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The Regional Value Chain for Mining Capital Equipment: Linkages and Firm Upgrading in South Africa and Zambia

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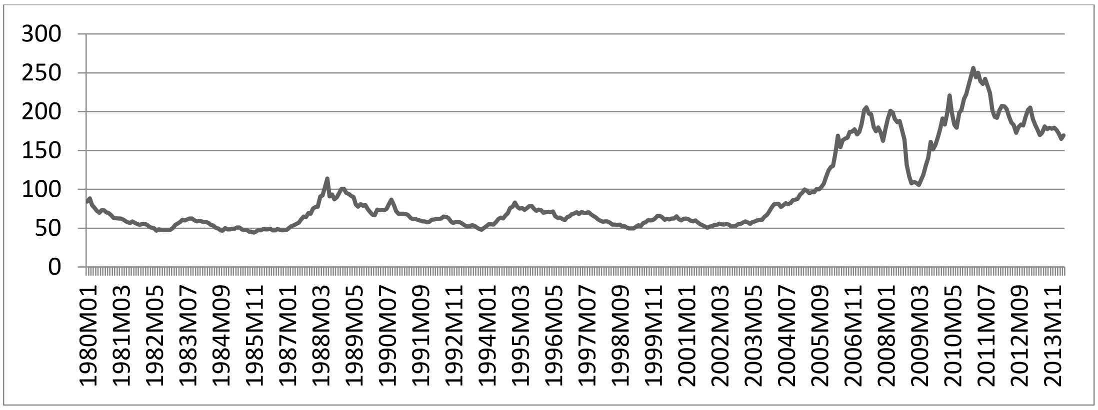
1. Introduction

The price boom for mineral and energy commodities in the early 2000s has underlined major changes in the global mining industry. Between 2003 and 2007, the IMF metals price index trebled from 61 to 183 (Figure 1). The price crisis in 2008-2009 was short-lived, and by 2010, metal prices had recovered above pre-crisis levels. Since 2012, world prices have weakened but are still substantially above the 1990s average. In particular, the world copper market has experienced the lowest price volatility and one of the highest price surges amongst hard commodities.

Figure 1: IMF Metals price index, Jan 1980-April 2014



Note. Index based on 2005 (average of 2005 = 100). Group indices are weighted averages of individual commodity price indices. Source: IMF Primary Commodity Price Data retrieved from http://www.imf.org/external/np/res/commod/index.aspx in May 2014.

The hard commodity price boom has spurred an investment surge in Africa's extractive industries. This led to significant debate among African policy makers on the role of extractive industries in promoting broader-based economic development. Within this context, upstream linkage development strategies are seen as increasingly attractive platforms to promote local industrialisation. Mining capital equipment is particularly important for the Southern African region in terms of value of procurement contracts, investment and trade flows, technological competencies and firm upgrading opportunities.

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In the Southern African region, regional value chains offer the opportunity to develop complementary industrial capabilities, promote technology and skills transfer, and create integrated markets which provide the economies of scale and scope required for a thriving manufacturing sector. Research within the Global Value Chain (GVC) literature found that the nature of inter-firm linkages and trade and industrial policies play an important role in shaping local industrialisation processes (Gereffi 1994; Kaplinsky and Morris, 2001). This literature produced significant empirical work on the nature and outcome of inter-firm linkages, in particular linkages with lead firms within a GVC (see for example Fold, 2002; Gereffi, 1999; Morris and Staritz, 2014). Lead firms face various constraints in terms of, among others, market failures, low supplier capabilities, changing consumer demand, and trade barriers, and design their global strategies accordingly. These strategies include prioritising which market parameters need to be met by suppliers, which firms participate and, crucially, move up a GVC, and whether various forms of assistance will be provided to upgrade local firm capabilities. These elements, defined as value chain governance, vary widely across GVC and often within the same GVC (Sturgeon, 2002; Gereffi *et al.*, 2005). Value chain governance determines the allocation of economic returns along the GVC, and the extent of local upgrading processes (Kaplinsky, 2005). Such upgrading processes are defined as the dynamic capabilities by firms to improve their method of production (process upgrading), what they produce (product upgrading), move into higher value added activities (functional upgrading) or moving into more remunerative value chains altogether (chain upgrading) (Gereffi, 1999; Humphrey and Schmitz, 2002). Ultimately, the interaction of national and regional policies with such firm-level upgrading processes will determine the extent and nature of local industrialisation, its firm-level profitability and industry-level sustainability, and its position in GVCs.

It follows that understanding the global dynamics of an industry is important to analyse governance strategies and firm upgrading processes. These dynamics are strongly industry-specific. Mineral-based value chains have been under-researched within the school of GVC analysis (Bridge, 2008; Morris *et al.*, 2012). In particular, Morris et al. (2012) investigated downstream and upstream linkage development from commodity sectors in a number of SSA countries. The study however only began to investigate the regional dimension of commodity-related linkage industries. The Southern Africa region provides an ideal case study in this regard because of the role of South Africa in supplying mining goods, services and skills to the regional mining complex.

The paper is structured as follows. Section two presents key trends in the global value chain for mining capital equipment. Section three presents a background on the South African and Zambian mining inputs clusters. Section four maps the regional value chain for mining capital equipment and presents the research findings in terms of firm entry, upgrading processes and regional inter-firm linkages. Section five discusses policy constraints at national and regional level. Conclusions, policy implications and areas for further research are discussed in section six.

2. Mining capital equipment: Key global trends

As a general trend, global mining houses are under pressure to reduce costs and increase productivity. In order to do that, they have focused on their core business and rationalised their supply chains by reducing the number of suppliers and developing more intense buyer-supplier relationships. These include technological alliances with Original Equipment Manufacturers (OEMs) aimed at improving mining operations in the areas of energy efficiency, operational productivity, worker safety and health, and environmental impact. OEMs have become the key source of innovation in the industry, mainly in the form of incremental product innovation (Bartos, 2007). As a result, investment in R&D in the mining sector has been dominated by OEMs and engineering firms, public institutions and various private-public partnerships, rather than the mining houses, which was the case in the past (Walker and Minnitt, 2006).

Global OEMs allocate very large budgets to R&D. Moreover, they have internationalised their R&D activities, more recently also to China and India, in order acquire new technological capabilities and tap into local knowledge.[2] Indeed, technological innovation is one of the main reasons behind the large number of mergers and acquisitions undertaken by OEMs since the 2000s (UNCTAD, 2007). Through these, OEMs have acquired new intellectual property and innovation capabilities. Mergers and acquisitions have been also instrumental to expand product portfolio, access regional markets and curtail competition.[3] As a result, the mining capital equipment industry is highly concentrated, with few players dominating several product markets at global level. For example, Sandvik, Atlas Copco, and Caterpillar dominate the market for Load Haul Dumps (LHDs), trucks, drills and bolters (RMG and Parker Bay, 2012).

A combination of large installed fleets – as a result of large capital investment during the last decade -, skills scarcity, and mining companies' outsourcing strategies, has resulted in aftermarket services becoming an increasingly important area for OEMs. The mining companies devise their procurement strategies with the objective of reducing their Total Cost of Ownership (TCO) that is inclusive of capital, maintenance and operational expenses. Because aftermarket sales are less exposed to fluctuations in greenfield and brownfield investment, they provide OEMs with a profitable and stable source of revenues. Table 1 compares the Stay in Business (SIB) expenditures/initial capital investment ratio per unit for a range of capital equipment items.[4] These figures provide a snapshot of the size of after-market revenues compared to the initial capital cost of the equipment. Processing plants offer overall the highest aftermarket opportunities in particular for grinding mills, cyclones and pumps (because of large numbers of units installed) and crushing plants. In mining, LHDs and continuous mining machines have the highest SIB/initial capital ratio.

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[2] For example, Sandvik invests over US$ 400 million per year in R&D and quality assurance, two areas which employ 2,700 people. It has 8,000 patents and intellectual property rights. Sandvik's largest R&D centres are based in Finland, Austria, Germany, the UK and the US, but it has opened new centres in India and China.

[3] This is illustrated by the examples of Atlas Copco's significant market presence in North America, through the acquisition of US-based Wagner, and Caterpillar market presence in Australia through the acquisition of Elphinstone (Company reports, 2014).

[4] The analysis is based on the following assumptions: SIB capital calculated as sustaining capital cost and operating capital cost on a per unit basis. Mining operations of 350-360 days per year, two shifts of 12 hours each, with 80% utilisation rates and 85% equipment availability, resulting in c5,700 hours of operation per year, or 171,000 over a 30-year life of the mine (LoM). Processing operations of 365 days per year, two shifts of 12 hours each, 90% utilisation rates and 95% equipment availability, resulting in c7,500 hours per year and c225,000 hours over a 30-year LoM.

Table 1: Mining and processing operations: SIB capital vs. initial capital

Mining equipment	Initial	Total SIB	Ratio SIB:initial	Processing equipment	Initial	Total SIB	Ratio SIB:initial
Underground loaders (LHDs)	1.9	27.0	14 :1	Grinding mill, rod & ball	5.5	197.6	35 :1
Shovels, hydraulic	15.9	179.3	11 :1	Cone crushers	4.0	65.0	16 :1
Continuous miners, u/ground	3.2	35.9	11 :1	Mobile crushing plants	1.2	17.7	15 :1
Roof bolters	1.4	16.5	11 :1	Gyratory crushers	13.0	170.0	13 :1
Tunnel boring machines	19.0	210.9	11 :1	Grinding mill, SAG	13.5	181.7	13 :1
Rotary blasthole drill rigs	3.0	30.3	10 :1	Stackers, conveyor	20.5	120.4	5 :1
Continuous miners, surface	4.9	49.7	10 :1	Mill drives, gearless	18.8	97.0	5 :1
Backhoes, hydraulic	17.0	164.9	9 :1		$, 000s		
Bucketwheel excavators	7.1	56.1	7 :1	Cyclones	26	1.0	39 :1
Wheel loaders	7.7	58.9	7 :1	Slurry pumps	84	2.1	25 :1
Shovels, cable	23.0	127.5	5 :1	Electric motors	185	3.6	19 :1
Underground ore & coal haulers	1.6	8.4	5 :1	Screens	403	5.4	13 :1
Draglines, crawler	5.5	24.5	4 :1				
Trucks, rear-dump (40t-400t)	6.5	29.6	4 :1				
Draglines, walking	184.5	523.5	2 :1				

Source. Virgo, Armstrong and Alftan, 2013

3. Mining inputs clusters in South Africa and the Zambian Copperbelt

South Africa

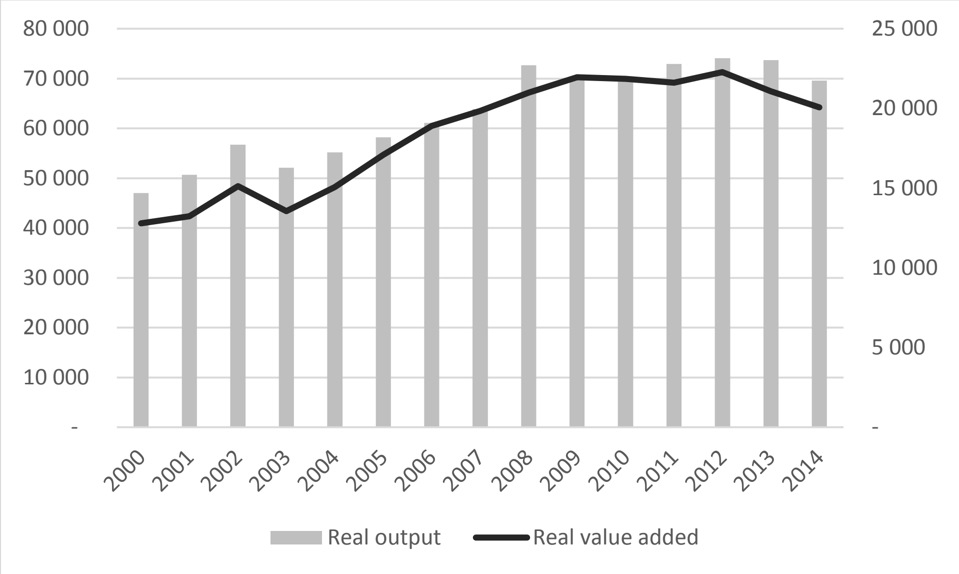
The South African mining inputs cluster, mainly located in Gauteng, is a well-established regional supply hub for Southern Africa. South Africa's mining inputs cluster has developed high-level technological competencies over the decades, and in some areas has become globally competitive. This is the result of a relatively long history of mining, during which suppliers had to find innovative solutions to the geological and metallurgical challenges of hard rock, deep level mining which characterised the South African gold mines (Walker and Minnitt, 2006; Kaplan, 2011). Such innovative efforts were driven by the Chamber of Mines Research Organisation (COMRO), which undertook significant levels of 'blue sky' R&D. A very dynamic national system of innovation (NSI), with strong linkages between mining companies, suppliers, research centres, universities and technical and artisanal schools, underpinned the cluster. With the decline of gold mining, supplier firms' technological capabilities subsequently migrated to other mineral commodities, such as coal and chrome, and more recently to PGMs.[5]

Since the 1990s, investment by the mining houses in the NSI declined, with the demise of COMRO, which was first moved within government and then saw its research capacity undercut (Altman, 2007). This has reduced the level of sectoral R&D undertaken domestically, which shifted from long-term, 'blue sky' R&D and pure innovation to short-term product development (Walker and Minnitt, 2006). While South Africa has retained a comparative advantage in mining-related innovation, the declining NSI is eroding its capacity to sustain such competitiveness in the future (Kaplan, 2011). Other important constraints to the cluster competitiveness include scarcity of skilled labour, weak Tier 2 suppliers and the struggle to compete with international OEMs on the provision of finance packages to buyers. OEMs like Sandvik and Atlas Copco offer attractive finance packages with competitive interest rates, and flexible finance terms and conditions, which South African OEMs struggle to offer.

Both real output and real value added for the South African machinery and equipment sub-sector have grown since 2000, reaching R 69.6 billion and R 20 billion respectively in 2014 (Figure 2). During the 2000-2014 period, real value added grew by 3.27% CAGR and real GDFI by 4.5% (R 1.2 billion in 2014).[6] The sector employed 113.700 workers in 2014, with no significant growth since 2000. The mining sector absorbed between 15.6% and 17.1% of this industry's output in 2012-2014. However, mining capital goods were the most dynamic section of the capital goods sector and represented more than 50% of total capital goods exports (Kuriakose, Kaplan, and Tuomi, 2011). Mining machinery, in particular, was the highest export product category to the SADC region in 2014.

[5] The areas of excellence for South Africa's inputs cluster included: mine design and development, construction and structural engineering, ventilation and cooling, contract mining, shaft sinking, mineral processing, tailings treatment, process control, metallurgical testing, smelting and refining, niche systems and components (hoisting, winding, hydropower drills, filters, pumps, pinch valves) and strategic consumables (cement, shotcrete, explosives, grinding balls) (Lydall, 2009).
[6] Quantec database, retrieved from http://www.quantec.co.za/ in June 2015.

Figure 2: South Africa's machinery and equipment sub-sector: Real output and real value added (R million, 2010 prices), 1990-2012



Notes. Output at constant 2005 prices. Quantec data is modelled data and not census or survey data hence it may not provide a completely accurate picture. *Source.* Quantec Database. Retrieved from http://www.quantec.co.za/ (February 2014)

The mining inputs cluster has been targeted by several policies, including the 2011 National Development Plan and the Broad-based Socio-Economic Empowerment (B-BEE) Charter for the South African Mining and Minerals Industry. Moreover, local content provisions are enforced by the Department of Trade and Industry (DTI) Export Credit and Insurance Company (ECIC) which provides political and commercial risk insurance. At the policy implementation level, the DTI Industrial Policy Action Plan is also developing a strategy for the cluster.

Zambia

Notwithstanding a relatively long history of mining also in Zambia, its inputs cluster has followed a very different trajectory from South Africa's one. With the nationalisation of mining assets by the Zambian government in 1969, upstream linkage development became a critical component of Zambia's industrialisation strategy (Fessehaie, 2012). This was pursued through a combination of direct state ownership, preferential procurement from the state-owned Zambia Consolidated Copper Mines (ZCCM), import substitution industrialisation and intense linkages between ZCCM, its suppliers and public research and training institutions. These policies were partially successful: they supported the development of a thriving manufacturing sector populated by large state-owned entities, family-run businesses established by European and Indian migrants, and OEM subsidiaries, such as Chloride (batteries), Dunlop (tires) and Boart Longyear (drilling equipment). Unlike South Africa, nevertheless, the Zambian inputs cluster did not develop niche technological competencies.

In the 1990s, Zambia privatised its mining assets and adopted swift trade and investment liberalisation measures as part of its Structural Adjustment Programme. The ownership structure of Zambia's copper sector became more heterogeneous, with the entry of mining houses from Canada, Europe, Australia as well as China and India (Fessehaie, 2013;

Haglund, 2010).[7] Past protectionist policies were dismantled very quickly with little time for suppliers to adjust, and the mining companies were no longer bound to preferential procurement policies (Fessehaie, 2012). Whilst a few firms seized the opportunities of a larger customer base by upgrading and specialising, a large part of Zambia's manufacturing capacity was lost and many firms exited the mining value chain. They have been replaced by importers, most of which are not specialized and do not contribute to local value addition.

According to South Africa Capital Equipment Exports Council (SACEEC) data, South Africa's exports of mining capital equipment increased from R 10 billion in 2005 to R 46.2 billion in 2014. Given that export flows can vary widely by year due to specific mining projects, Table 2 looks at export values cumulatively and as averages for the period 2012-2014. Zambia followed by DRC, Mozambique, Zimbabwe and Namibia, are the largest export markets for South Africa's OEMs, accounting for an average 50% of South Africa's exports.

Table 2: Top ten export markets for South Africa's mining capital equipment industry, 2012-2014 (R million and %)

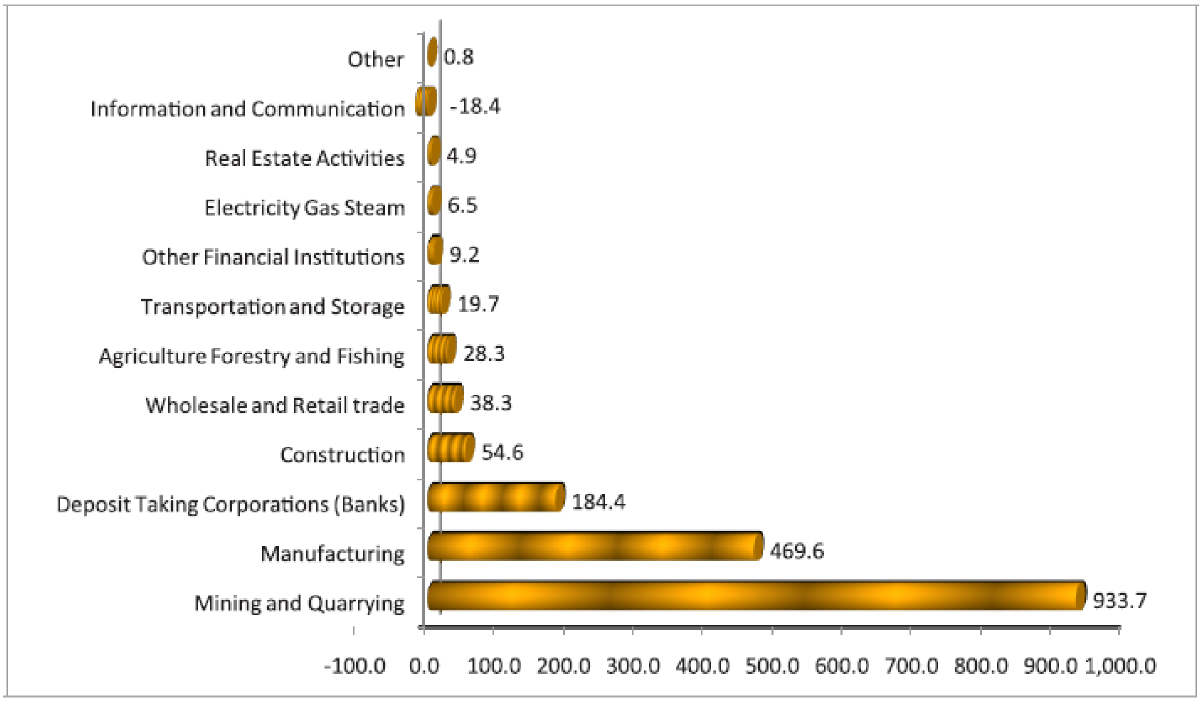
	Cumulative	Average	% world exports
World	108 187	36 062	
Zambia	16 751	5 584	15.5%
DRC	11 041	3 680	10.2%
Mozambique	10 428	3 476	9.6%
Zimbabwe	7 933	2 644	7.3%
Namibia	6 791	2 264	6.3%
US	4 880	1 627	4.5%
Botswana	4 853	1 618	4.5%
Australia	2 803	934	2.6%
Tanzania	2 617	872	2.4%
Angola	2 612	871	2.4%
Germany	2 591	864	2.4%

Source. SACEEC (2015)

The re-capitalisation of the Copperbelt mines since in the second half of 2000s underlies Zambia's large imports of capital equipment. FDI stock into Zambia has increased from approx. US$ 4 billion in 2000 to US$ 14.3 billion in 2013.[8] The mining sector has absorbed the lion's share of Zambia's inward FDI: out of US$ 1.7 billion FDI flows in 2012, US$ 933 million targeted mining (Figure 3), bringing the total of 2012 FDI stock into the mining sector to US$ 9 billion (Bank of Zambia, 2014). South Africa is Zambia's main source of imports for mining capital equipment.[9]

[7] NFCA from China, in particular, although relatively small in terms of copper output, has been fast-growing and has invested in the Chambishi Zambia-China Economic and Trade Cooperation Zone (ZCCZ), a US$ 800 million-worth investment, inclusive of the Chambishi Copper Smelter, acid plants, as well as a copper semi-fabricates manufacturing plant.
[8] UNCTAD Stats, retrieved from http://unctadstat.unctad.org/ in June 2015.
[9] UN Comtrade database, retrieved from http://comtrade.un.org/ in June 2015.

Figure 3: Sectoral distribution of Zambia's inward FDI flows (US$ million), 2012



Source. Bank of Zambia, 2014

The challenges faced by Zambia's inputs suppliers include firms operating outdated machineries and processes, lack of access to long-term capital, high cost production structure, skills scarcity, and fluctuating exchange rate (Fessehaie, 2012; Kasanga, 2012). In terms of legislation, Zambia does not have a mandatory local content policy. Before 2008, the voluntary local content provisions included in the bilateral Development Agreements between the individual mining companies and the government were not implemented (Fessehaie, 2012).[10] In 2008, these agreements were replaced by the 2008 Mines and Minerals Development Act, which includes best endeavour provisions on favouring local suppliers (Kasanga, 2012). In 2013, the Chamber of Mines of Zambia and the Zambia Association of Manufacturers, working with government, and mining companies, launched the Zambian Mining Local Content Initiative (ZMLCI), which is being designed.

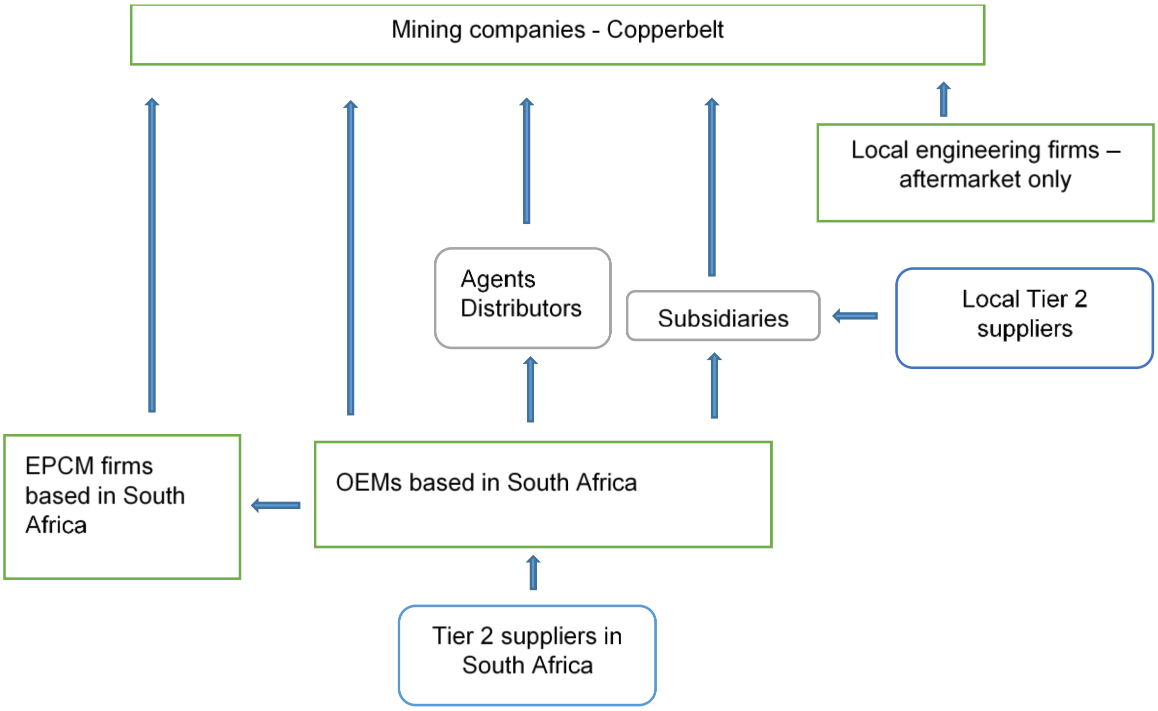
4. The regional value chain for mining capital equipment

Figure 4 maps the regional value chain for mining capital equipment. Mining companies source capital equipment directly from OEMs, or indirectly through their agents and distributors. South Africa-based OEMs include South African-owned as well as transnational corporations from Europe, the US, Japan, etc. ('international OEMs' from now onwards). OEMs are the main source of borehole drilling, radar processing, remote sensing, geological assaying, drilling consumables and replacement items, opencast and underground bulk materials handling and

[10] The mining companies were to grant local firms an adequate opportunity to bid for tenders and submit a local business development programme. Apart from a small supplier development programme implemented by the International Finance Corporation, these provisions were largely disregarded by both the mining companies and government, for a range of reasons which included poor institutional capacity of the Ministries involved.

haulage equipment, electrical equipment, comminution (crushers, mills, cyclones) and concentration equipment (flotation cells, filters, pumps), metallurgical testing, chemicals and reagents, driers, converting equipment, smelting and tapping equipment, environmental/gas-treatment and refining equipment (Lydall, 2009). South Africa-based OEMs have a relatively well developed network of Tier 2 suppliers of standard (idlers, cables) or specialised components (hoisting hooks, valves). The competitiveness of some Tier 2 suppliers however has been eroded over the years (Phele *et al.,* 2005).

Figure 4: Regional mining supply chain



The largest OEMs operate in Zambia through subsidiaries: in 2012 it was estimated that up to 80% of capital equipment was procured by the mining houses via local OEM subsidiaries (Kasanga, 2012). Zambia however also has a wide network of agents and distributors, some of which have repair and maintenance capabilities.

Engineering companies provide the mining companies with a broad range of services, often sub-contracting specialised engineering firms. In particular, Engineering, Procurement, Construction and Management (EPCM) companies, operating under Lump Sum Turnkey (LSTK) or EPCM arrangements, are sub-contracted by the mining companies to develop greenfield and brownfield projects.[11] Under these arrangements, they are responsible for the procurement of capital equipment to be integrated into complete systems. EPCM firms are predominantly based in South Africa. In Zambia, small-sized engineering companies provide

[11] Under an EPCM model, the EPCM firm is appointed by the client to act for and on behalf of it, e.g. procuring on behalf of the client. The client appoints the subcontractors, which are then managed by the EPCM firm. Under a LSTK or Engineering, Procurement and Construction (EPC) model, the EPCM firm is responsible for procurement. The firm receives a lump sum for the engineering work, acts as a separate organisation and takes on the risk around price, delivery and schedule. This model is preferred because it is more profitable.

repair and maintenance services to the mines and have done relatively well thanks to strong locational advantages and high skills-related entry barriers for competing firms.

The paper is based on interview data collected between June and October 2014 in South Africa (mostly Gauteng Province) and Zambia (Copperbelt Province). The interviews were conducted on the basis of semi-structured questionnaires and targeted OEMs and EPCM firms in South Africa, and supplier firms in Zambia. This sample design allowed for some level of data triangulation. Additionally, a number of institutional actors were also interviewed. The categories of respondents are included in Annex 1.

The case study focuses on four clusters of products:

1. Mineral processing equipment;
2. Off-road specialised equipment;
3. Pumps and valves; and
4. Conveyor systems.

These product clusters feature among the top Zambian imports from South Africa, and existing literature and anecdotal evidence suggest that South African firms are globally competitive. In South Africa, the OEMs interviewed were involved in the 4 product clusters, with the addition of an OEM for mine support products. In Zambia, in addition to firms supplying products from the four selected clusters, interviews covered metal fabrication, electrical, civil, chemical and mechanical engineering.

Tables 3 to 4 show the export performance of South Africa in the Zambian market in relation to the four product clusters during the period 2006-2013. Mineral processing equipment and conveyor systems show the highest CAGR in South Africa's exports to Zambia during the period 2006-2013, 19.2% and 18.3% respectively. Mineral processing equipment exporters have done particularly well in growing their market share to almost a third of the Zambian market. Conveyor systems have defended their large market share, 70% in 2013. For these two product clusters, the regional market has been more important than the global one in supporting export growth (compare South Africa's exports to the rest of the world in Annex 2). The aftermarket business is critical for mineral processing equipment OEMs: parts accounted for ¾ of total sales to Zambia in 2013.

Exports of South African off-road special vehicles, pumps and valves grew by more than 10% CAGR during the period 2006-2013, with almost 60% market shares in Zambia. South African OEMs for special off-road vehicles are very competitive in the regional and global market, with exports totalling US$ 158 million to Zambia and US$ 2.4 billion to the world in 2013. These OEMs have maintained their market shares in Zambia, which have not grown but remain high. Exports were dominated by two products: diesel powered trucks and dump trucks. Zambia is a relatively small destination market, global exports are more significant both in terms of growth and absolute values.

Conversely, South Africa's pumps and valves OEMs, whilst still large exporters, are losing market shares, a decline by 4.4% CAGR. This is due to the entry of large competitor OEMs from emerging economies (Brazil, China). On average pumps made up over 4/5 of the total export values in this cluster. Aftermarket sales are an important part of the pumps business, indeed spares accounted on average for 45% of pumps sales to Zambia in the period under examination.

Table 3: Zambia's import from South Africa in selected product clusters, US$ '000

Product Cluster	2006	2007	2008	2009	2010	2011	2012	2013	CAGR
Mineral Processing	24,773	53,780	57,563	38,733	42,906	80,135	71,191	84,548	19.2%
Off-road special vehicles	64,486	77,129	99,149	46,113	87,811	116,397	195,671	157,562	13.6%
Pumps and Valves	33,979	46,691	47,492	38,443	57,003	74,362	68,524	77,588	12.5%
Conveyor systems	5,418	7,491	8,759	5,464	6,549	13,411	9,905	17,599	18.3%

Source. UN Comtrade database, retrieved from http://comtrade.un.org/ in July 2014.

Table 4: South Africa's market share in Zambia for selected product clusters (%)

Product Cluster	2006	2007	2008	2009	2010	2011	2012	2013
Mineral Processing	14.7%	27.0%	52.4%	49.5%	44.5%	40.5%	50.1%	28.2%
Off-road special vehicles	60.6%	69.3%	63.3%	57.3%	68.0%	50.6%	61.3%	57.4%
Pumps and Valves	79.6%	79.0%	72.0%	79.0%	79.4%	73.3%	65.8%	58.0%
Conveyor systems	68.5%	65.2%	65.4%	63.3%	66.3%	59.2%	60.8%	70.0%

Source. UN Comtrade database, retrieved from http://comtrade.un.org/ in July 2014.

The next sub-sections discuss the research findings on the local and regional dynamics of the four product clusters as follows: firm entry, upgrading and competitiveness, and extent and nature of inter-firm linkages across the two countries.

4.1 Entry into the mining supply chain

Most South Africa-based OEMs were well-established firms. International OEMs had been established up to 130 years ago, in Europe or the US, and had, over decades, entered global markets, and built competencies across commodities and products, in particular through M&As. Most South African OEMs were established during the apartheid era, under a very conducive environment for supplier firm upgrading. During the economic liberalisation process in the 1990s, South African OEMs faced considerable pressure from imports. They succeeded by internationalising, merging, outsourcing and innovating. In comparative terms, however, South African OEMs had been internationalising later than the global OEMs, hence the latter had a more established regional footprint.

The findings highlight two important issues surrounding entry into the mining supply chain: firstly that new entrants struggled to enter given the size and competitiveness of incumbents, and secondly that there was significant lateral migration of technologies, which opened up additional opportunities for existing firms.

Well-established OEMs had deep market knowledge, strong reputation and customer relationships, and large installed capacity to secure repeated orders and profitable aftermarket sales. The latter were particularly important when greenfield investment slowed down. This opened an important question regarding new entrants and access to procurement opportunities. The example of a South African new entrant is illustrative. The OEM was the result of a JV between two existing players. It started as a joint project with Anglo American to find a system that could control roof movement in deep mining. This resulted in its flagship product, the ROCPROP roof-support system, which was exported to the rest of Africa, the US and Australia. The firm was expanding to drilling rigs and roof bolters. The relationship with the parent companies was important to secure access to resources for aggressive R&D and a large buyer, which reduced uncertainty. Also, the firm entered the Copperbelt market by 'piggy-banking' on the agent of the parent company. The evidence from other South African OEMs suggested that access to resources for upgrading and expanding into new markets was more problematic.

Secondly, both international and South African OEMs were characterised by significant lateral migration of technologies: they started off supplying sectors as diverse as electricity, food industry, recycling, infrastructure, construction, forestry, sugar, transport, and defence. Whilst this process needed to be further unpacked to understand its determinants, there was prima facie evidence of opportunities for OEMs currently active in other resource and non-resource sectors to enter the mining value chain, and for mining OEMs to expand their markets beyond mining.

Compared to South Africa, Zambian firms faced lower entry barriers related to capital, skills, and R&D because the majority of firms were agents or traders. A few supply firms had been established by entrepreneurs previously employed by the mining companies. They had good networks and knowledge of the technical and procurement aspects of the mines' operations, which helped them to secure contracts. These entrepreneurs managed every aspect of their businesses, with no apparent succession plan. Their size and organisational structure made it very difficult to upgrade, because of limited capabilities to mobilise resources and manage change.

There is a paucity of research on the role played by EPCM firms in promoting or constraining local participation in the mining supply chain. Irrespective of the type of contractual arrangement with the mining houses, the procurement process was essentially a joint decision making process between the EPCM firm and the client. EPCM firms active in the regional market originated from Canada, Australia, US and South Africa (Table 5). The region represented a growing share of the business for South Africa-based EPCM firms: 50% or more of their turnover. They supplied a broad range of commodities and countries in SADC: copper (DRC, Zambia, Botswana), coal (Mozambique), iron ore, uranium (Namibia), PGMs (Zimbabwe). Gold in West Africa was also important. Most of the EPCM work for Zambia was done out of South Africa.

When moving into the region, EPCM firms tapped into the South African inputs cluster, where they had long-standing and well-established relationships (Table 6). Proximity enabled them to monitor supplier performance, and the presence of South African engineers employed in Zambia's mines meant buyers were familiar with South Africa-based suppliers. If the project financing was sourced by a local agency such as South Africa's ECIC, preference for South Africa-based suppliers was also motivated on the ground of local content requirements.

Table 5: Main EPCM firms operating in the Southern Africa region

Company	Home country
DRA Global	South Africa
Tenova	International (originally Italian)
Senet	South Africa
Worley Parsons	Australia
MDM Engineering	South Africa
AMEC Engineering	Canada
Fluor SA	US
ADP Group	Canada
Hatch Engineering	Canada
Sedgman	Australia

Source: Interviews, 2014

Table 6: Key suppliers for EPCM firms

Category of capital equipment	Key suppliers
Mineral Processing	Sandvik Mining Metso Minerals Outotec FLSmitdth Vibramech Multotec IMS Citec
Offroad Special Vehicles	Barloworld Barloworld Equipment Liebherr Africa
Conveyor Systems	Osborn Engineering SEW Eurodrive Dunlop Belting BMG CPM Venk
Pumps and Valves	Weir Minerals Invincible Valves Warman Africa Curo Pumps DFC Mining
Electrical Equipment	Actom ABB South Africa Siemens Limited Denwa RWW

Source. Interviews, 2014

South-Africa based OEMs confirmed that there was no particular entry barrier in supplying through EPCM firms. Indeed two OEMs reported that EPCM firms facilitated entry in the Copperbelt, which would have otherwise been difficult because of corruption in the mines' procurement processes, the incompetency of Copperbelt agents in supplying the correct products, and the importance of relationships to secure contracts. However, some OEMs reported that the EPCM firms were more cost-driven than the mining houses, which implied lower margins for suppliers.

Access to contracts through EPCM firms was particularly important for OEMs supplying mineral processing equipment, which reported that up to 70-80% of their sales were done through EPCM firms. OEMs selling pumps, valves and offroad vehicles relied less on EPCM firms. Offroad special equipment OEMs in particular accessed the supply chain through contractors, in charge of material extraction. The role of contractors was likely to become increasingly important as mining houses in the region outsourced more activities in related to mineral extraction.

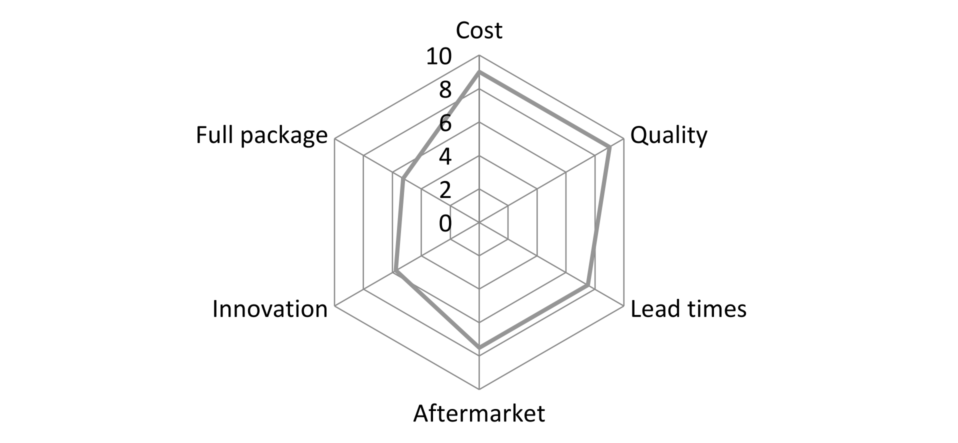
Conversely, Zambian suppliers did not participate in the EPCM-driven supply chain because of their small size, low firm capability and inability to market their products to EPCM firms. They entered the mining supply chain only after the mine design and construction phases were completed, and operations had started. For capital equipment, there was no OEM to compete with the South Africa-based ones, but lack of local participation was problematic because of missed sub-contracting opportunities.

In order to gauge the EPCM firms' procurement strategies, respondents were asked to rate the weight attached to selected factors on a one to ten Likert scale (1 being *unimportant*, 10 *very important*) (Figure 5).

EPCM firms were focused on both the commercial and technical value of their offer, hence cost and quality considerations were paramount. There were variations across products, for example the value chain for standard valves was more cost-driven than the one for speciality valves. Cost was defined as TCO, hence aftermarket sales were very important too. The EPCM firms provided guarantees to clients, which required reliable aftermarket services from the OEMs. Aftermarket solutions varied with the business environment. Whilst in Australia, EPCM firms designed very sophisticated, high quality maintenance and operating systems which attracted a price premium but saved labour costs, in Africa, labour was relatively cheap and they tended to focus on least cost solutions. Suppliers' capability to adhere to short lead times was less important for EPCM because they operated on long-term project timeframes. Lead times were however critical for the mining houses in the Copperbelt, especially for spares, maintenance and repair services.

Demand from the mining companies for full package suppliers was low but growing, as the latter reduced transaction costs, stocks and logistics overheads. There were variations though as some mining companies preferred to diversify their supply chain and have multiple suppliers. Local supplier capabilities influenced this decision: in South Africa, where firm capabilities were relatively high, buyers would subcontract aftermarket services to various service centres, and would prefer to diversify their supplier basis. In Zambia, where supplier capabilities were low, buyers would rely on the OEMs for the full range of aftermarket services and valued full package options. EPCM firms saw these competences as being their own responsibility rather than the OEMs'. As discussed later, this was an area of increasing competition between these two categories of suppliers.

Figure 5: CSFs according to South Africa-based EPCM firms



Notes. N=4. Source. Interviews, 2014

The market parameters discussed above varied with buyer ownership. Compared to blue chip and mid cap companies, low cap companies were more cost-driven. Moreover, Western mining companies focused on long term profits hence they were willing to pay price premiums, invest in quality products and make large scale capital investment. Indian and Chinese buyers were more cost-driven. Indian companies preferred smaller modular units, which required less investment and allowed faster installation times, and were less interested in innovation. When Chinese companies were engaged in comprehensive packages that linked resource extraction and infrastructure development, South Africa-based EPCM firms were excluded from the supply chain. Some suppliers nevertheless mentioned that they were making headways with Chinese buyers and these were increasingly focusing on TCO and quality considerations.

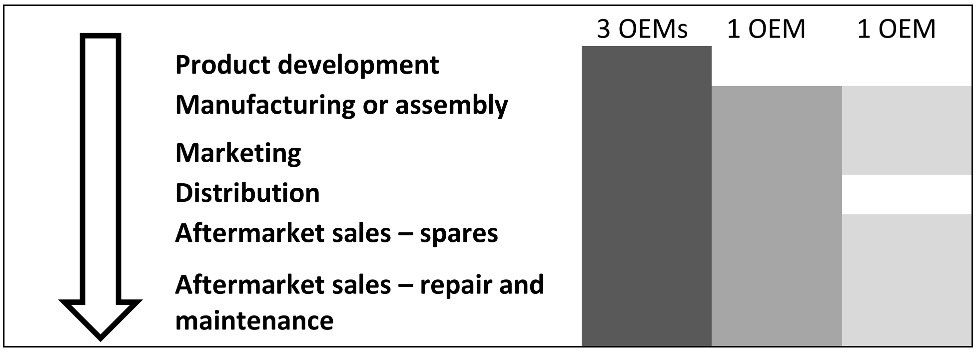
Mining houses were increasingly relying on turnkey solutions from their suppliers. On the one hand this was due to their strategy to outsource any activity which fell outside their core business, on the other hand they struggled to access skilled labour, hence they had to tap into external expertise. As a result, systems design and management responsibilities have been progressively shifted onto OEMs that had until recently only supplied equipment. OEMs were upgrading to supply fully operational plants. This ate into the core business of EPCM firms, which would jealously protect process-related competences associated with putting together different equipment and systems. On the other hand, some EPCM firms started offering their own branded equipment, which secured aftermarket business.

This two-fold development blurred the lines between OEM and EPCM firms, and most importantly had potential implications for future most profitable activities in the capital equipment value chain. In terms of regional supplier capabilities, upgrading towards full package solution capabilities would require multiple strategies, including horizontal cooperation between OEMs to offer a full range of equipment or systems.

4.2 Upgrading and competitiveness

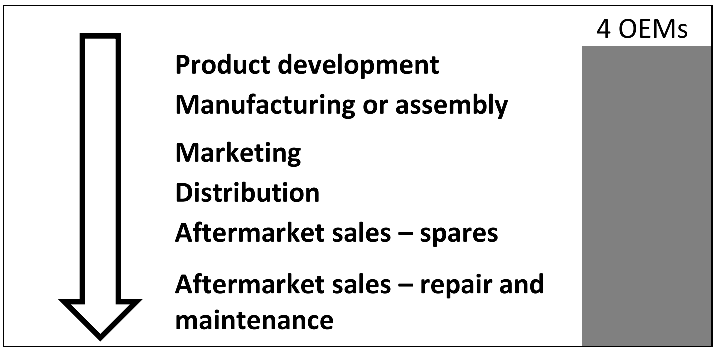
South Africa-based OEMs generally participated along the entire value chain, from product development to aftermarket sales (for example, Figure 6 and 7). This finding however required further qualifications.

Figure 6: Mineral processing OEMs - value added



Notes. N=5. Source. Interviews, 2014

Figure 7: Offroad special vehicles – value addition



Notes. N=4. *Source.* Interviews, 2014

Product development was undertaken, to different degrees, across all four product clusters, including adapting technologies across commodities and sectors. In general, international OEMs were doing some level of product development locally, but R&D was done in one or more centres in the US and Europe, and the IP was controlled by the parent companies.[12]

South African OEMs invested considerably on product development. The South African offroad vehicle manufacturers were involved in all stages of product design, including testing and commercialisation. The EPCM firms confirmed that South African OEMs were innovative and could match international OEMs in this respect. The case of Desmond Equipment was illustrative. The South African firm was established as a result of a significant effort at technological adaptation: equipment with sophisticated components was re-designed in order to make applications simpler. The electronic component was reduced, the equipment was suited to the harsh conditions and wet environment typically found in Africa, and the machinery was easier to operate and to maintain. Its product range included offroad trucks (particularly

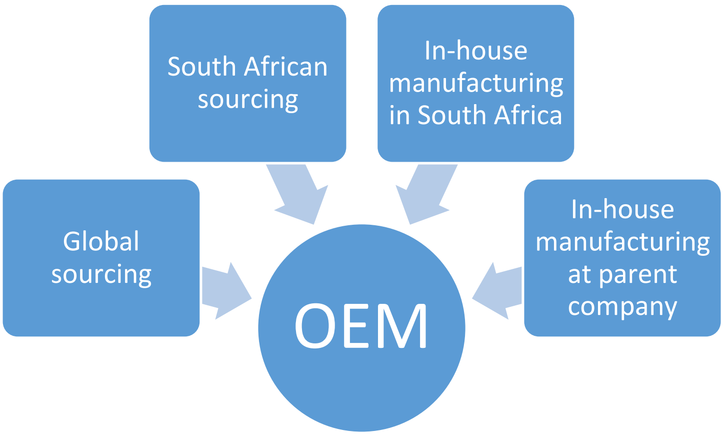
[12] Training was often an important area for these OEMs. One international OEM sponsored a Chair in condition monitoring at the University of Pretoria (Centre for Asset Integrity Management), plus a partnership with the University of Strathclyde, Scotland. In Zambia, the same OEM sponsored degrees at the local university and distance courses with UK universities.

articulated dump trucks), front-end loaders, haulage tractors. These were sold to various sectors: municipalities, mining, harbours, airports, sugar industry, road-making, general construction and forestry.

All the OEMs in South Africa were involved in local manufacturing. However, the international OEMs had localised only a segment of their manufacturing operations. For example one mineral processing OEM manufactured locally pumps, crushers, and feeders, but these represented only 20% of the value of its mineral processing system.

International OEMs' manufacturing operations were structured around a multi-faceted strategy (Figure 8). OEMs relied on global sourcing of non-IP intensive components, especially heavy fabrication work, from low cost, large scale, ISO certified producers in Asia and Eastern Europe. Competition among contractors was stiff, and access to economies of scale, cheap steel, and very good infrastructure was critical. Due to the exchange rate, South African heavy fabricators had become competitive in 2014. These contractors however operated at the lower end of the value chain. Indeed, one of the contractors interviewed developed an upgrading strategy. As a contractor, the firm received product design and specifications from the OEMs and advised only on the 'manufacturability' of their product design. In order to move up the value chain, the contractor concluded two JVs: one JV with a local firm to develop underground mining equipment, the other JV with a European firm to develop fixtures for surface mining equipment.

Figure 8: OEMs manufacturing strategy



Source. Interviews, 2014

OEMs sourced some specialised components from South African Tier 2 suppliers, but manufacturing of components with high IP-content was vertically integrated. More data was required to assess the extent to which international OEMs had localised critical components manufacturing, but the initial evidence pointed to significant production done by the parent companies (drive components and motorised pulleys for example). South Africa was also losing competitiveness in generic component manufacturing, which led to increased imports from low-cost sources in Asia. In selected, cost-driven value chains, such as valves, this often implied that firms ceased local production and moved into distribution. The low capability of

Tier 2 suppliers meant that imported small-sized valves could be shipped and received within 15-20 days while ferrous castings from local foundries could take between 4-6 months to be delivered. A South African valve OEM developed a three-fold strategy to face competition from Chinese manufacturers:

- In-house manufacturing of high quality valves, ISO and SABS certified. These products were mainly for the domestic market, which was protected by standards deviating from international standards.
- Sub-contracting of Chinese valves manufacturers, under own design. The OEM visited the Chinese factories to ensure they met the quality standards. These products were exported to the Middle East;
- Import of valves (not own design). The OEM monitored suppliers' ISO certification and designs, and tested the valves in-house

All OEMs were involved in marketing and distribution. Driven by increasing demand for full package solutions, some South African OEMs used their marketing and distribution activities strategically to offer a broader product portfolio. Bell Equipment for example completed its range by distributing equipment by John Deere, Finlay, Hitachi, Bomag and Liebherr. Aftermarket sales were critical for almost all OEMs. The only exceptions were manufacturers of valves and specific components of conveyor systems, because these did not require repairing and/or spares but replacing.

Zambia's mining inputs cluster was positioned at the bottom of the regional value chain. The majority of Zambian supply firms were not specialised: they were involved in varying combinations of services (construction), manufacturing (fabrication, engineering) and distribution of imported products. Local production was limited, with the exception of fabrication and machining work, and some assembly work by the OEM subsidiaries. The Tier 2 supply network was very weak, which implied reliance on high cost imports from South Africa. None of the 33 firms interviewed had R&D budget, and involvement in product development was limited. Two thirds of the firms were involved in marketing and distribution, often as agents for South African OEMs, but also for Chinese and European ones. Some agents were however able to provide higher value added activities in terms of repair and maintenance services.

Firm competitiveness

Competition from Chinese suppliers had increased cost pressures on the South African mining inputs cluster, with few exceptions such as the secondary equipment market. Even innovation-driven OEMs were affected because of reverse engineering done in China. India was also becoming a competitor, for example Volvo had moved outsourcing of front-end loaders from China to India.

OEMs for mineral processing equipment, offroad special vehicles and pumps were competitive because they supplied high quality, ISO-certified products. Cost-wise, they focused on TCO, which meant ensuring long life span of the machine, low cost of repairs and maintenance, lower downtime, and energy saving.[13] Clients were willing to pay a premium, which made these OEMs not the cheapest in the market. It was clear that they were not competing on price, because they would have not been able to withstand competition from China. The currency depreciation also increased South African OEMs competitiveness in the regional market. An EPCM firm with a Shanghai-based procurement arm confirmed that, having done extensive supply chain analysis, the South African OEMs were more cost effective.

Lead times were a function of demand: if demand boomed, lead times would increase significantly, but they did so for all competitors. However, the mines and EPCM firms placed orders well in advance, and the OEMs were able to plan on the basis of the client's installed equipment and in some cases the OEMs helped with inventory planning and management.

Lead times however were critical for aftermarket service providers in the Copperbelt. Holding stocks for spares near the mines was important - one OEM maintained up to US$ 5 million worth of inventory in the Copperbelt. The mining companies were increasingly outsourcing stock management but required short lead times. OEM subsidiaries were more competitive than agents in this area. It was highlighted however that holding capital spares which were not replaced regularly carried tax implications. While the SADC FTA allows for duty-free import into Zambia, it must be shown that the spare has been sold. If the equipment has not been sold within 12 months, the OEM is liable for tax on the equipment. Therefore some OEMs would hold big ticket items in South Africa. Lead times were also influenced by demand in South Africa. For example, for high pressure valves, lead times increased from 10-12 weeks in 2000 to 18-22 in 2014 because of high demand in South Africa.

All the OEMs with aftermarket services operations invested significant resources to be competitive in this area, although not all of them did so in the Copperbelt. Capital sales were very cyclical; hence aftermarket sales offered stability and sustainability to the business. Running 'service exchange programmes', under which the OEMs took responsibility for the maintenance of the equipment and the client received a working piece of equipment, required considerable capital investment: the OEM needed in loco workshop facilities, replacement equipment, and technical staff, which were significant expenditures for smaller OEMs.

International OEMs had some advantages over South African OEMs. They had branches across the globe, and used those in India and China to develop customer relationships there, and follow Indian and Chinese mining companies in Africa. At product design stage, South African OEMs subsidiaries received technical support from the parent companies' engineers and could send prototypes to the parent companies for testing. International OEMs would have engineers specialised in each machine, several R&D centres, and when there was a problem in the operations in South Africa or an urgent aftermarket service request, the parent company could pool resources and fly in engineers from other subsidiaries. Finally, when the South African subsidiary was producing for export, it received assistance from the subsidiary in the destination market to assist in meeting technical standards.

[13] In terms of lead times, OEMs for mineral processing equipment and pumps were on industry average or not very competitive. Some offroad vehicles OEMs were doing better.

Localisation requirements were likely to become more stringent not only in South Africa and Zambia, but in the entire African market. B-BBEE requirements and skills localisation requirements in Zambia already shaped the strategy of the OEMs. One OEM was planning a significant investment in Zambia, worth US$ 2 million. Planned investment included a bonded warehouse and a manufacturing facility for components, which implied that some activities would be relocated away from South Africa. The investment decision was driven by the need to upgrade the local presence, especially in light of the DRC market, and to meet more stringent local content requirements.

4.3 Extent and nature of regional linkages

The South Africa's mining industry did not offer major growth perspectives for OEMs, except with respect to increased mechanisation, and hence opportunities of low and extra-low profile mining equipment, and large aftermarket services because of large installed fleet and equipment. For products more specifically linked to greenfield projects, such as mineral processing equipment and conveyor systems, firms depended on the export market for future growth.

South Africa was a regional hub for the mining capital equipment supply chain. International OEMs used their subsidiaries and sole distributors (Barloworld for Caterpillar) based in South Africa to export to the entire SSA market, SADC being the largest market.[14] South African OEMs targeted the global market. Other than the Copperbelt, their export markets included:

- SADC (Mozambique, Zimbabwe, Botswana, Angola, Namibia)
- Other Africa (Burkina Faso, Ghana, Sierra Leone, Guinea, Nigeria, Ethiopia),
- South America, Australia, Malaysia, Northern Europe (Sweden, Norway), India, Russia Mongolia

Export propensity between OEMs was high and varied across product groups:

- Mineral processing OEMs exported between 50 and 95% of sales
- Conveyor systems OEMs between 30 and 60% of sales
- Except for Bell Equipment (more than 50%), offroad vehicles OEMs around 30-35% of sales
- Valves OEM only 10% of sales

The regional market offered an important opportunity for South African OEMs focused on adapting technologies to Africa's environment (wet weather, weak skills base among workers and suppliers). Bell Equipment was one of South Africa's most successful OEMs, with a global footprint, but smaller South African OEMs struggled to enter the export market due to various intra-firm and exogenous constraints.

OEMs were looking at the Zambian Copperbelt as a regional supply centre for Central Africa. The DRC in general was perceived such a risky environment that companies were not willing to set up a stable presence there. Apart from DRC, two OEMs were using Kitwe to supply also Tanzania, Botswana, Malawi, and Congo-Brazzaville.

[14] Operations for the North African market were usually run from Europe.

The OEMs' internationalisation strategies in the Copperbelt showed two patterns. Firstly, there was a considerable amount of trial and error, with firms trying different strategies to enter the market, failing, and trying different ones. Failed strategies included working with local agents, cooperating with international OEMs on joint marketing and distribution, and setting up JVs. In 2014 some South African OEMs tried but did not succeed in setting up a JV to build shared facilities. On the Zambian side, agents struggled to make connections with South African OEMs and the ones that were successful in setting up distributorship agreements had made significant efforts to gain the trust of the OEMs. It was also obvious that, without adequate support from South Africa-based OEMs, local Zambian firms would struggle to meet their expectations due to low firm capabilities.

Secondly, as expected, there was a progression from direct exports, to working with an agent or establishing a JV, to establishing a subsidiary. Direct exports reduced risks for the OEM, but there was a consensus that having local connections and knowledge increased market access. Working with agents however was difficult because they often lacked the technical knowledge to advise clients and were not trusted to be loyal to one brand. For this reason, OEMs preferred sole distributorship agreements. In Zambia, conversely, many agents struggled to develop high trust relationships with their OEMs that would convince them to invest in training and holding more stocks. The valves example was illustrative: according to trade data, 56% of Zambian valves were imported from South Africa. However, most of these were actually imported from China. Imports took place mostly through small-sized agents who lacked technical knowledge. As a result, the quality of valves supplied to mining houses was affected, with specifications of the valves ordered sometimes not matching the needs of mining operations and ending up in stocks of unusable valves. In Zambia, in fact, a JV for high pressure valves did particularly well because the manager had a deep knowledge of the field, and had been in partnership with the South African OEM for long time. Unlike other agents, he was able to advise buyers, and provide repair services (although there was no investment from the South African partner in workshop facilities to upgrade this aspect of the business).

Establishing a subsidiary allowed firms to have complete control of their relationship with clients, and to ensure competitive aftermarket sales. Nevertheless this decision could be taken only if installed capacity at the mines justified the investment. Bell had the installed equipment to justify 5 branches: Kitwe, Mazabuka, Solwezi, Lusaka, Kitwe, and Mkushi. Smaller OEMs struggled to do so. It was estimated that it would cost R200 000 per month just for rent and employees (with equipment it would be much more expensive) without a guarantee of securing orders. This was particularly risky for products that took time to sell, such as offroad vehicles. For listed OEMs, having an installed capacity was essential for shareholders to agree to establish a subsidiary. The parent company policy could also be restrictive, for example, if it stipulated that there would be only one subsidiary per continent.

Localisation requirements had a two-fold effect on the OEMs' export strategies: local content policies in the Copperbelt forced many OEMs to invest in local employment, training and promoting Zambian workers. For example an OEM employed 120 workers, 80 of which were service technicians, split into medium skills (proficient in reading electrical drawings, hydraulics etc.) and advanced skills; only 5 were foreign expatriates. Given that these OEMs were heavily involved in aftermarket services, there was evidence that they built a local skills base. Local content policies in South Africa such as Eskom procurement policy may have had the perverse effect to reduce incentives for some firms to search for export markets, especially where the investment was difficult and uncertain.

The data suggested that linkages between South Africa-based OEMs and Copperbelt suppliers varied according whether these were subsidiaries or not (Table 7). Subsidiaries in the Copperbelt were supported by the South Africa-based OEMs in different ways: back up services, training of local staff, joint marketing, and access to credit lines. Training was done in-house and in South Africa (Table 8). In two cases, training occurred abroad, in Sweden and at a Mill Circuit University in South America. Zambia-based subsidiaries provided aftermarket services. Mostly, however they would not provide the entire range of repair and maintenance services, and fell back on the South Africa-based OEM for complex services. Moreover, only a few OEMs had plans to upgrade and build local capabilities.

There was evidence that employment localisation requirements provided an incentive for OEMs to employ and train Zambian workers. There were however skills gaps, for example Zambian rock engineers were less trained and experienced than South African ones. Skilled Zambian workers were in high demand, and firms were struggling with workers' poaching.

Table 7: Zambia South Africa inter-firm linkages

	Linkages					Local sub-contracting		
	Back up support	Training	Credit	Joint product development	Joint promotion	Yes	Some	No
Subsidiaries	100%	100%	83%	0%	83%	0%	50%	50%
Others	33%	17%	0%	0%	17%	0%	17%	83%

Notes. N=12. Source. Interviews, 2014

Table 8: South Africa-based OEMs contribution to local knowledge intensification

	Training for Zambian firms				Innovation in Zambia		
	In-house	In South Africa	Abroad	Support to local institutes	R&D budget	Product development	Subsidiary/agent involved in OEM/mine collaboration
Subsidiaries	100%	100%	50%	17%	0%	17%	17%
Others	17%	0%	0%	0%	0%	0%	0%

Notes. N=12. Source. Interviews, 2014

The OEMs with a regional presence through agents, JVs and direct exports provided very little support to upgrade local capabilities. They did not have aftermarket services, did not invest in training and were not planning to do so. Credit lines to local agencies were often tight or non-existent. These issues were raised by Zambian agents as a serious constraint to their competitiveness.

Taking into account higher value added activities, manufacturing and R&D, linkages were weaker even for the OEM subsidiaries. In terms of manufacturing, there was very little sub-contracting: small fabrication work, structural steel and lagging (Table 7). In general, Zambian supply firms struggled to source locally (only 10 – 30% of their inputs), for inputs such as machining jobs, casting, bearings, nuts and bolts. OEMs would increase local sub-contracting if it reduced transport costs and helped meeting local content requirements, but the local manufacturing base was too uncompetitive, especially because the OEMs required ISO certified suppliers or at least firms with good quality, if uncertified, assurance systems. It should also be noted that sometimes OEMs' global procurement strategy, set at HQs, relied on global low cost suppliers with little consideration for local content measures in the places like the Copperbelt. This made it difficult for the South Africa-based OEMs to work with local high cost vendors.

There was no joint product development and no R&D budget for the Zambian operations (Table 8). Collaborations between OEMs and mining companies were common– for example Weir Minerals' Global Framework Agreement with Anglo American focused on improving energy consumption and lowering maintenance requirements across AA's operations in South Africa, South America, North America and Australia. In general, innovation seemed to take the form of incremental innovation and customisation of equipment. For example, in Zambia, the Australian mining company required wider, bigger and faster conveyor belts to move larger volumes. Innovation targeted also operational efficiency and energy saving. Even in cases where the South Africa-based OEMs cooperated with the mining companies in the Copperbelt to innovate or customise products, the involvement of local subsidiaries or agents was only in terms of logistics and providing customer feedback once the equipment was installed.

5. Policy issues at national and regional level

The research uncovered two levels of constraints to firm upgrading: constraints at national level in Zambia and South Africa, and constraints of a regional nature.

Zambian firms faced a high cost environment, which included unreliable electricity, poor quality and expensive industrial land, and poor road and railway infrastructure. Transport of a 20-foot container from China to Dar es Salaam or Durban costed US$2,000, but further transport to Lusaka costed an additional US$6,000 to 8,000; additionally the routes Kitwe-Chingola and Kitwe-Solwezi were unreliable due to poor road conditions. Some OEMs had to incur the expenses of chartering flights to deliver their equipment. Access to capital was reported by most Zambian firms, especially SMEs, as particularly problematic. The local business association also highlighted challenges in enforcing contracts between suppliers and mining companies.

In terms of promoting local value added activities, Zambia's tariff structure discouraged assembly operations. SADC originating inputs were duty free but non-SADC originating inputs attracted 5-15% duties. This implied that a South African assembler importing inputs duty free had a cost advantage compared to a Zambian one. Moreover, because the mining companies received financial incentives including duty treatment of capital equipment, a firm involved in local assembly would be more expensive. Other constraints related to red tape and policy inconsistency, for example, the hasty introduction in 2013 and subsequent withdrawal of a regulation that required firms to trade in the domestic economy in Kwacha and not in US$.[15]

[15] Access to procurement opportunities in the mining value chain was hampered by corruption and competition from briefcase businessmen.

In South Africa, constraints faced by OEMs included skills scarcity, in terms of output and quality, with degree courses not conferring practical skills. Smaller South African OEMs struggled to find resources for marketing in Africa and their turnover prevented them from accessing government incentives. Firms argued that their turnover was high due to the value of the equipment (one piece of equipment can cost R2.5 million), but did not reflect the volume of their sales nor their profitability. Hence, even a start-up or a small-sized OEM could not access incentives which were earmarked for small companies.

The competitiveness of Tier 2 suppliers affected OEMs. For example, South African valves OEMs faced import competition where the cost of imports was 30% of cost of local manufacture. Steel castings in China costed R18/kg compared to R40/kg (early 2014 data). Moreover, imports would take 15-20 days lead times compared to 4-6 months for local production due to low capacity in the foundry sector.

At regional level, the study identified two critical constraints. Firstly, regional suppliers faced conflicting local content policies in South Africa and Zambia. The DTI's ECIC local content requirements for a South African exporter into Zambia clashed with increasingly stringent localisation requirements set by the Zambian government. It was noted that indeed South Africa's industrial policy only targeted the domestic market not the regional one. Reciprocal and harmonised incentives schemes within SADC would provide a better framework to promote regional investment and mutually beneficial outcomes.

Secondly, the DRC offered important market opportunities for Zambia-based suppliers and South Africa-based OEMs. However, export documentation and handling requirements to DRC were cumbersome. Moreover, the DRC was characterised by a highly risky business environment which raised costs and reduced efficiency. The role of the DRC in strengthening competitiveness in the regional value chain was critical.

6. Conclusions

This paper aimed to uncover the determinants of local upgrading processes in the regional value chain for mining capital equipment in Southern Africa. In order to do so, the research has looked beyond trade and investment flows, to analyse firm-level strategies and inter-firm linkages. The most obvious fact emerging from the analysis is that the regional extractive industry is driving the recent growth of the South African mining inputs cluster. Faced with stagnant domestic demand, mainly for aftermarket sales and specialised underground low-profile equipment, South African OEMs are moving into the region to find new customers and strengthen relationships with existing ones.

In this respect, the paper offers new insights on the role of EPCM firms in facilitating regional suppliers. EPCM firms tap into the South African mining inputs cluster for national and regional projects. This is critical for specific groups of suppliers, such as the mineral processing equipment OEMs. For other groups of suppliers, such as offroad special vehicles, it is mining contractors rather than EPCM firms that manage access to mining procurement contracts. The EPCM firms' supply chains are quality-driven and focused on TCO, which are parameters in which South Africa-based OEMs are most competitive. Zambian suppliers on the other hand are largely excluded from the EPCM firms' procurement strategies. From a policy perspective, this implies that EPCM firms, and contractors, should be involved in any cluster development programme designed at national level, in both South Africa and Zambia, as well as any regional initiative.

The South African mining inputs cluster includes both domestically-owned and international OEMs. Whilst they both contribute to the competitiveness of the cluster, there is evidence that South African-owned OEMs are more heavily involved in all stages of the value chain, including product development, technological innovation and manufacturing. Yet, they lag behind international OEMs in their regional footprint. The reasons include constraints in accessing government incentives, and competition with international OEMs able to offer attractive financing packages and aftermarket services to the mining companies. The latter are crucial in light of the outsourcing and procurement strategies of the mining companies, which emphasise TCO and access to reliable aftermarket services within short lead times. To offer this, OEMs have to invest in the Copperbelt in facilities, equipment, stocks and skilled personnel (although they fly in from South Africa very specialised labour). Given the uncertainty of future orders and capital requirement for overheads, even well-established firms are reluctant to make such investment. Yet, exporting directly or via agents represents a sub-optimal solution.

In Zambia, local mining suppliers are involved in low value added activities, mostly as agents and traders. Whilst tighter linkages to South African OEMs would help them to become more competitive, both Zambian and South African firms struggle to develop such business relationships. This is mostly due to information asymmetry, risk of opportunistic behaviours and low firm capabilities.

In this context, this research finds that the region could play an important role, not only as an export market for the South African mining inputs cluster, but also as a space for cooperation to build regional supplier competitiveness and mutual growth. So far, the relevant policy frameworks have actually shown inconsistencies, for example between local content policies in South Africa and Zambia, which make it difficult for firms to create a coherent strategy for investment and value addition. Localisation requirements in Zambia are becoming increasingly stringent and there is evidence that employment requirements are already shaping the human resource strategies of OEMs in the Copperbelt.

Regional cooperation should build on existing regional linkages across South Africa, Zambia and the DRC. South Africa-based OEMs support their subsidiaries in multiple ways: back up services, training of local staff, joint marketing, and access to credit lines. Manufacturing and R&D linkages however are weaker for any type of firm. There is very little sub-contracting to Zambia-based firms and this is limited to very simple inputs. Moreover, even when the South Africa-based OEMs cooperate with the mining companies in the Copperbelt to innovate or customise products, there is no significant involvement of local subsidiaries or agents. The DRC offers a large market for mining inputs, which OEMs are supplying through Zambia. Suppliers however face infrastructural and regulatory barriers which raise inefficiencies.

The findings of this study suggest that there is significant scope for cooperation at regional level. A regional strategy to increase value addition in South Africa and Zambia should rest on two pillars:

1) Building a regional market across South Africa-Zambian Copperbelt-DRC Copperbelt; and
2) Intensifying linkages between South African and Zambian mining inputs clusters.

Zambian and South African suppliers are using the Zambian Copperbelt as a basis to participate in the DRC mining supply chain. OEMs find the DRC too risky to consider a solid market presence there. The DRC Copperbelt therefore offers an opportunity for Zambian suppliers to acquire larger economies of scale. This in turn implies that South Africa-based OEMs have more incentives to increase the value added content of their activities in the Zambian Copperbelt. This strategy however requires the removal of barriers between South Africa, Zambia and the DRC. Such barriers include high transportation costs linked to road transport and trade facilitation issues. For example, Zambia and South Africa should facilitate the establishment of bonded warehouses. The latter would allow South Africa-based OEMs to move larger stock of equipment and spares to the Zambian Copperbelt to supply the regional market. It would lower transport costs thanks to bulk transport, and shorten lead times in supplying clients.

Linkages between South Africa-based OEMs and Zambian suppliers play an important role in supporting firm upgrading in the Copperbelt. A regional value chain strategy should leverage on this, and provide incentives to South Africa-based OEMs to build their market presence in the Copperbelt. Elements of this strategy should include cluster initiatives in South Africa and in Zambia to address constraints to firm upgrading, and establishing a regional approach to local content requirements which reduces conflicts in national local content incentives and support a win-win outcome. South African OEMs and startup companies should be supported by DTI in establishing their Copperbelt subsidiaries and increasing their local value added content. This would be mutually advantageous: OEMs would become more competitive in terms of aftermarket services and lead times, and Zambia would benefit in terms of, among others, employment, skills development, knowledge transfer, and sub-contracting opportunities.

On the Zambian side, this strategy requires that local content policies are part and parcel of a broader industrialisation strategy. Multiple stakeholders, in particular the mining companies and the OEMs, need to be involved. Employment localisation requirements need to be complemented by an aggressive skills development strategy through technical and vocation schools and apprenticeship programmes. Particular support should be given to manufacturing companies to become Tier 2 suppliers to the OEMs, even if for simple, low value added components and spares initially. South Africa should have a forward looking policy and support Zambia’s strategy in these areas. In the longer term, regional cooperation could target cooperation in technology innovation and R&D and higher value added activities in South Africa and the Copperbelt.

Some of the issues raised in this paper would require further research to better understand the potential for regional upgrading processes. These include the nature of lateral migration of technologies to and from the mining sector, the progress of regional suppliers in building turnkey and full package capabilities, and the dynamics of the mining supply chain in the DRC.

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Annex 1

Table A: Categories of respondents, June - October 2014

	South Africa	**Zambia**
Suppliers	14 OEMs, both South African and International, in Gauteng, KZN	33 mining supply firms. Combination of Zambian, international and South African OEMs in Kitwe, Ndola and Chingola (Copperbelt)
Buyers	EPCM firms, both South African and International, in Gauteng, KZN	
Institutions	South Africa Capital Equipment Export Council	• Kitwe Chamber of Commerce and Industry • Zambia Association of Manufacturers • Zambia Chamber of Commerce and Industry • Zambia Development Agency • Private Sector Development Reform Programme

In Zambia, there was a considerable level of ‘interview fatigue’ and the mining companies did not grant their availability for interviews. Hence the closest information regarding buyers’ strategies was collected through the EPCM firms’ interview data. These data should be read with some caution, because for some product categories, EPCM firms’ procurement strategies may differ from the mining companies’ ones.

Annex 2

Table B: South Africa's exports to the rest of the world for selected product clusters (US$ 'million)

Product Cluster	2006	2007	2008	2009	2010	2011	2012	2013	CAGR %
Mineral Processing	212	223	276	215	290	328	405	436	10.8
Off-road special vehicles	887	1 085	1 344	668	940	1 415	2 230	2 365	15.0
Pumps and Valves	97	135	172	183	195	259	332	349	20.0
Conveyor systems	35	50	43	28	49	68	75	102	16.2

Notes. South Africa’s mining capital equipment total exports minus exports to Zambia. *Source.* UN Comtrade database, retrieved from http://comtrade.un.org/ in July 2014.