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South African mining equipment and specialist services: Technological capacity, export performance and policy

David Kaplan

Department of Economics, University of Cape Town, South Africa

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ABSTRACT

South Africa has developed a technologically sophisticated and globally competitive mining equipment and specialist services sector. The paper provides evidence for and measurement of technological competency and global competitiveness and a brief outline of why South Africa was successful in this regard. While there are significant prospects for future growth, there are, at the same time, a number of constraints and South Africa is becoming a less advantageous site for both production and for innovation. Current government policy does not address these constraints and the sector does not feature in government's vision for industrial or technology development. An alternative approach is proposed whereby the constraints are addressed and the companies supplying the mining sector that have sophisticated technological competencies are encouraged to spread "laterally" into new products and new global markets. By way of conclusion, the importance of this sector in developing countries where mining plays a major role is outlined.

Technological change in mining equipment and specialist services

There is a widespread perception that natural resource based activities, and mining in particular, are not the sites of significant technological change. Together with the purported long term decline in the prices of commodities relative to the prices of manufactures, low levels of technological change were the foundations for the Singer–Prebisch thesis in favour of a development path based on the development of manufacturing industry. Singer argued that "…they (natural resource based activities) do not provide the growing points for increased technological knowledge, urban education, the dynamism and resilience that goes with urban civilisation as well as direct Marshallian external economies." (Singer., 1950, p. 476).[1]

This perspective has enjoyed wide but not universal acceptance.[2] More recently, there has been a growing recognition that a number of factors are resulting in mining and mining related specialist services becoming increasingly technologically intensive. These factors include inter alia the growing utilisation of generic transformative technologies especially ICT; the reorganisation of the industry to allow for the growth of specialist mining services companies; the segmentation of markets; the intensification of technological challenges particularly as the industry has to meet stricter safety and environmental standards and to discover and exploit more marginal resources.

Marin et al. (2009, p. 9) provide a detailed discussion of the forces that are driving innovation in natural resource activities. They divide these forces into four categories:

- Market requirements—product segmentation; public opinion and environment.
- S&T advances—ICT and other new technology paradigms such as biotech. And nanotech.
- Market context—globalisation, outsourcing, environment and other regulations, government policy.
- Market volume—the intensification of traditional challenges, including the diminishing quality of resources.

This literature sees the centrality of technological progress in the development of the minerals industry as a relatively recent phenomenon, coinciding with the introduction of the ICT paradigm in the organisation of the global mining corporations (Marin et al., 2009; Upstill and Hall, 2006). However, at least in the case of South Africa, sophisticated technologies and developments in basic sciences such as chemistry were widely utilised in order to resolve critical problems in relation to local mining deposits for

E-mail address: david.kaplan@uct.ac.za

[1] Prebisch (1959) similarly argued that extractive industries provided fewer possibilities for technological progress than other sectors.

[2] For a contrary view see North (1955, p. 252), Viner (1952, p. 72) and more recently Wright and Czelusta (2007).

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almost a century. Moreover, while these technological capacities were initially based on imported skills, they were, at least in some important instances, rapidly localised in the early development of the Witwatersrand. For example, the development of the cyanide process in the 1890s "…led to an influx of metallurgical professionals from around the world and gave birth to one of the early professional societies in Johannesburg, the Chemical and Metallurgical Society or the 'Cyanide Club' as it was popularly known" (Pogue, 2006, p. 82).

The mining industry is often regarded as low technology because the conventional indicator employed to determine technological intensity is R&D expenditure as a percentage of turnover. However, much of the product development expenditure in this sector is not classified as R&D. The R&D measure when applied to the mining industry in aggregate also ignores the more technology intensive activities within mining such as exploration.

The sectors supplying the mining industry with equipment, intermediates and sophisticated services are the site of significant technological change. These supplier industries – here termed mining equipment and specialist services – employ sophisticated technologies and undertake considerable research although here too, research activities are often applied and incurred in relation to product development rather than formal R&D. Technological sophistication has been increasing rapidly, particularly as mining and metal processing firms have focused on operational competencies and have increasingly contracted out other activities to specialised suppliers. While South Africa has had a long standing and highly developed mining sector which has been the subject of considerable study, what has been barely recognised and not been the subject for any extensive research is that South Africa has also developed a very sophisticated mining equipment and specialist service sector.

Utilising a number of technology and trade data indicators, this paper explores the technological capacities and competitive position of South Africa's mining equipment and specialist services sector. The paper examines the sector and its future prospects. The paper proposes that government policy be directed at further developing this sector and encouraging companies that supply the mining sector and that have sophisticated technological competencies to spread those competencies "laterally" and engage in new activities and new markets. This case study has broader implications for technology and industrial policy in general and specifically for other countries where mining plays a major role in the economy.

Technology and trade data are supplemented by extensive firm visits and interviews. Interviews were conducted with senior management in dozen firms in the industry. Firms selected were across the size spectrum and they included both local (2/3) and foreign owned firms (1/3). In addition interviews were conducted with the Chamber of Mines, with two universities and with the industry export council—the South African Capital Equipment Export Council (SACEEC). The firm interviews focused on three issues—first, the technological competencies and competitive position of the firm; second, the constraints currently faced by the firm and how they were being addressed and finally, the future plans of the firm.

The rest of the paper is divided into six sections:

Section 2 provides evidence for and measures of the level of technological sophistication and competitiveness of mining equipment and specialist services sector in South Africa.

Section 3 provides a brief explanation for the development of the mining equipment and services sector in South Africa.

Section 4 outlines the future prospects for the sector with a focus on the key constraints.

Section 5 provides, in the light of the constraints outlined earlier, an examination of current government policies and proposes an alternative approach.

Section 6 briefly explores the broader implications of this study.

Technological capacity and export performance: evidence and measurement

Assessing the technological capacities of an industry and its distance from the global technology frontier is not a simple task. The most widely utilised measure is the number of patents registered abroad by locally registered companies. This measure is employed here. In addition to the number of foreign patents, measures are provided here of the quality of the patents. Since a significant share of the research work undertaken in this sector is product development, the extent to which South African firms have developed and introduced new technologically sophisticated products into the market is also outlined. A further measure is the extent to which South Africa provides a location for foreign firms to undertake research and product development. The final measure is the presence of local South African companies providing mining equipment and specialist services with a significant technological component in global markets.

In respect of measures of the competitiveness of the South African industry, export trade data are central but are supplemented by an examination of the balance of trade (exports–imports) and the degree of local value add.

Technological sophistication

Patents[3]

An examination of the patents taken out by South African companies, organisations and individuals at the United States Patent and Technology Office (USPTO) utilising 3-digit USPC classes, revealed a clear technological cluster which can broadly be termed "mining related technologies." The quantity and the quality dimensions of this cluster of mining related technology patents were assessed utilising 1976–2006 USPTO patent data.

The share of mining related patents in total South African patents was compared to the global average in order to construct an index of revealed comparative advantage in innovation (RCAI). But, in order to "go beyond the numbers," the quality of South African mining related patents was determined and then compared to mining related patents for three selected comparator countries that are widely acknowledged to be at the global technology frontier in mining—the United States of America, Canada and Australia.

Patent quantity

Mining-related technology patents make up a much larger share of South Africa's total patenting activity at the USPTO than for other comparator countries which have significant mining industries and are considered to be at the technology frontier (Table 1).

An index of South Africa's revealed comparative advantage in innovation (RCAI) analogous to the revealed comparative advantage in trade (RCAT) can be calculated. The RCAI is the number of South African mining related patents over the total number of all South African patents (4.5%), while the denominator is the analogous data for the number of global mining related patents over the total number of all global patents granted at the USPTO (0.54%). South Africa's RCAI for mining technologies is accordingly 4.5/0.54 viz. 8.4. This indicates that South Africa has a very significant global comparative advantage in mining related technology innovation. South Africa's RCAI is also higher than for

[3] The patent data were supplied by Lee Branstetter of Carnegie Mellon University for the World Bank project, Closing the Skills and Technology Gap in South Africa Kaplan et al. (2011, Annex).