tinto Partnership on China Economy and Business.

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The China Boom and the Australian Economy

INTRODUCTION

Australia is currently experiencing a resources boom of historic dimensions. Its immediate and important cause is sustained rapid growth in China. Terms of trade have reached heights unknown since the early seventies of the last century. This time, high export prices are concentrated in energy and metallic minerals, when they were broadly based across agricultural and mineral products a third of a century ago. Australian exports are now (although in the twenty first century decreasingly) more diversified across manufactures and services, so it has taken higher relative prices of minerals to take overall terms of trade back to earlier peaks.

High export prices have been joined (belatedly) by exceptional rates of growth of investment in the resources sector. Minerals and energy production and processing are now relatively larger in the Australian economy than at any time since Federation, so that the leverage of the resources investment boom on overall Australian economic growth is unprecedented.

The high terms of trade and resources investment have allowed Australia to avoid what would have been a painful and probably recessionary end to a virulent early twenty first century housing and consumption boom. The terms of trade effects have kept Australian incomes and public revenue growth well in excess of expansion of production for several years.

The resources boom has shifted the centre of gravity of national economic growth decisively from the great cities of the southeast to western and northern regions, with the state of South Australia also beginning to receive a boost to activity from the minerals sector. This challenges longstanding assumptions of Federal fiscal relations, which have been calibrated to redistribute public revenues from Victoria and New South Wales to the smaller states and the two territories.

For all of these reasons, it is of great importance to Australian national policy to understand the origins and dynamics of the resources boom, its likely longevity, stability and future dimensions.

The contemporary resources boom is global rather than regional in nature, and so has the potential fundamentally to change the environment for Australian international relations. Amongst our immediate neighbours, in Papua New Guinea the China boom has provided the foundations from which, with good leadership in the key economic ministries, the public finances have been rebuilt, economic stability restored and economic growth rekindled after a decade of stagnation. Growth has been assisted in several Southeast Asia economies—although not yet in Indonesia, which is still grappling with the implications of the political decentralisation that has been introduced with democratic government. Brazil, Chile and other substantial economies in Latin America have emerged from periods of difficulty to hope for much better. Chinese investment and demand is

incubating new projects and industries through Central Asia, the Middle East and parts of Africa. Significantly for global politics has been the boost that the new international resources environment has given to Russian economic performance and self confidence, with implications running through domestic and international political arrangements, and to the economic power of oil exporting countries in the Middle East.

This paper focuses on the central cause of these changes rather than the wide-ranging implications. It addresses the questions about the longevity and future strength of the current resources boom. It identifies some of the main factors that will determine the scale of economic expansion in China and its effects in international markets. It examines some of the general economic considerations affecting the impact of rapid growth in one country on the global resources economy.

CHINA'S GROWTH AND RESOURCES DEMAND IN INTERNATIONAL HISTORICAL CONTEXT

The current period of exceptionally high growth in demand for and prices of energy and metallic minerals is a "China boom", rather more than high metals prices from the late 1950s to 1973 represented a "Japan boom", or in the two decades preceding the First World War a "United States-Germany" boom.

There are two principal reasons why this is so, and an additional reason why the impact of Northeast Asian including Chinese growth on global resources markets has been greater than that of the United States in its period of rapid industrialisation.

The first reason why the current resources boom has been generated in one country, China, to an exceptional degree, arises out of the nature of rapid, internationally-oriented economic growth. Such growth, which Australians associate with East Asian development over the past half century, involves backward economies "catching up" with the technologies, institutions and intensity applied in the most advanced economies. The global frontiers of productivity investment incomes continue to be extended over time, so that latecomers can move more rapidly than their predecessors, because the gap is larger between the productivity of their own and the world's most advanced economies.

British productivity and incomes growth in the late eighteenth century at the onset of the "industrial revolution" built upon the invention of the early institutions of capitalism in the small states of the "low countries" and Italy. Once modern industrial growth was established in the United States and Germany in the second half of the nineteenth century it proceeded more rapidly than it had in corresponding periods of economic development in the British homeland through absorption and adaptation of the pioneer's technology, business institutions and in some circumstances capital. In the two decades after the restoration of a functioning political system in Japan after the Second World War, Japan became the first economy to grow so rapidly that it doubled output in a single decade. Famously, having done this once in the 1950s, it doubled output again in a shorter period in the 1960s. Japan was able to do this because the productivity gap over which it was

“catching up” was larger than that facing earlier economies experiencing rapid internationally-oriented growth. Rapid growth ended in Japan when its average productivity and income levels entered the range of the developed economies in the mid-1970s.

Of course, rapid growth requires a number of institutional and policy conditions to be met. Following the Japanese example, one after another of the smaller East Asian economies—most importantly Taiwan and Korea—implemented the necessary reforms and grew at rates fast enough to more than double output in each of several decades.

When Deng Xiaoping and his supporters, with their commitment to economic reform and opening to the outside world, established a dominant position in the Central Committee of the Chinese Communist Party in December 1978, the opportunity for sustained rapid economic growth through absorption of institutions, policies, technologies and capital from abroad was greater in China than it had been for any of its East Asian predecessors.

The obstacles to the necessary reforms were in many ways more fundamental in China than they had been for Japan, Taiwan or Korea. The ideological, institutional and political economy barriers were formidable. Through the early years of reform there was no finely developed strategy—no “blueprint”—for reform. Early steps towards an internationally-oriented market economy were awkward and incomplete. But the size of the opportunity was so large that the steps that were taken generated large results from the beginning. Since 1978, the average rate of growth in output of goods and services has been about nine and a half percent per annum. The “gap” with the advanced economies has been closed to some extent over that time, but any diminution of opportunity with which this has been associated has been outweighed by continued progress in policy and institutional reform. One can see today many imperfections in the institutional and policy basis for Chinese growth that represent substantial risks to its continuation. But the barriers that remain are small compared with those which have been overcome in the past 27 years. The most likely although necessarily uncertain prospect is for growth in China to continue at something like the rate of the past quarter century to continue for several decades, albeit with the cycles associated with a market economy, and the inevitable bumps in the path of modernisation of a backward economy. If this is the way things turn out, by the middle of this century Chinese people in the mainland, too, will enjoy average productivity growth and living standards within the range of the advanced industrial countries. (For reasons that I have explored elsewhere, the process of ‘catching up’ with the average incomes of the advanced countries, once it is well established, proceeds more rapidly than the simple arithmetic of differential growth rates would suggest).

The relative backwardness of China at the beginnings of internationally-oriented reform and rapid growth, together with the magnitude of the obstacles to reform, mean that economic growth can proceed at the high rates of China’s Northeast Asian neighbours for a longer period before it is slowed by the economy’s approach to the global productivity frontiers.

The second reason why the impact of rapid Chinese growth on international markets is greater than that of any of its predecessors is simply that China has a much larger population—almost twice as large--than all of the established advanced economies taken together. At the peak of its per capita demand for metals and energy—in a few decades in the most likely case—China will be using considerably more metals and energy than the rest of the developed world combined. It will probably account for the majority of the world's growth in import demand for resource-intensive products for most of the intervening years.

Finally, China relative to the established developed economies—especially relative to the United States, but also relative to other populous developing countries (Brazil and India) that have been experiencing acceleration of economic growth over the past decade—has a low per capita domestic endowment of most economically valuable natural resources. Following the trade policy reforms of the past two decades, a high proportion of incremental Chinese demand for most minerals flows directly into imports. Coal is an exception, and this has major implications for the impact of Chinese industrialisation on the global resources economy.

One only has to identify the possibility of China absorbing twice the amount of resource-based products as the currently developed world to raise some fundamental questions. Is it possible that Chinese economic growth will be hampered by exhaustible resource constraints, as Slade (1987) suggested might be the fate of rapidly growing newcomers to industrialisation? Are the energy and other natural resources available to allow China, India and other developing countries to achieve the living standards of the advanced industrial countries? Or will global living standards eventually be limited by a “finite amount of essential, depletable natural resources” (Nordhaus, 2000, p529).

Economists today, unlike other social scientists and the general polity, do not fear that the world economic growth will grind to a halt because the world “runs out” of potential for expanding production of energy, metals or other natural resource-based products. The experience of development, and not only our theory, inform us that higher prices will induce expansion of output and substitution in supply and demand for scarce resources, as well as some modification of the rate and pattern of economic expansion. But while, in the end, supply will equal demand at some higher level of global economic output, the process of adjustment is of great importance, and can affect economic activity in the rapidly growing economies and elsewhere.

This paper deals mainly with one corner of these issues: the growth in demand for resource-based products that can be expected to be associated with economic growth in China. But it says a little about the economics of the global supply response, that will play a large role in the market adjustment process and the prices generated through adjustment.

The paper pays considerable attention to the experience of growth in resources demand in, and the associated pressure on global markets from, Japan, Taiwan and Korea during their periods of sustained, rapid economic growth in the second half of the twentieth

century. In comparing the Chinese experience so far, and that of Japan, Taiwan and Korea two, three and four decades ago. China is different in several ways but most importantly in its size, in the wide 'gap' at the beginning of the reform process, and by the gradual introduction of the reforms that gave rise to economic growth. These may turn out to be decisive differences. They may cause the resources boom associated its growth in the decades ahead to raise the prices of resource-intensive products by a large amount, not for a few years, but for several decades. This will have important implications for economic development and the distribution of incomes within and between all countries, and on power relations between States in the Asia Pacific and through the world community.

THE ECONOMICS OF THE MINERAL RESOURCE INDUSTRIES

The natural resources that are used in the production of the energy and metals that are essential to economic development are not scarce in any absolute sense. All of the industrial metals are abundant in nature, to an extent that is unlikely to be challenged by human demands for the foreseeable future at any conceivable rate of global economic growth. And while it is possible that the growth of demand might test the limits of some particular sources of energy—notably petroleum occurring naturally in liquid form—the total potential supply of natural energy sources that are available for utilisation by humans exceeds any conceivable requirements.

All of the important economic questions about natural resource “limits to growth” are about the costs of converting naturally occurring metallic minerals and the various sources of energy into forms that are suitable for supporting economic development, and the costs of transporting them to the loci of human demand.

For the fossil fuels, there are separate issues of the environmental costs of their use. It may be - indeed, it is likely - that the environmental limits to the rational use of fossil fuels will be reached long before the absolute availability of the natural resources comes into question. Indeed, growth outcomes for China near those that this paper judges to be most likely, accompanied by reasonable rates of growth in large developing economies in which it has accelerated over the past decade, in the absence of effective international policy response, would be likely to generate global environmental outcomes that validated the fears of the most zealous of environmentalists. If realisation of this reality were to lead to effective constraints on expansion in the use of fossil fuels, the demands on other energy sources would be increased. Supply of energy from some combination of other sources could be expanded beyond practical limit at some cost. The environmental limits on use of some sources of energy are discussed in the wider work of Song and myself, but not in this paper.

All of the economically valuable minerals are available abundantly in nature, but at varying concentrations, and in different chemical associations with other elements that affect the cost of extraction, concentration and purification. They are available in nature at varying depths below the earth's surface, and separated by varying distances and natural barriers from the locations in which they are in demand for economic activity.

The costs of supplying minerals to the places where there is demand for them have several elements. One is the cost of discovery and definition of the ore bodies that have the concentrations of the economically valuable element, and other characteristics, that make total costs of supply relatively low, and therefore make the ore body suitable for economic use. A second is the capital cost of building the mine and the processing facilities to convert the natural mineral into an economically valuable form. The third is the recurrent cost of producing and processing the mineral. The fourth is the cost of transporting the product of mining to the place where it is to be used.

In the early stages of use of minerals in modern economic activity, mines were mainly located close to the main centres of industrial production—first of all in the North Atlantic. In these early stages, mining was confined to ore bodies of high concentration, close to the surface of the earth, in chemical forms from which they could be extracted at low cost with simple technology. The expansion of global industrial activity led to extension of the locations of mining beyond the main industrial centres, to the mining of lower concentrations of minerals, and to technological innovation that increased the range of chemical compounds that had economic value as a source of metals or energy.

There are high capital costs in exploration and mine development. The supply price of investment is higher in some locations than in others—today, typically much higher in developing countries with poor legal and political institutions and in which international investors have less confidence in the stability of property rights, contracts, the fiscal regime and the political order more generally.

It is typically much cheaper to expand production of valuable minerals from an established mine, than to create new capacity to mine an ore body which, at the margin, has similar characteristics. It is obviously much cheaper to supply minerals from an ore body close to an established centre of industrial activity and joined to it by an established transport infrastructure. Transport economics plays a much larger role in the supply of commodities with low value relative to volume or weight (iron ore, bauxite), than to commodities with high value-to-weight (gold).

These characteristics of the economics of the global minerals industries might be expected to lead to steadily increasing mineral prices with the expansion of global demand. Depletion of the best-located and highest quality ore bodies would require the mining of higher-cost and more distant mines, located in countries where the supply price of investment was higher. The more global economic activity expanded, the faster the rate of increase in global mineral prices. Within this framework, more rapid modern economic growth in major countries—Japan in the third quarter of the twentieth century and China in the late twentieth and the twenty first centuries—would lead to acceleration in the rate of increase in global commodity prices.

The reflection of these realities in commodity prices has been obscured by a tendency for technological and institutional change affecting the supply of mineral commodities to proceed more rapidly than similar change in the total economy. Political change has

expanded the number of countries from which minerals can be drawn into world markets, and lowered the supply price of investment to many countries. The decentralisation of global economic activity away from the North Atlantic, especially to East Asia, has reduced the remoteness of many ore bodies, notably in Asia and the Pacific. Innovations in transport technology have reduced the costs of supplying minerals from remote locations. Developments in technology have reduced the costs of discovery of new ore bodies, and facilitated identification of potential mines that are so deep or otherwise obscured to humans that their presence had hitherto gone undetected. New processing techniques have allowed the extraction of minerals from chemical compounds that were once beyond economical human use. New construction technology has reduced the capital cost of establishing new mines. And innovations in mining methods and equipment have reduced the recurrent costs of mining.

The history of technological innovation in economic development tells us that necessity is the mother of innovation, so looming scarcity and rising prices of minerals could be expected to support high rates of innovation. But this provides no reason why technological change in mining should have proceeded so much more rapidly in mining than in other industries that the price of minerals relative to other minerals should actually have fallen over much of modern economic history. And yet it has for considerable periods for some commodities—a fact that, pending explanation, we should put down to accident and not consider to be necessarily a permanent feature of global economic development.

Minerals and energy prices over long periods have been characterised by wide cyclical fluctuations. This derives from the long lead times in the generation of production from investment in exploration and mine development, and from uncertainty about future demand at times when exploration and mine development decisions are taken. Once the investment has been committed, the owner of a mine has an economic interest in continuing production from it so long as the price of the product covers recurrent costs, even if it makes little contribution to recoupment of the cost of capital. Production levels are therefore maintained even if demand growth is unexpectedly low—as a result of recession or political dislocation, or a change in growth trajectory, in major economies. This can keep prices at levels well below the total cost of production for long periods, while global demand catches up with earlier expectations and investment in new capacity is discouraged. On the other hand, if major economies grow at an unexpectedly rapid rate, prices can remain well above the total cost of production for the long period that is required to find and to develop a sufficient number of sufficiently large new mines.

So we can characterise the behaviour of resources prices over time in the following manner. There is a tendency for mineral prices to rise over time with global economic growth, as a result of requirements to bring lower quality and more poorly located ore bodies into production. This tendency is stronger the more rapid is global expansion of economic activity. It is offset to some extent by institutional and technological innovation, which proceeds more rapidly at some times than others, one might expect more rapid institutional and technological improvement in mining than other industries simply because, in its absence, the real prices of mineral products would be rising, thus

increasing the incentive to innovate. But there is no reason why—indeed, one would be surprised to find consistent evidence over long periods that—the technological improvement should proceed so much more rapidly in mining than in other industries that real prices of mineral products actually fall.

Around these determinants of long-term tendencies in real prices of mineral products, there are wide and sometimes long-lasting cycles in prices, resulting from market participants' failure to anticipate correctly the growth in global demand.

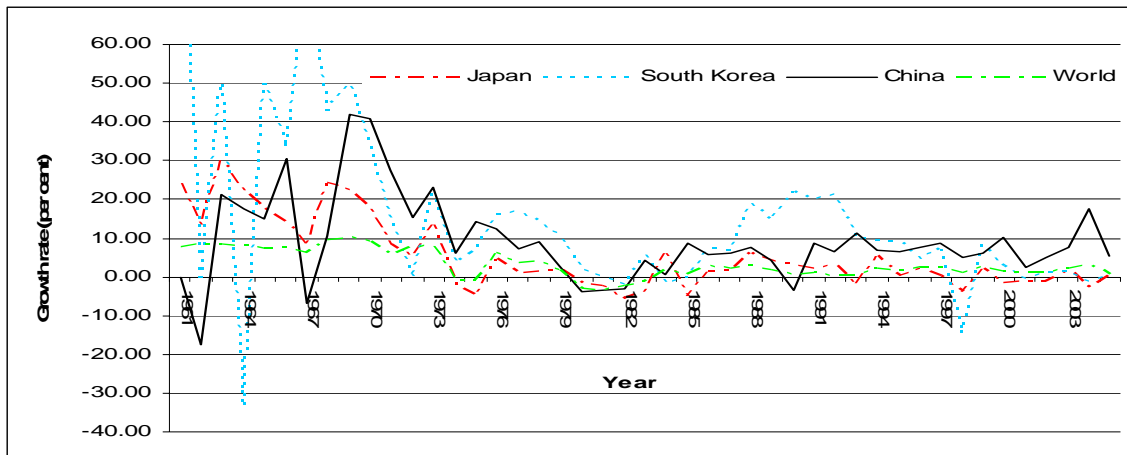
The discussion so far has been in terms of a single mineral commodity. In reality, the many natural sources of energy and the many metallic minerals are substitutes for each other, and for non-mineral products, in supply and in demand. These tendencies introduce powerful corrective forces if the real price of one product rises or falls a great deal.

RESOURCE PRICES AND NORTHEAST ASIAN DEMAND

The extraordinarily rapid economic growth in Northeast Asia over the past half century—at first in Japan, then in the newly industrialising economies with Korea the largest, followed by China, has added significantly to growth in global demand for energy and metallic minerals. The Northeast Asian economies now loom large enough in global demand for unanticipated fluctuations in the growth in their demand to affect global prices.

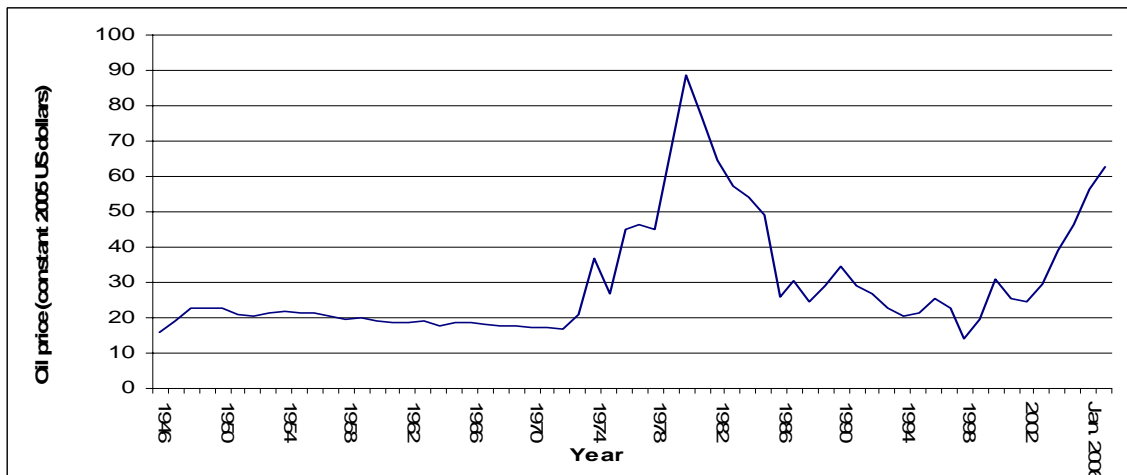
Figure 1 presents data on global and Northeast Asian demand for petroleum over the past four decades. The most striking story to be taken from Figure 1 is that global demand growth is highly sensitive to price, independently of growth in global economic output. The period of rapid Japanese economic growth, ending in 1973, was characterised by rapid growth in global energy demand, commonly around 8% per annum, and well in excess of world economic growth. Growth in Japanese energy demand was very strong, commonly contributing around 2% per annum to growth in total global demand, but the rapid pace of consumption increases elsewhere meant that this was only one quarter of the world total. This happened to be a period of stable oil prices in real terms (Figure 2), which ended with the “oil shock” of 1973. Over the two decades to 1973, global supply was able to keep pace with rapid increases in demand as new discoveries were made in the Middle East and as major United States and British oil companies turned themselves into effective multinational corporations.

Figure 1, Growth rates of demand for petroleum: Northeast Asia and the world



Source: Authors' calculation using the data from US Department of Energy.

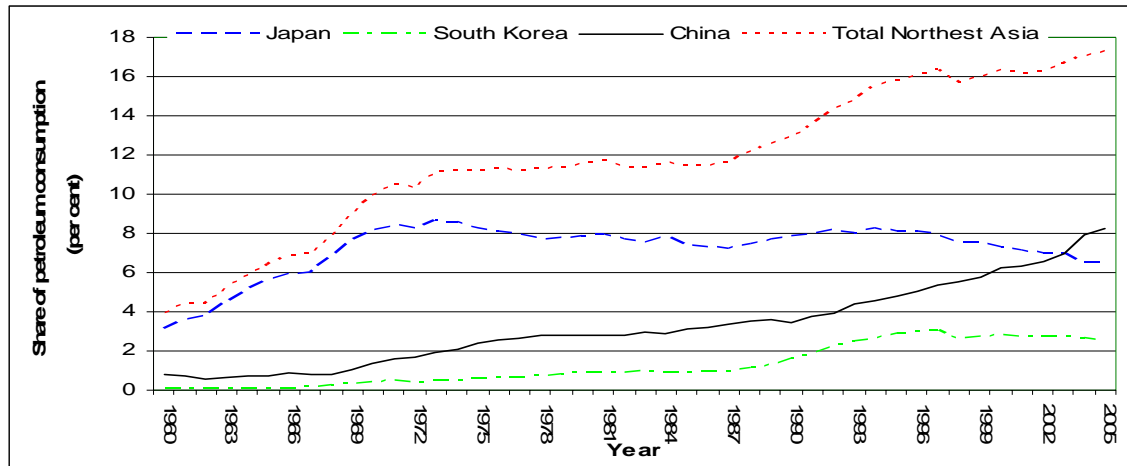
Figure 2 Crude oil prices adjusted for inflation: 1946-February 2006



Source: Authors' calculation using the data from US Department of Energy.

Japan contributed a significant part of the growth in global petroleum consumption in the 1960s and early 1970s. (Figure 3). It was therefore part of the cause of the tightening in world markets in the early 1970s that set the scene for the large lift in oil prices. But the shift that generated the higher prices was more evident in supply than in demand conditions.

Figure 3 Shares of petroleum consumption in the world: Japan, South Korea, China and total Northeast Asia: 1960-2005

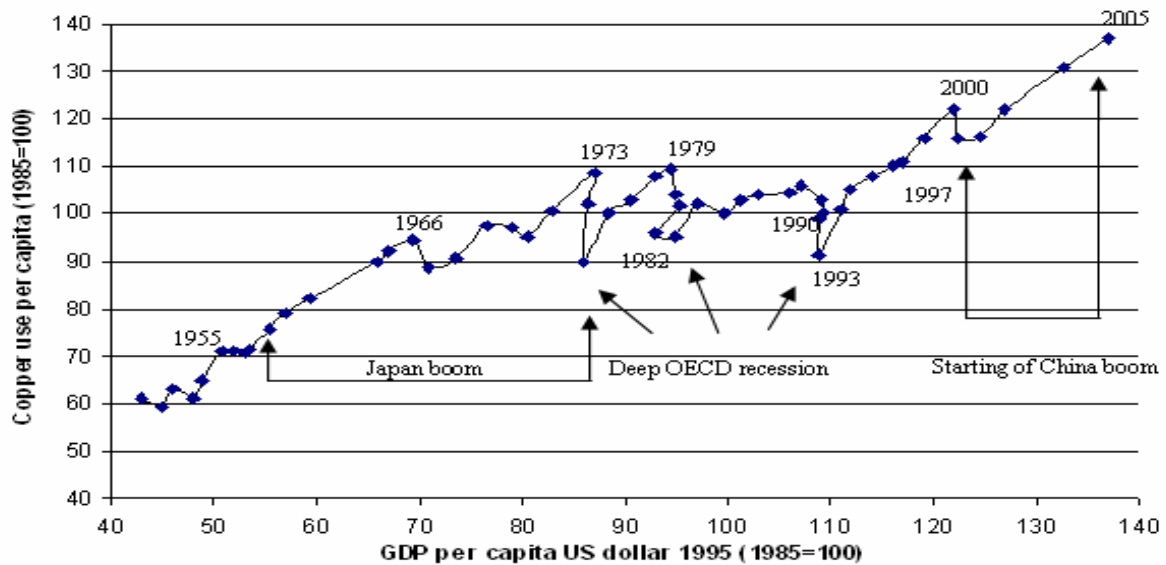


Source: Authors' calculation using the data from US Department of Energy.

The much higher energy prices from 1973 to 1986 (gradually extending from oil to energy in all its forms) had a dramatic effect in reducing growth in consumption. World energy use fell from 1979 to 1983—at first as the United States and some other major economies went into recession, but still as global economic activity recovered. This was a time when Northeast Asian moved more or less in line with global demand—after the deceleration of Japanese growth, and at a time of deliberate and effective phasing out of energy-intensive industries and processes in Japan, and before Korea and China were large enough to make a mark on the global economy. From 1987, rapid expansion in the Korean and Chinese economies began to contribute a large proportion of the growth in global demand for energy, but at a time when demand growth in the rest of the world was weak. Continued strong growth in Chinese demand came to be associated with tightness in global markets only in the early twenty first century, when reasonably strong growth in consumption was again evident in the rest of the world—encouraged by historically low prices in the immediate aftermath of the East Asian financial crisis.

Figure 4 tells the story of global demand growth for copper in the second half of the twenty first century. Per capita global consumption was exceptionally strong through the period of sustained rapid growth in Japan with reasonably strong growth in the North Atlantic economies, from the early 1950s to 1973. Per capita copper consumption then grew slowly, dipping sharply during the recession of the early 1990s (which coincided with the collapse of the Soviet economy), and again in the United States recession of 2000-01. It has since resumed strong growth, with China the major influence.

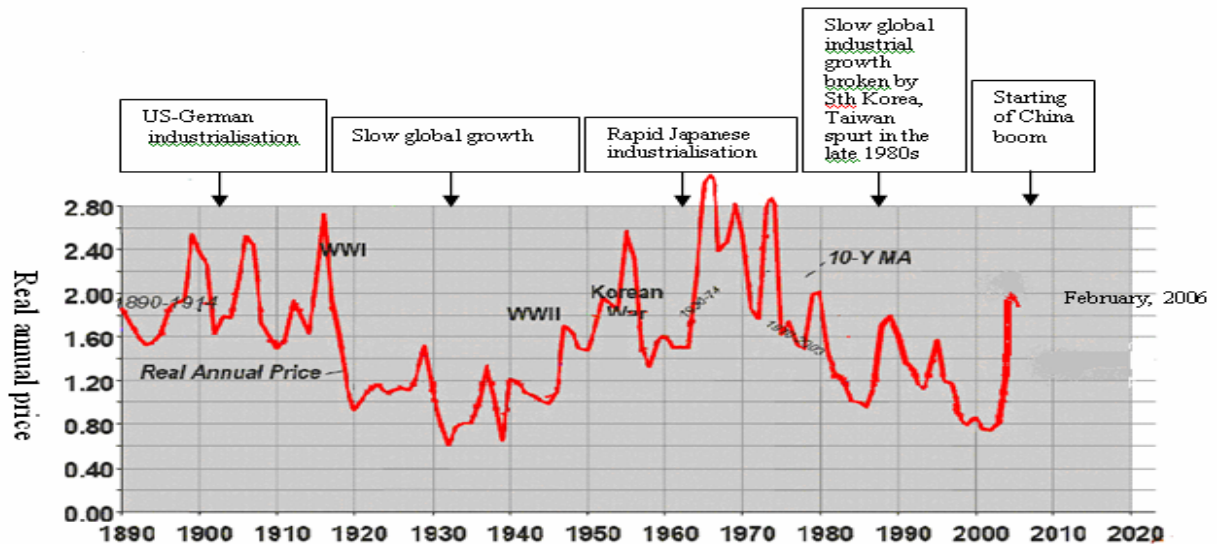
Figure 4 World copper consumption and GDP per capita: 1950-2005



Source: Macquarie and authors' calculation.

The global price of copper in real terms has fluctuated widely with cyclical and periodic variations in consumption growth (Figure 5). In this long-run perspective, there have been four distinctive periods for global copper prices since the late nineteenth century. Prices fluctuated around 180 cents per pound in today's values in the rapid global economic expansion from the recession of the early 1890s until the First World War. They fluctuated around a much lower level through the relative stagnation of the 1920s and 1930s—with a mean about 100 cents per pound in today's prices. The price trend was steadily upward from the Second World War until the oil crisis of 1973. It reached an historically high average above 200 cents per pound over the last decade of this period, corresponding to the time of sustained rapid Japanese growth after Japan had become large enough to influence global markets. The trend was then steadily down: a bit above a dollar in the 1980s and 1990s, and to Great Depression levels near and below 80 cents in the years straddling the turn of the century. Since then, we may have entered a fifth period, marked by price revival, with the current (February 2006) spot price of about 230 cents being shockingly high by the standards of the immediate past, but not unusual for earlier periods of sustained global prosperity, notably the two decades leading up to the First World War, and the decade or so preceding the first oil crisis.

Figure 5 Global copper price: 1890-February 2006



Source: Natural Resource Canada, Australian business.

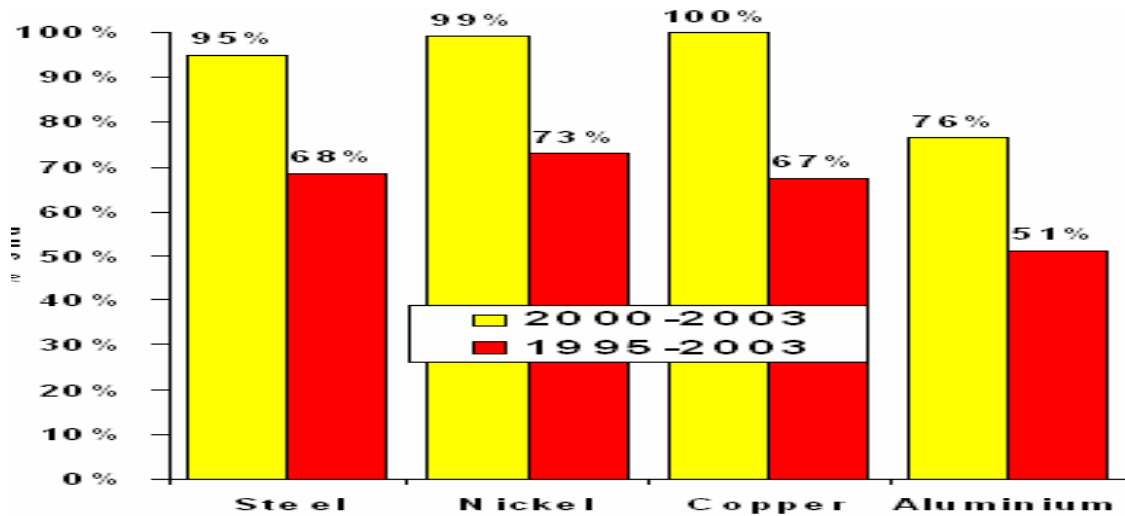
Copper prices much more than oil or energy generally have fluctuated widely with cyclical variations in global economic activity. In this, copper and other metals are affected by their intensive use in capital goods, the demand for which is highly sensitive to the business cycle.

A CLOSER LOOK AT RESOURCE DEMAND IN NORTHEAST ASIA AND CHINA

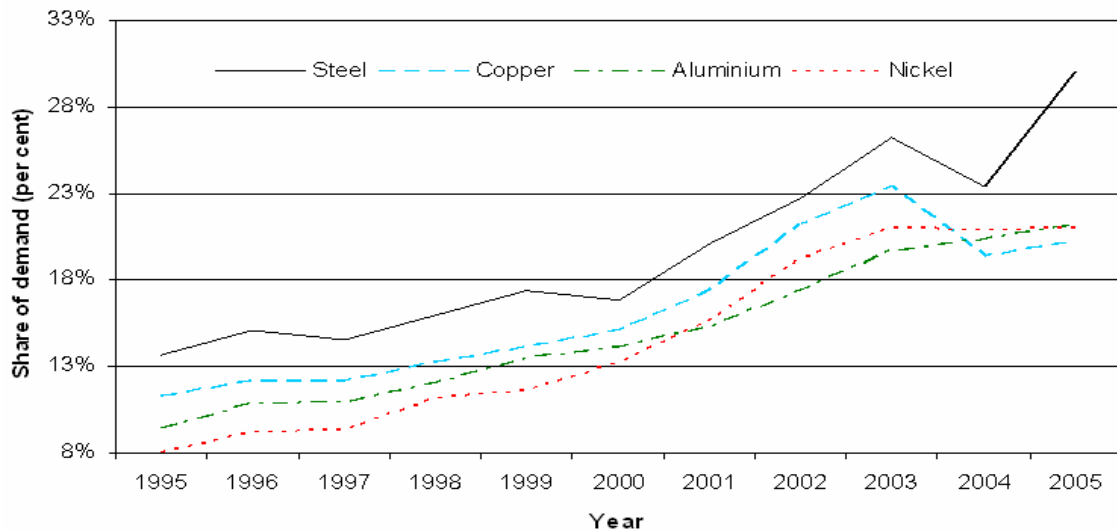
The preceding section of the paper suggested that, for both energy and metals (exemplified by copper), strong growth in Chinese demand has been associated with a new era of rising real global prices in the early twenty first century. Figure 6 underlines the importance of China to the recent period of rising real minerals prices. It complements Figure 3, which revealed the large position of China in recent growth in global energy consumption. China accounted for a majority of the growth in world consumption for each of the main industrial metals in the decade from 1995, and for virtually all of the growth for several metals in the early years of the twenty first century.

Figure 6 China's shares of major demand of key metals: 1995-2005

(a) China's share of total world growth 1995-2003



(b) China's share of global demand: 1995-2005



Source: data for 2004 and 2005 are collected from websites of Chinese Mining and Resource (www.ChinaMR.net). Earlier data Macquarie.

China has achieved this large position in global markets when it is in the early stages of what is likely to be a long period of rapid economic growth and when its per capita consumption of energy and metals is low by the standards of the advanced industrial countries (Table 1 and Figures 7 and 8). This follows, of course, from China's demographic size: China's population is almost twice as large as that of all of the currently developed countries combined.

Table 1 International comparison of energy consumption per capita: 2003 (toe)

Year	Coal	Petroleum	Natural gas	Hydro- and other power	Total
United States	1.95	3.11	1.93	0.83	7.82
France	0.21	1.57	0.66	1.91	4.34
Germany	1.06	1.52	0.93	0.52	4.03
Japan	0.88	1.95	0.54	0.59	3.95
United Kingdom	0.66	1.29	1.45	0.36	3.76
China	0.61	0.21	0.02	0.06	0.90
World average	0.41	0.58	0.37	0.19	1.55

Source: China Energy Research Institute.

What will be the effect of China's continued economic growth on global energy and metal demand? Here we look at the experience of East Asian and other advanced economies in their periods of rapid growth, industrialisation and urbanisation, and discuss ways in which China may be similar to and different from those which have gone before it.

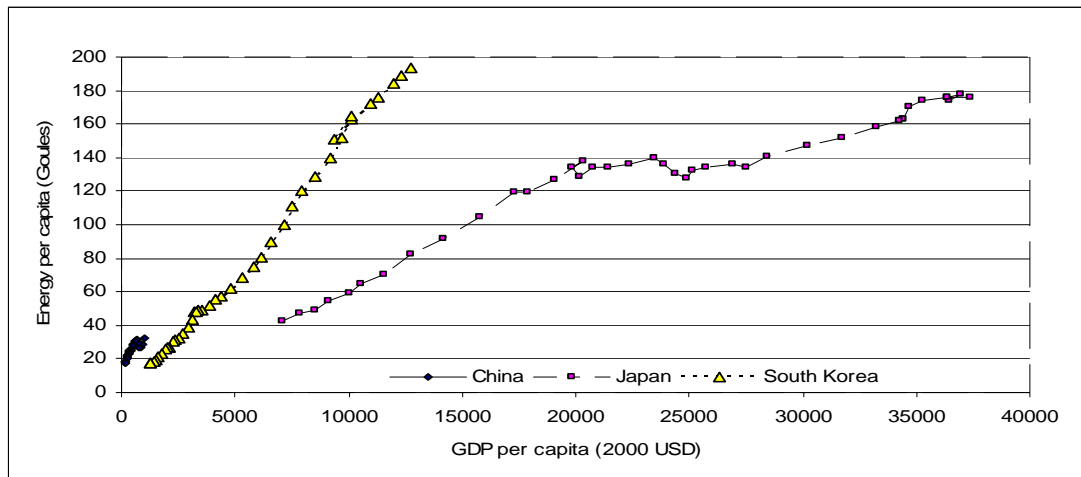
In seeking to draw lessons from the experience of other countries, we quickly come up against an awkward fact: China consumes far more of virtually all goods than other countries which have, or when they had, per capita incomes similar to China's. Work undertaken a little over a decade ago suggested at that time that China's consumption per capita of most foodstuffs was comparable to that of other East Asian economies when their per capita incomes, as measured by the standard national accounts, had been three times as high as China's in the early 1990s when all data were expressed in the dollars of the same year. The consumption of energy and metals was comparable to that of other economies when their per capita incomes were four or five times as high as China's at that time (Garnaut and Ma, 1993; Garnaut and Huang, 1994). While the legacy of central planning and price distortion may have contributed to some upward bias in metals and energy use, the divergences across countries could not be explained without acceptance that there was a degree of underestimation of income in the Chinese national accounts, which were used by the international financial institutions. The apparent underestimation of Chinese income was less pronounced but still present in the international Purchasing Power Parity estimates of national output and incomes.

In the years since then, there has been some upward adjustment to Chinese national income as reported by the Chinese domestic statistical agency and the international financial institutions. The most recent, and large, upward adjustments were announced in late 2005. However, the levels of consumption for virtually all goods remain high for a

country with China's reported per capita output and income. There are likely to be further upward adjustments in Chinese official data on output and incomes before the data can be used without qualification for international comparisons.

Figure 7 shows that Chinese per capita energy use has risen rapidly in recent years, to levels approaching those attained by Japan when its per capita income was almost \$US7,000 in constant dollars of the year 2000. Energy demand in all of the Northeast Asian economies expanded more rapidly than income until, in Japan's case, average incomes reached almost \$US20,000. Energy consumption relative to income has increased more rapidly in Taiwan and Korea than in Japan, and more rapidly again so far in China. The general pattern is for per capita energy and metals consumption to rise more rapidly than per capita GDP during the period of rapid growth associated with the movement to and through middle incomes, but to fall behind as the global frontiers of average productivity and income levels are approached (Slade, 1987). This pattern is evident in the experience of Japan in Figure 7, but not yet in that of Taiwan or Korea.

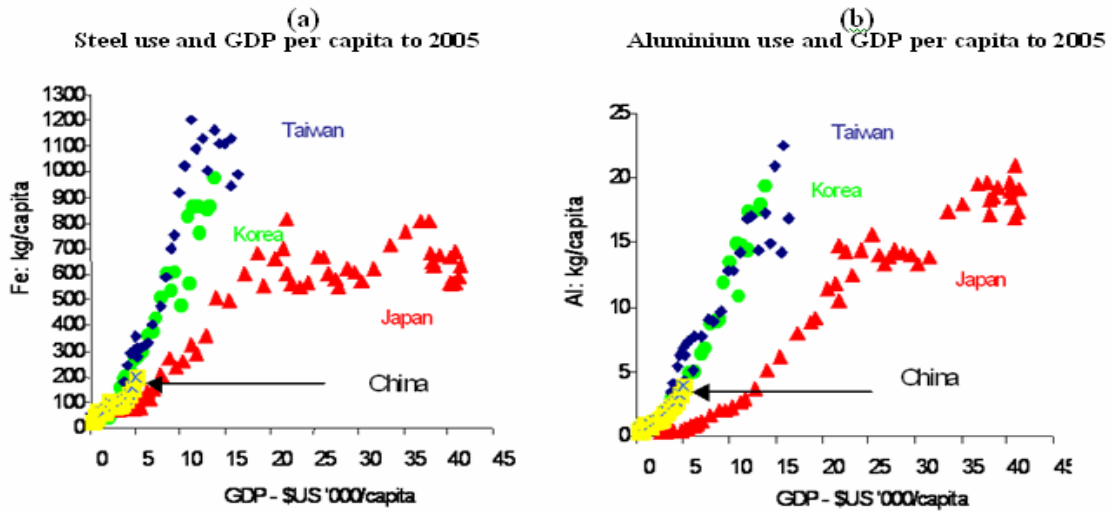
Figure 7 Total energy consumption intensity: China, Japan and South Korea



Note: the data for China coming from pre-2005 national account.
Source: authors' own calculation.

While there are important similarities in the relationship between resource use and economic growth across the Northeast Asian economies, there are also differences. Figure 8 reveals higher income elasticity in metals demand in Taiwan and Korea than in Japan. The data suggest that China so far is following a Taiwan-Korea pattern for aluminium demand, but an intermediate position for steel. The difference between Taiwan-Korea and Japan seems to derive to a considerable extent from the much greater international orientation of Taiwan and Korea: the continued strong growth in exports, and the size of exports relative to GDP, together with the considerable metals content of those exports, has maintained strong demand growth for metals through the period when services have come to occupy a large place in domestic demand growth.

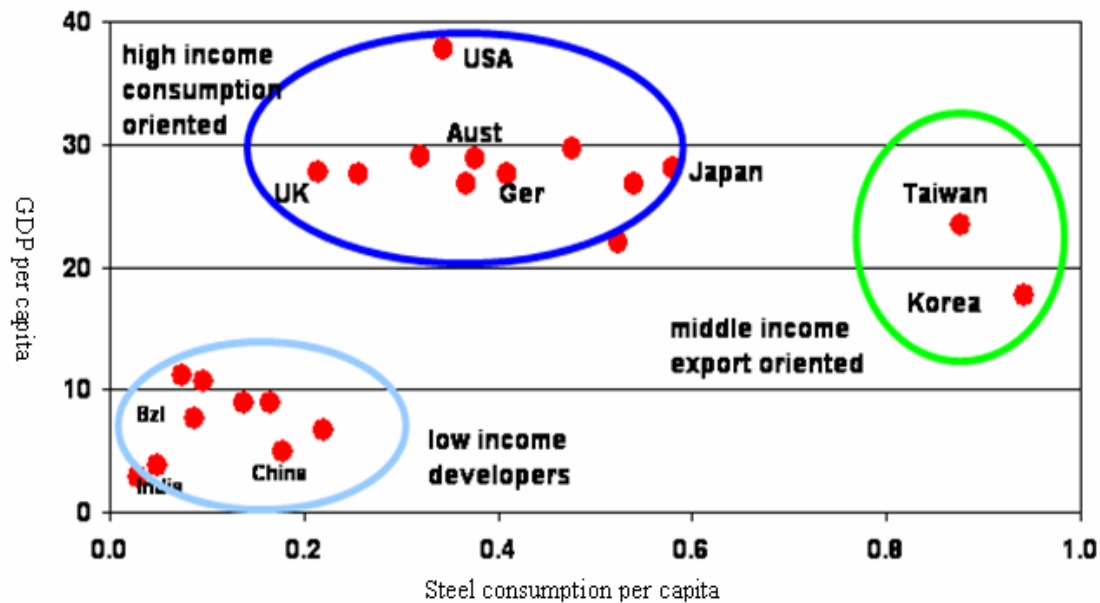
Figure 8 Metals demand and economic growth in Northeast Asia



Source: Macquarie Research Metals and Mining and authors' calculation using pre-2005 China national account data.

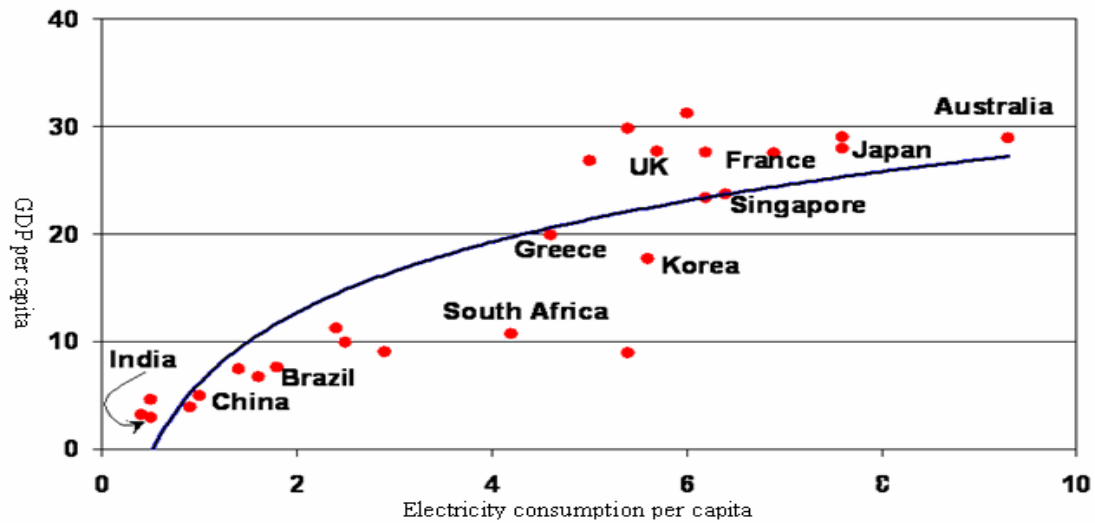
On a global scale, it is Taiwan and Korea rather than Japan that are distinctive in the relationship between incomes and resource use. Figure 9 reveals Japanese per capita steel consumption to be high by the standards of other developed countries, but much less so than Taiwan and Korea. Japan's per capita electricity consumption is close to the general relationship between consumption and per capita GDP (Figure 10).

Figure 9 Steel consumption and level of development



Note: the calculation is made with the data from China pre-2005 national account.
Source: Westpac.

Figure 10 Electricity consumption and level of development

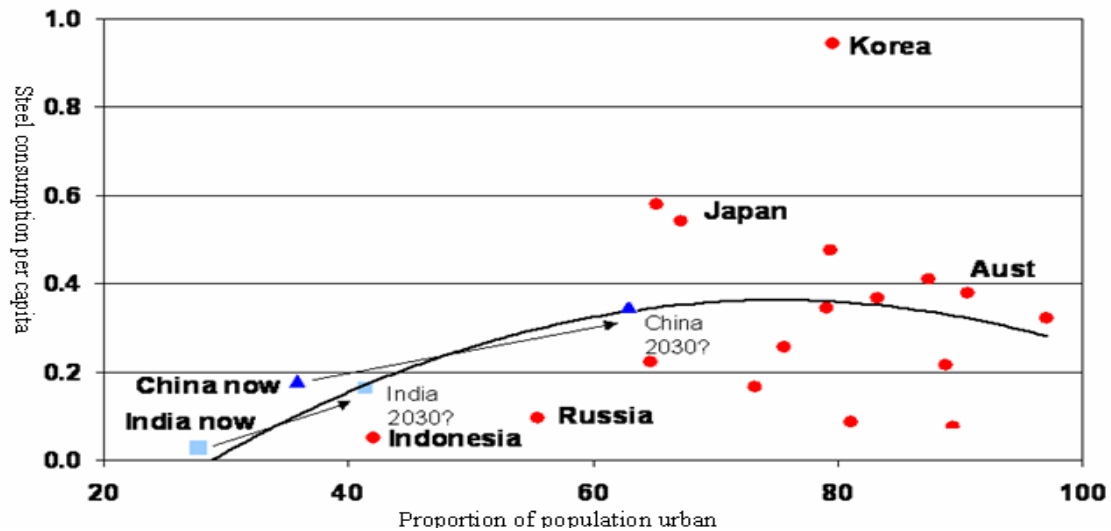


Note: the calculation is made with the data from China pre-2005 national account.
Source: Westpac

However one looks at the comparative data, there is no doubt that the rapid growth in Chinese demand for metals and energy will continue as incomes rise in the decades ahead. The analysis in the following section suggests that the Chinese experience may contain some of the elements of that of Taiwan and Korea, in which economic development was associated with exceptional growth in demand for resources.

A further clue to likely future growth in demand for energy and metals can be found in analysis of the typical relationship between urbanisation and resource consumption. The extent of urbanisation in China (defined as the proportion of the population living in urban areas) is low for China's income levels (Figure 11). This is to a considerable extent the result of controls on internal migration. These have loosened and urban growth has been rapid in the reform period. The urban population more than trebled, from 172 million to 524 million, between 1978 and 2003. Continued rapid urbanisation can be expected to underpin demand for resources in the decades ahead.

Figure 11 Steel consumption and urbanization



Note: the data for China coming from pre-2005 national account.
Source: Westpac.

DETERMINANTS OF RESOURCE INTENSITY OF CHINESE ECONOMIC ACTIVITY

We have noted that per capita resource use in China has been showing some similarity to that of other Northeast Asian economies in their periods of rapid growth. What factors will contribute to similarities and differences in future?

The legacy of central planning and price distortion has provided some artificial stimulus to metals and energy consumption. This has been largely unwound over the past two decades of reform, but energy prices remain artificially low, and the degree of distortion has increased through the recent period of rising world oil prices. Low energy prices have provided minor stimulation to the use of metals through the encouragement that they have provided to consumption of metallic consumer durables, first of all automobiles. The likely unwinding of remaining price distortions in the years ahead will dampen energy consumption growth.

The unwinding through reform of artificial constraints on rural to urban migration will be a significant factor in the opposite direction, encouraging the use of both energy and metals.

Chinese input-output tables reveal a much higher direct and indirect metals content in investment than in other components of GDP (Table 2). By 2000, the metal product contribution to each unit of investment output was twice as high as the metals component of total GDP. The coal and petroleum content of investment was also much higher than of GDP.

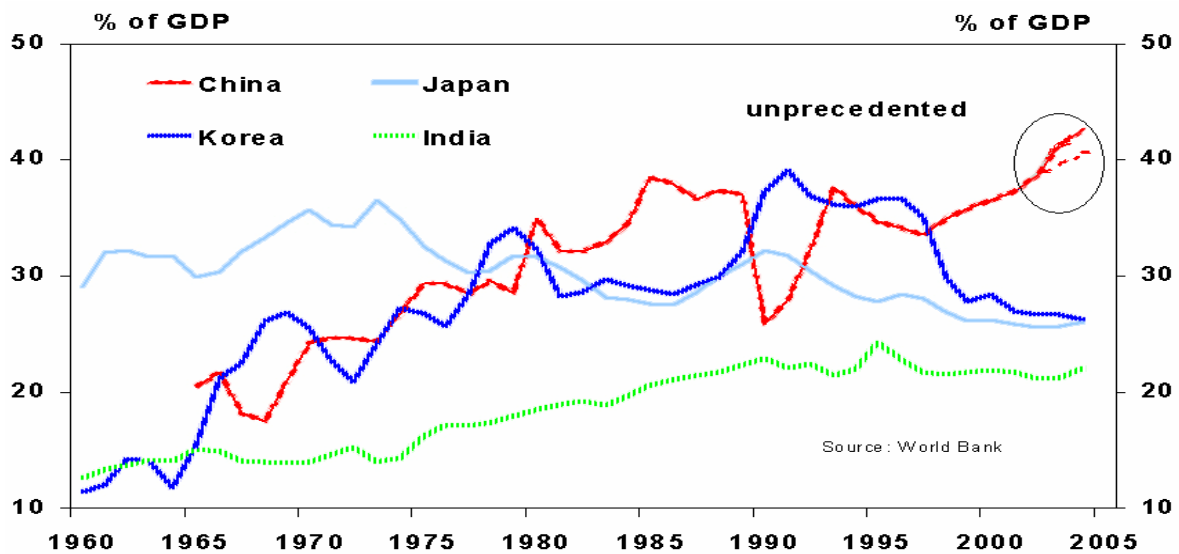
Table 2 China: shares of resource sectors in total investments, exports, and outputs (per cent)

Sector	Investment		Export		Total Output	
	1997	2000	1997	2000	1997	2000
Coal and Petroleum	2.09	5.58	1.51	1.92	1.91	3.35
Metal Product	11.29	13.56	6.94	7.81	6.25	6.28

Source: Calculated using the Input-Output Tables of China: 1997 and 2001

The extraordinarily high investment share in Chinese growth is therefore highly stimulative to metals consumption. The investment share in GDP is higher in Northeast Asia (and in Singapore) than in any other economies, now or in any historical period. It is already higher in China than at any stage of development of any other Northeast Asian economy. Investment continues to grow more rapidly than total output. While it is not possible for the investment share of GDP to rise without limit, it will remain extraordinarily high, and probably above the unprecedented levels reported for 2004 in (Figure 12 and Garnaut and Huang, 2005.) The unusual level of and growth in investment has contributed to per capita consumption of fossil fuels and especially metals being high for China's income. It will help to underpin high levels of resources use for a long period into the future, although it will not for much longer be a separate source of rising consumption.

Figure 12 Long run investment shares of GDP: China, Japan, Korea and India



Note: the dotted line for China is calculated with the adjusted national account data, and the solid line is calculated with the pre-2005 national account data.

Source: Calculated using the data from Garnaut and Huang (2005) and the World Bank.

We have commented that the high export-orientation of Taiwan and Korea together with their strong and strengthening comparative advantage in metal manufactures has

contributed to the continued rapid growth in per capita consumption of metals, beyond the income levels when per capita metals consumption began to slow in Japan. The metals value-added in Chinese exports is currently little higher than in total GDP, because China's comparative advantage remains strong in labour-intensive products. But this comparative advantage is evolving into more capital-intensive and therefore more metals-intensive products as rapid growth continues and Chinese incomes rise. Chinese export-orientation is and will continue to be stronger than Japanese, but less pronounced than in Taiwan or Korea. The "export factor", to the extent that it is influential in a mix of factors, will therefore tend to place China on a path of metals consumption growth somewhere between the high levels of Japan and the extraordinarily high levels of other Northeast Asian economies.

WHO WILL FUEL CHINA?

While there are risks to the sustainability of rapid economic growth in China, there is a reasonable prospect that it will proceed at average rates near the average for the past quarter century for several decades (Garnaut, 2005. Reference: Garnaut, Ross (2005), "The Sustainability of Rapid Growth in China", Australian Journal of International Affairs, forthcoming).

The above analysis suggests that China's per capita rates of consumption of energy and metals will have approached the average for the developed world by the end of that time. In the absence of major changes in behaviour in response to higher prices or realisation of negative environmental effects, the expansion in China's own consumption will have raised global energy demand by something like 40 per cent of what it would otherwise have been. With the same qualifications about responses to price, on the expectation that its pattern of growth in demand for metals will be somewhere between that of Japan and Korea, China's proportionate impact on global metals markets will be somewhat larger. The trend increase in Chinese demand may be augmenting global energy demand by about 3 percent per annum for a considerable period.

Where would the supplies come from and what would be the nature of the impact on global markets?

We have drawn on historical analogy in this paper, and we will do so again. Given the slowdown in growth in established developed economies, even this rate of growth in Chinese demand would not push the total rate of increase in global energy consumption to the high levels of the last decade of rapid economic growth in Japan, 1963-73. Those high rates of increase in energy demand were supported by low-cost expansion of petroleum production. There was some tightening in oil markets over time, but prices did not move until the political shocks of 1973.

The long lead times in exploration and development mean that we know now that there are no opportunities in the decade ahead painlessly to expand global oil expansion in the manner of the years of rapid growth in Japan. This time, the international market

response will be more varied and complex. Prices will rise above the average levels of the past two decades. This will lead to economisation in use of oil, as did the high prices in the decade after 1973. It will lead to more rapid development of the many alternative sources of energy all over the world. Amongst much else, there will be heavy investment in expanding production from China's own coal reserves, and in nuclear energy generation in China.

The increases over the past two years have already taken oil prices to levels where economisation in use of energy occurs at a rate that is evident in the global numbers. Prices have already reached levels at which investments in many alternative energy sources are profitable. The increases over this period may turn out to be unnecessarily large or small, but there are reasonable prospects that we have seen most of the necessary adjustment in relative prices. For the global economy, the greatest costs of higher prices are borne in the adjustment to change, and we are in the process now of bearing a major part of those costs.

The experience of the 1960s and early 1970, covering the last decade of rapid economic growth in Japan, may provide a closer guide to prospective global market developments for metals than for energy. The strong growth in postwar demand led to average real prices that were twice as high for most metals, as the average during the long stagnation from 1914 until the years of recovery from the Second World War (Figure 5). This induced steadily expanding supplies, including from countries which had hitherto played marginal roles in global markets. New forms of long-term contracts and project finance underpinned the development of major new sources of coal and alumina in Australia and iron ore in Australia and Brazil.

The big lift over the past two years has taken copper prices to around the high averages of the 1960s and early 1970s. There have also been large price increases for other metals—some a bit more than for copper, some a bit less. For all metals, there have been large increases in investment in exploration, mine development, and increasing output from established mines. As in the 1960s, new institutional arrangements (the Chinese multinational corporation) and new suppliers (Papua New Guinea for nickel and several African and Latin American and Central Asian countries for a wide range of metals) are the focus of large investments. As with oil, much and probably most of the price adjustment has already occurred, and there is no reason to doubt global markets' capacity to meet the new demands on them.

We should end with one note of caution. China's rapid growth involves economic, social and political change on a scale that is unprecedented in world history. It is unlikely to proceed over decades without bumps in the road, and an occasional dead end and detour. With China in a few decades consuming annually more resource-based products from world markets as the whole of the currently developed world, the rest of the world will feel every bump through energy and metals as well as other markets.

