

Mining in the knowledge-based economy

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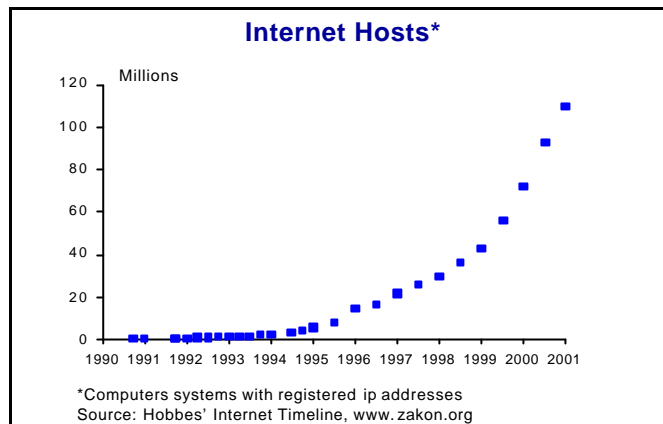
I am grateful to the organisers for asking me to speak on mining and the knowledge-based economy rather than on mining and the new economy. This is not just because the new economy is having rather a hard time of it at the moment. It is also because mining struggles to position itself within the framework of the new economy but has much less difficulty in doing so within that of the knowledge economy.

On the face of it mining might seem the very antithesis of the knowledge economy; the bricks as opposed to the clicks. Consider, however, the following definition of the knowledge-based economy from a recent UK government white paper. "A knowledge driven economy is one in which the generation and the exploitation of knowledge has come to play the predominant part in the creation of wealth. It is not simply about pushing back the frontiers of knowledge; it is also about the more effective use and exploitation of *all types of knowledge in all manner of economic activity*" [emphasis in original].

The paper goes on to identify four "mutually reinforcing processes" which are increasing the importance of knowledge as an engine of economic growth. These are the revolution in Information and Communications Technologies (ICTs), increased global competition, the acceleration of scientific and technological advance and changing patterns of demand. All these processes have profound relevance to the mining sector both in shaping the world in which it operates and the manner in which it operates. While none is exactly new, it is at least arguable that they have been given an extra twist by the arrival of what is known as the new economy

ICTs and global growth

The revolution in information and communication technologies – illustrated in the chart below by growth in the number of internet hosts - has been helping break down barriers of geography to create truly global markets in goods and in factors of production. Wider access to information and easier means of communication promote the efficiency of markets and enable capital and skills to flow to where they can most productively be employed, boosting output and raising living standards.



The precise impact of these technologies is hard to assess. Research by Goldman Sachs published last year suggested that productivity benefits brought about by the new technologies contributed about 0.75% a year to US growth between 1980 and 1994 rising to around 1.5% over 1995-1999. Research in the UK suggests a contribution of 0.6% a year. One thing we do know, however, is that a decade in which the contribution of knowledge to growth is widely believed to have increased also saw an acceleration in demand for products of the minerals industry, this despite the strongly depressing effects on consumption of the economic collapse of the Soviet Union.

World Growth Rates 1960-2000

annual average percentage changes

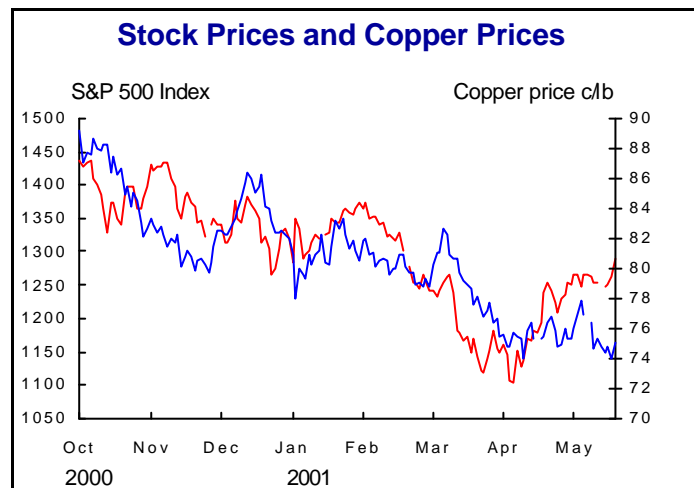
	1960-70	1970-80	1980-90	1990-00
GDP	5.0	3.9	3.6	3.8
Aluminum	9.6	4.6	2.8	3.1
Copper	4.3	2.8	1.7	3.6
Nickel	6.8	2.7	2.6	3.7
Zinc	5.3	2.0	1.2	3.0

Source: IMF, Metallgesellschaft

Patterns of demand

If demand for mineral products has accelerated across the board over the past decade, some commodities are clearly better placed to benefit from the emergence of the knowledge economy than others.

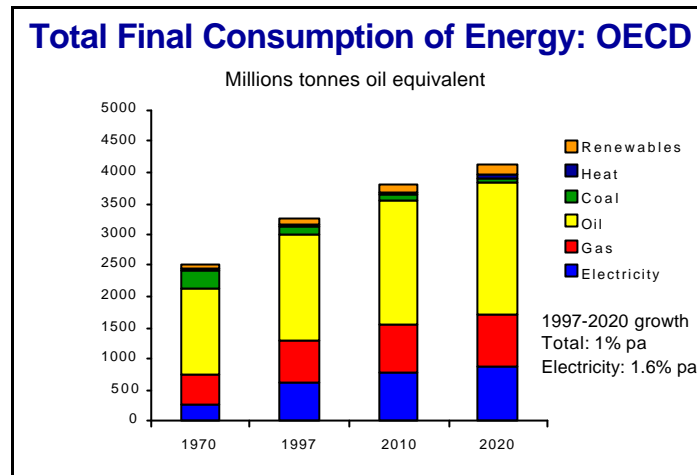
The knowledge economy is above all an electrical economy and commodities which have a key role to play in electrical supply and in electronics look set to emerge winners. Copper, with its numerous applications in electronics and telecommunications, is one such. For anyone who doubts the relevance of metals to the modern economy, an examination of how copper prices have tracked stockmarkets over the past few months is instructive. The only pity is that the general direction of the trend has been down.



Coal, a product more associated in the public mind with the steam economy, might seem a less likely champion of the knowledge-based economy, or at least might have done up to the point when the Californian power crisis struck and highlighted the critical dependence of the knowledge economy on secure and reliable power supplies. The internet warehouses which have sprung up around Silicon Valley, and which are now coming to Europe, absorb the power of a good sized town. The US Energy Secretary in a speech in March stated that the internet already consumed 8-13% of electricity in the US and that, just to maintain the rate of growth of the last decade, more than 90 power stations would need to be built every year for the next twenty-five years. Europe, which has been similarly reticent about building new power stations, will doubtless face similar pressures in time.

Forecasts of energy use from the International Energy Agency show, as might be expected, the primary drive for power generation over the next twenty years

coming from the developing world. However, it is also noteworthy that they show demand for electrical power in the developed world running well ahead of the demand for energy more generally.

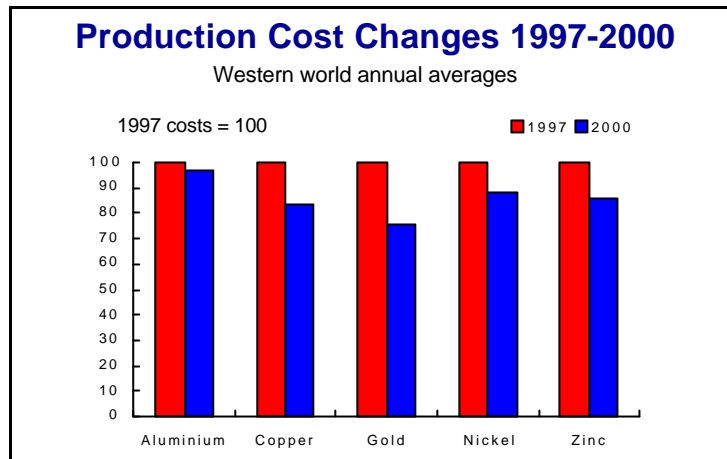


The precise manner in which this electrical power will be generated is of course highly speculative and dependent on matters such as policies aimed at restricting greenhouse gas emissions. However, two things are certain. First, the world is not going to give up its requirement for increased electrical power lightly. And second, whatever power options are adopted, they will depend heavily on mined products to fulfil them, whether in the form of coal or uranium for fuel, copper for wires, lead and nickel for batteries, platinum catalysts for fuel cells, or high-performance alloys for windmill blades

Competitive pressures

Along with the revolution in ICTs has gone a less benign influence for the minerals sectors, the intensification of competition. By bringing increased market transparency, ICTs strip away regional protections and other market imperfections which have in the past supported inefficiencies and local price premiums.

Information on market opportunities today spreads instantaneously. State-of-the-art technologies and industrial best practice can be transmitted to mine operators wherever they may be, pushing up performance and driving down the cost curve. The chart below shows how industry operating costs dropped an average of 14% between 1997 and 2000, with aluminium least affected and gold most. While persistent pressure on margins is scarcely a new experience for the mining industry, these developments do not suggest that there is going to be any relief going forward.

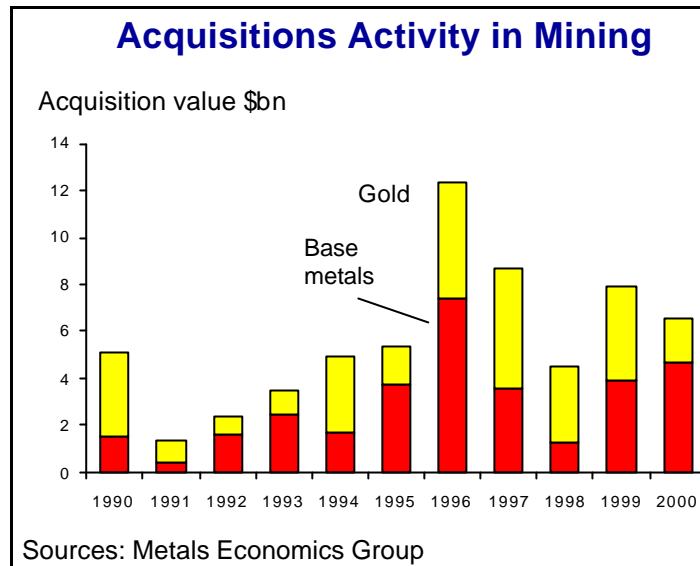


There has also been some debate over whether the use of ICTs to promote e-trading could intensify price competition for miners by providing readier access to market for marginal players. While this may be the case for a few commodities, for most minerals and metals it is not clear that the impact of e-trading will be that great. Markets for ores and concentrates are generally characterised by few players and highly differentiated products, limiting the scope for e-trade. As regards nonferrous and precious metals, these markets were already extremely efficient before the latest wave in ICT growth set in. With transaction costs typically less than 1% of the value of the metal, it is hard to see where major savings can be achieved. What is perhaps a more serious risk from the mining industry's point of view is that competing e-marketplaces could lead to a fragmentation of market liquidity and the diminished reliability of reference prices for mined products.

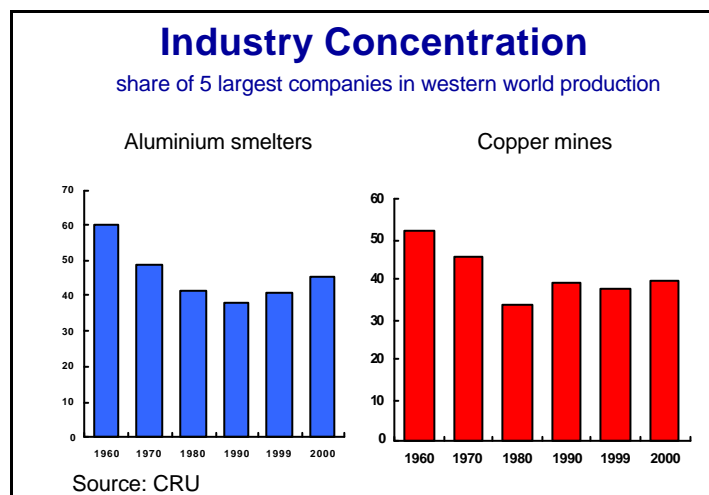
Structural impacts on mining

Impacts of the knowledge-based economy are not confined to the environment in which the industry operates. They also have important implications for the way the industry is organised and run.

The globalisation and intensification of competition which have accompanied the ICT revolution have been important contributing factors to the recent restructuring of the mining industry, illustrated here by acquisitions activity over the past decade.



Through consolidation, industry players are seeking to size themselves according to the global markets in which they operate, thereby to meet the demands of their increasingly globalised customers and to be able to identify and exploit investment and market opportunities at a global level. Some concerns have been voiced that this might give mining companies greater pricing power. In practice, it seems more likely that greater size will enable companies to compete more effectively across a broader spread of markets. Moreover, for all the recent mergers and acquisitions, the degree of concentration, in aluminium and copper at least, remains below what it was in the 1960s and 1970s.



At the same time that the knowledge economy has been contributing to pressures for mining companies to consolidate, so it has also been equipping them with a new range of opportunities to benefit from greater size.

Traditional economies of scale focused on the individual operation and on the spreading of fixed costs over a larger and larger output. These have undoubtedly played a key part in driving down mining industry costs in the past.

The ICT revolution brings with it a whole new range of cost saving possibilities, commonly referred to as 'economies of scope'. These are economies which arise at the corporate level and flow from having control over more than one operation. They include, for example, economies from being able to disseminate best technological and environmental practice across a wide range of operations; from being able to standardise equipment across a company's operations and benefit from the central procurement of that equipment; from being better able to coordinate shipping and marketing activities; from the availability of opportunities to exploit geographical diversification; and from being able to share back-office services amongst several operations. In addition, by linking these various developments together using integrated business systems – or Enterprise Resource Planning systems as they are sometimes called – companies have the possibility of making the whole add up to more than the sum of the parts, leveraging the entire value chain through from supplier to customer. Clearly, little of this could have been contemplated without recent developments in telecommunication and internet technologies.

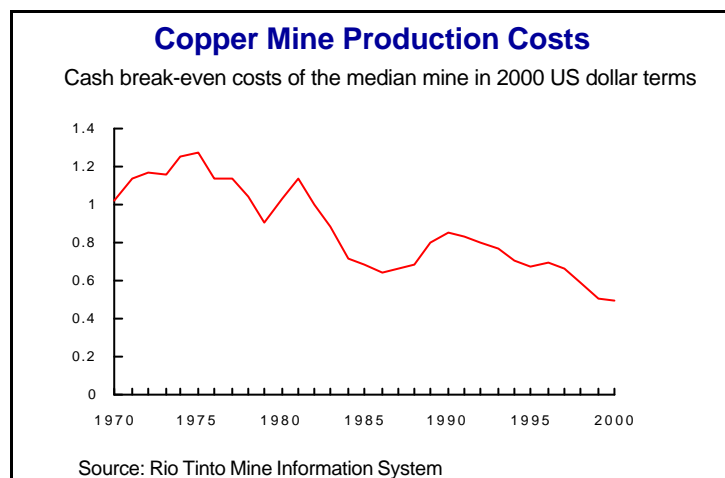
Knowledge in mining value-added

The emergence of these economies of scope marks a more general shift in the location of value-added in the mining sector. In the knowledge economy, as our definition at the outset emphasised, the contribution of knowledge to wealth-creation increases relative to the contributions made by the other three factors of production, land, labour and capital. Looked at another way, value-creation comes to depend progressively less on the possession of physical assets. In mining, an effect of this has been to shift value-adding opportunities away from discovery and capital spend towards the application of intelligence to reconfiguring and streamlining existing industry assets. This has arguably been a key factor behind a lot of the recent acquisition activity in the industry and behind the growing pursuit of capital efficiency; which is to say, making existing capital work harder. The popularity of 'benchmarking' in the 1990s could also be considered a manifestation of this tendency.

For an industry which works a depleting asset, discovery will always play an important role in value-creation and doubtless new knowledge-based technologies will play a role in helping to identify new deposits. It may also be the case that the growing importance of knowledge to the mining industry will put a premium on certain types of deposit, for example those with long reserve lives which maximize the period over which learning can take place and capital be written off. However, the prosaic reality appears to be that much of the value creation in the mining industry has come from grinding out costs at and across

existing operations and that the downshift in the industry cost curve owes more to this fact than to the entry into the industry of new low-cost capacity.

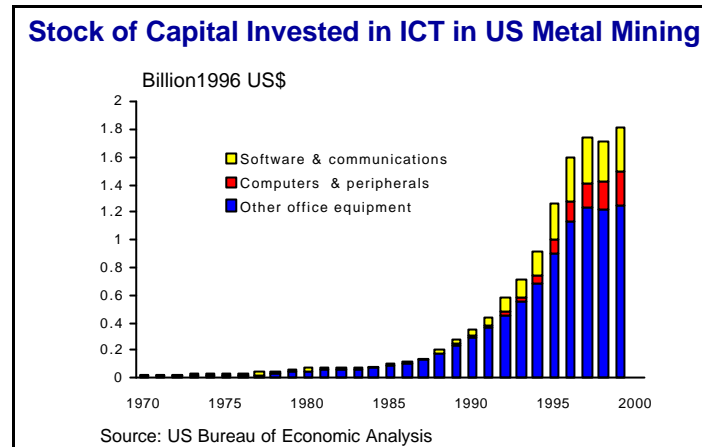
Through knowledge-led productivity improvements, mining companies have made massive strides in cost reduction, in many cases without major expenditure of new capital. Moreover, this has not just occurred with the arrival of the new economy but has been going on for many years. Illustrative of the tendency, the chart below shows median production costs for the copper mining industry since 1970; that is to say, the costs of the mine half way up the industry cost curve.



Such developments owe much to the systematic application of knowledge. At existing mines, developments in ICT have been able to improve knowledge of the ore body, mine planning, truck scheduling, process control at the mill, waste and water management, transaction and inventory management, and so on. At new mines, or where mines are being expanded, ICT developments make possible a more rigorous assessment of the investment options, optimisation of process spreadsheets and of the associated capital requirements. Linking all these different stages together, and managing them as a seamless process from mine face to market, potentially adds still another level of benefit. Time spent on these matters is likely to pay for itself many times over in a 20-30 year operation.

A combination of data availability and problems in statistically separating out the various drivers of output growth makes it extremely difficult to demonstrate empirically the increasing contribution of knowledge to value-adding in mining. Really, this is the subject of another paper. However, there is some circumstantial evidence available. Data produced by the US Bureau of Labour Statistics and, in Canada, by the Centre for the Study of Living Standards, show that the contributions to mining output growth *not* accounted for capital, labour or the consumption of intermediate products - and therefore potentially attributable

in part to knowledge effects - have increased sharply since the early 1980s. Moreover, as the chart below clearly shows, the stock of investment in ICT in metal mining (here in the US) exploded over the same period.



Changes in the basis of competition

The final, and perhaps most profound, fact of the knowledge economy which the mining industry has to confront is that it is bringing about changes in the basis of competition. As one of the most perceptive commentators on the knowledge economy, John Kay, has observed, "competitive advantages in the knowledge based economy derive from distinctive non-reproducible capabilities of organisations themselves, not from changes in market structure or access to technology".

While it is evident enough what such 'non-reproducible capabilities' might be in other sectors - a product standard in the case of the software industry, a brand in the case of consumer products, or a patent in the case of pharmaceuticals - it is harder to see what they might be in mining. How does a company set itself apart when it is producing the same product as all its competitors and where most of the technologies and cost savings available to it are reproducible?

Where a company is producing the same product as everyone else and has no leverage through technology, branding, or market share, then the 'non-reproducible capability' becomes, by default, the producing company itself, the ore bodies to which it has access, the skills it brings to decision-making, the services it provides along with its products, and the distinctive manner in which it operates.

The importance of the first three aspects of this - ore bodies, management and marketing - have long been recognised even if they have not been thought of in this way. As its poor financial history attests, the industry has suffered in the past every bit as much from a scarcity of good management as from a scarcity of good deposits. And as all fund managers know, there is real value to be had from companies with focused, knowledgeable and motivated management, even in circumstances where it is working with old and higher cost assets. Similarly, with marketing, there is real value - in premiums and volumes if not always in prices - in a company establishing itself as a reliable and consistent supplier, sensitive to the needs of the customer and responsive to feedback. Developments in ICTs prospectively offer new means by which producers can seek to serve still more effectively their customer base.

However, perhaps the most interesting development of the knowledge economy is the opportunity it creates for mining companies to differentiate themselves by the manner in which they operate. It may historically have been the case that the mining sector derived its legitimacy largely from the utility of *what* it produced. No longer. Today its legitimacy derives every bit as much from *how* it produces, which is to say its contributions to local economies, the manner in which it deals with environmental matters, and the quality of its relationships with neighbouring communities.

The advent of the knowledge economy may have enormously increased the transparency of the mining industry, forcing it to operate under the direct gaze of a not always sympathetic public. However, it has also armed companies with some powerful tools with which to differentiate themselves according to the manner in which they go about their business. The employment of environmental scientists and of staff possessing the softer skills of community relations may look like just another cost. But in a society which has shown it cares deeply about how companies in sectors like mining behave, and in the face of customers who are showing a growing interest in the manner in which the products they buy are produced - as illustrated for example by the debate over 'conflict diamonds' - a company's reputation for dealing with these matters in a sensitive and responsible fashion has become increasingly important. Moreover, it prospectively represents a key to obtaining access in future to resources, to capital, and to the sort of quality skills and management it will need going forward. In short, the key non-reproducible capability which mining companies need to aspire to in a knowledge-based society is reputation.

Conclusion

The knowledge economy is influencing the mining industry in many and varied ways and challenging many of its traditional preconceptions. Developments in

technology and in industry structure mean that an increasing part of the value-added of the mining sector is flowing from the application of knowledge to a company's resources rather than from simply the possession of those resources or the associated deployment of capital. While this is not a new development, the arrival of the new economy may have given it an extra twist. In addition, changes in the social expectations of mining have broadened the range of knowledge which is relevant to mining success and put a premium on management which can best adapt to the new conditions. The knowledge economy does not change the basic business of mining, nor does it appear to be threatening its markets, but it is having an important impact on the way companies are having to go about this business and how they realise value for their shareholders.