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Metals, Machinery, and Mining Equipment Industries in South Africa

The Relationship between Power, Governance, and Technological Capabilities

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3.1 Introduction

The metals, machinery, and mining equipment industries have been at the heart of South Africa's industrial ecosystem for many decades. This is due to the importance of mining in the country for more than a century and the close demand- and supply-side linkages with metals and machinery production. These industries include basic iron and steel, non-ferrous metals, fabricated metal products, and a diverse array of machinery and equipment manufacturing. The industries are characterized by well-established technological capabilities developed through linkages with mining and extensive state support under apartheid. During apartheid, there was particularly extensive support for basic metals production.

The industries continue to be crucial to the South African economy for several reasons. They make up a very substantial part of manufacturing, accounting in 2019 for 19 per cent of manufacturing value added and 23 per cent of employment, with employment mainly in downstream fabricated metals products, and machinery and equipment. They also provide intermediate products to other sectors across the economy. The industries are central to the processes of learning and technological change, and are critical for convergence between the ICT, and machinery and equipment industries in the context of the fourth industrial revolution (Min et al., 2018). As such, machinery and equipment are 'root industries' for any strategy that seeks to diversify the domestic economy towards higher value adding and more sophisticated activities, while creating jobs (see Chapter 12).

This chapter analyses the restructuring and development of these complex value chains in post-apartheid South Africa, from 1994 to 2019. In section 3.2, key turning points in this development are identified, in relation to the initial phase of the liberalization of the economy, the growth in demand associated with

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the global commodities boom in the 2000s, and the period of adjustment from 2008, after the financial crisis, until 2019. Notwithstanding major changes, the overall record is of a basic steel industry that performed better in terms of value added relative to the more diversified downstream industries.

Section 3.3 involves a critical examination of the engagement of the post-apartheid state with the main companies producing basic metals—the key inputs for downstream manufacturers of metal products. The principal firm was the major basic-steel producer Iscor, which became ArcelorMittal South Africa (AMSA). This is followed by a discussion on the use of procurement as a demand-side industrial policy, given the importance of infrastructure and investments by state-owned enterprises and mining companies as buyers of metal products and machinery.

In section 3.4 the focus turns to the downstream mining machinery and equipment industry. While South Africa has strong production capabilities, these have been eroded. The section includes a reflection on the challenges in terms of technologies, changing ownership, and governance arrangements in production systems, and an examination of the related changes in the domestic environment. Conclusions and implications for industrial policy are set out in section 3.5.

3.2 Missed Opportunities for Structural Transformation

The metals, machinery, and mining equipment value chains serve a critical role in South Africa as a source of employment, output, and high-value products. In 2019, the industries accounted for the largest source of formal employment in manufacturing, contributing a total of 284,000 direct jobs, of which 228,000 were in the machinery and equipment, and fabricated metal products industries. The industry's strong linkages with support industries such as engineering services, transport, and logistics generate further employment. While the upstream capital-intensive basic metals industry saw output growth alongside shrinking employment, the growth of output in the diversified machinery and equipment industry was accompanied by employment growth, highlighting its labour-absorbing characteristics.

3.2.1 Mapping the Metals to Machinery and Equipment Value Chains

The metals, machinery, and equipment value chains are quite complex, with backward and forward linkages underpinned by integrated production systems. The upstream segment begins with the mining and production of mineral ores, including iron ore, chrome, manganese, and other related mining activities that feed into both basic ferrous and non-ferrous production. The basic metals go

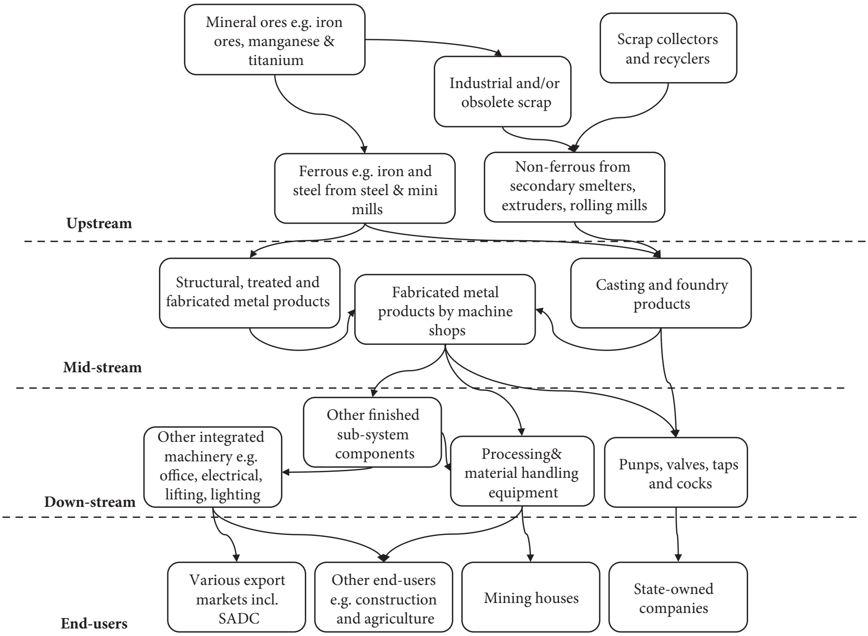

Figure 3.1 Metals to machinery and equipment value chain

Note: The arrows are only illustrative of the main linkages and supplies of, for example, pumps and valves are supplied to a range of customer groupings.

Source: Adapted from Rustomjee et al., 2018.

through various processes of value addition, until being manufactured into sophisticated products and components including pumps and valves, material handling equipment, mineral processing, and earthmoving equipment (see Figure 3.1). These are demanded by mining houses, utility providers (including state-owned companies in energy and transport), and other sectors such as agriculture and construction. The mining sector is the largest user of these inputs, directly accounting for 24 per cent of domestic demand in 2019 and further demand for metals and machinery components (Quantec, 2020), as they are embodied in intermediate goods.[1]

Steel is by far the most important basic metal, followed by aluminium and other non-ferrous metals. Primary steel production is a large-scale, capital- and energy-intensive industry, with strong backward linkages to iron ore, coal, and electricity, as well as scrap metal (used in mini-mills for producing long steel products). Basic steel is widely traded, notwithstanding substantial transport costs, as is aluminium. Cast-metal products are produced in foundries, melting steel and other metals to produce components that are used in a range of

[1] It is important to note that the Quantec data are not official statistics. They have been compiled including data from Statistics South Africa, with some computations by Quantec, and this should be borne in mind.

downstream finished manufactures. The cost and quality of steel, as a key input, is a major contributor to the competitiveness of downstream fabrication of a range of metal products.

Basic steel production in South Africa has been dominated throughout the period by the steel plants of by the formerly state-owned Iscor, which became ArcelorMittal South Africa (AMSA). Acerinox is the major stainless-steel producer, while there were a few very large aluminium smelters. Iscor's first plant came into production in Pretoria in 1934 (Zalk, 2017). Following its privatization in 1989, Iscor continued to receive substantial government support in the 1990s and was the subject of a major government-sponsored restructuring strategy resulting in its acquisition to become AMSA (Roberts and Rustomjee, 2009; Rustomjee et al., 2018). Other steel producers then included Highveld Steel and Vanadium, using iron ore as the main feedstock, and Scaw Metals, manufacturing from scrap metal. Both companies were part of the Anglo American conglomerate until the 2000s. Parts of Highveld Steel were taken over by Evraz in 2006, while parts of Scaw were acquired by the IDC following the downturn after 2008 (Rustomjee et al., 2018).

Downstream products have strong backward linkages with the upstream steel producers and foundries that provide fabricated metal products as key inputs into machinery and equipment production. In addition to basic metal products from which intermediate components are manufactured, there are a range of cast products made by foundries. These cast components can be manufactured from alloys and are important for the automotive industry. The key components sold to the industry include a combination of low-tech, medium-tech, and high-tech components, illustrating some level of structural transformation.

Despite the importance of the foundry industry at the midstream level as producer of cast components, its capabilities were severely eroded after the opening up of the economy in 1994. The industry continued to struggle competitively, resulting in a dramatic decline in the number of foundries and levels of output, particularly between 2008 and 2016, when the number of foundries fell by 38 per cent and output declined by 15 per cent (Rustomjee et al., 2018). The weakening capabilities are partly explained by the lack of any substantial investment in capital and technology upgrading in the two decades up to 2020, coupled with increasing import competition from Asia and Europe.

In South Africa, the local mining machinery and equipment industry, which is the most imprtant downstream segment, is characterized mainly by medium-sized local companies that are highly specialized in specific product segments, including underground and surface mining equipment, off-road specialized equipment, mineral processing, and material handling. These firms compete with global original equipment manufacturers (OEMs) which have increased their share of the South African and Southern African markets. The South African producers have innovative and advanced technological capabilities in deep-level mining, including rock mechanics, shaft sinking, refrigeration, ventilation, pumping, and hoisting systems, and drilling and blasting (Fessehaie, 2015; Andreoni and Torreggiani, 2020). Some of the domestic manufacturers supplying equipment to the mining houses have backward linkages to foundries providing metal casting and to suppliers of components such as pumps, valves, and conveyor systems, as well as with related services, especially in engineering, and product-system and software design (Phele et al., 2005; Phele and Roberts, 2005).

3.2.2 Competitiveness and Structural Transformation

Structural transformation in the industry requires better performance in diversified downstream activities, instead of in the upstream, capital- and energy-intensive basic metals industries. Despite the downstream sector accounting for a larger proportion of value added in total manufacturing, the relatively stronger growth in value added through the 1994–2008 period was observed in the upstream basic metals industries (Table 3.1).

Major investments were made in the basic iron and steel industries in the early 1990s and in the non-ferrous metals industry in large aluminium smelters in the early 2000s, as reflected in the average rates of investment (Table 3.1). The continuation of support to the main producers underpinned high average growth in value added in basic metals industries from 1994 to 2002, alongside major restructuring efforts to reduce employment. The upstream industry growth reflected the strength of path-dependency effects in response to liberalization, and how the balance of interests in favour of concentrated incumbents influenced policy (Goga et al., 2020). This path dependency is evident in the capital-intensive upstream industries continuing to attract higher levels of investment through the period as a whole, accounting for the great majority of real gross fixed capital investment (in constant 2010 prices) in the metals and machinery industries overall.

The commodities boom in the 2000s further drove growth in steel value added, with an 11.8 per cent compound annual average growth rate in the 2002–8 period. The growth in mining activity in other parts of Southern Africa increased demand for machinery and equipment in this period and saw average annual growth in value added in this industry of 5.7 per cent from 2002 to 2008, even while import penetration increased to 67.6 per cent of domestic consumption (Table 3.1). The import penetration, especially from China and including in cast metal components, eroded capabilities even while overall the industry grew in both output and employment. This impact is evident in the decade following the financial crisis, when production stagnated, notwithstanding a few areas of excellence in machinery and equipment, which regained competitiveness following investments in capabilities (Barnes et al., 2019).

Table 3.1 Performance across the metals, machinery, and mining equipment industry grouping

	Period	Basic iron and steel	Basic non-ferrous metals	Fabricated metal products	Machinery and equipment
Value added (Rbn)	1994	9.2	7.8	16.5	12.5
(% share of total manufacturing)		(3.8%)	(3.3%)	(6.8%)	(5.2%)
	2019	16.7	11.8	21.3	21.7
		(4.4%)	(3.1%)	(5.6%)	(5.7%)
Average value-added growth	1994–2002	3.9%	7.9%	2.7%	2.4%
	2002–8	11.8%	3.8%	0.7%	5.7%
	2008–19	−3.3%	−3.7%	0.1%	0.3%
Employment (in thousands)	1994	80	27	118	97
		(5.5%)	(1.8%)	(8.1%)	(6.6%)
(% share of total manufacturing)	2019	32	15	104	124
		(2.7%)	(1.2%)	(8.5%)	(10.1%)
Average employment growth	1994–2002	−5.4%	−3.7%	−1.5%	−0.2%
	2002–8	−0.7%	2.3%	1.8%	3.9%
	2008–19	−3.8%	−3.8%	−1.0%	0.3%
Average investment	1994–2001	41.0%	31.6%	9.4%	9.4%
(gross fixed capital formation as % of gross value addition)	2002–8	37.2%	36.2%	11.2%	10.0%
	2009–19	34.1%	43.7%	9.9%	9.4%
Imports as % of domestic consumption	1994	10.4%	11.7%	13.8%	54.0%
	2002	7.7%	22.3%	19.1%	57.4%
	2008	25.9%	66.9%	24.5%	67.6%
	2019	13.8%	39.9%	24.3%	69.1%
Exports as % of domestic output	1994	45.1%	29.1%	5.1%	14.2%
	2002	35.6%	38.9%	10.0%	22.2%
	2008	67.0%	57.2%	12.7%	27.4%
	2019	37.2%	42.6%	15.0%	40.4%

Note: The imports and export measures for fabricated metal products are for 'Other fabricated metal products'.

Source: Quantec data and authors' calculations.

The downstream industries have not had a major coordinated industrial policy programme of support and services, including targeted skills and technology support through institutions of industrial policy. Instead, there has been an evolving mix of ineffective incentives and initiatives. These include investment incentives in the 1990s, the bulk of which went to the basic metals producers rather than diversified downstream and labour-absorbing producers (Roberts and Rustomjee, 2009). There were also technology support measures under the Integrated Manufacturing Strategy and the Advanced Manufacturing Technology Strategy (Machaka and Roberts, 2003). Cluster developments were championed by the South African Capital Equipment Export Council (SACEEC), established in 2000 as a public-private partnership between the industry and the Department of Trade, Industry, and Competition (DTIC), but the emphasis was on driving market access through public procurement, export promotion, and marketing initiatives, such as international trade fairs.

In fact two separate developments worked against diversifying the industrial base. First, substantial engineering capabilities in subsidiaries of the major conglomerates, led by Anglo American and including its Dorbyl business, were eroded when the conglomerates unbundled and a short-term asset stripping took place (Zalk, 2017; Rustomjee et al., 2018). Second, the procurement policies, including under black economic empowerment (BEE) provisions in the 2000s to favour black suppliers, did not measure local value added and led to black entrepreneurs setting up as local suppliers for multinational producers importing into South Africa (Chapter 9).

3.2.3 Trade Performance and the Poor Performance of Machinery and Equipment

The opening-up and international reintegration of the South African economy from 1994 saw the basic metals industries (iron and steel, and non-ferrous metals) maintain trade surpluses while the trade deficit in machinery and equipment reduced somewhat, as the real exchange rate depreciated in line with the unwinding of protection measures (Figure 3.2). Fabricated metal products maintained

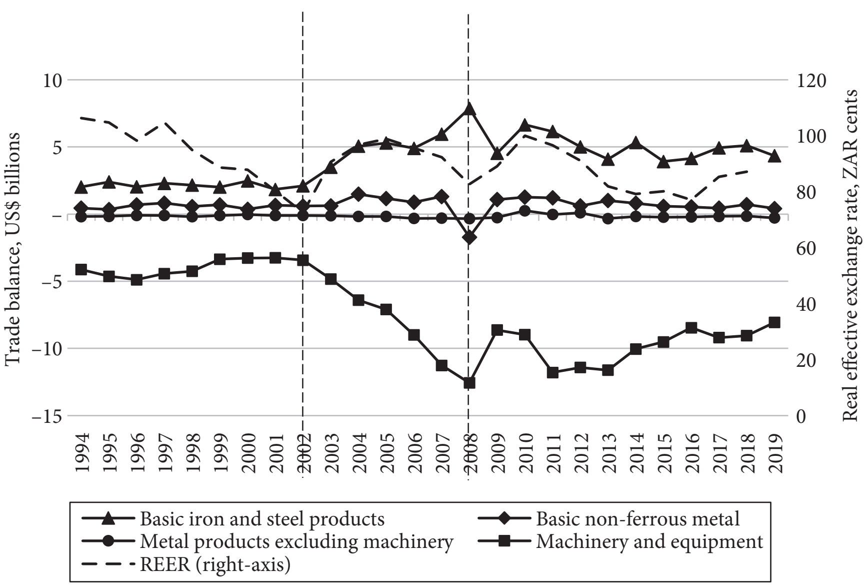

Figure 3.2 Metals, machinery, and equipment trade balances, nominal US$ millions
Source: Trade Map and South African Reserve Bank, accessed in March 2020.

roughly balanced trade throughout the entire 1994–2019 period, as exports were similar to imports.

From 2002, as the commodity boom took hold and international commodity prices increased substantially, the trade surplus in basic steel quadrupled. However, while robust domestic demand meant that the machinery and equipment industry continued to grow output and employment, under the stronger commodity-supported currency it could not compete with the massive import penetration. The currency appreciation made it more attractive for domestic demand to be met by relatively cheaper imports. The increase in the trade deficit from 2002 to 2008 was equivalent to the domestic value-added of the industry in 2008, which supported 100,000 direct jobs.

The global financial crisis saw a sharp decline in the output of both basic metals and fabricated metals as prices collapsed. While the trade balance in machinery and equipment improved somewhat, as imports declined, the hollowing out of capabilities in the previous period from 2002 to 2008 meant that performance continued to be weak overall, and value added in 2019 remained lower than ten years earlier.

The failure to maintain and grow from a strong industrial base in machinery and equipment is most evident in the declining competitiveness in the Southern African region, which accounts for the great majority of South Africa's exports of these products. For example, in Zambia, which has been one of the largest export markets for South Africa, market share fell from above 60 per cent in 2002 to around 30 per cent in 2019 (Figure 3.3). Shares are higher in Botswana, Namibia,

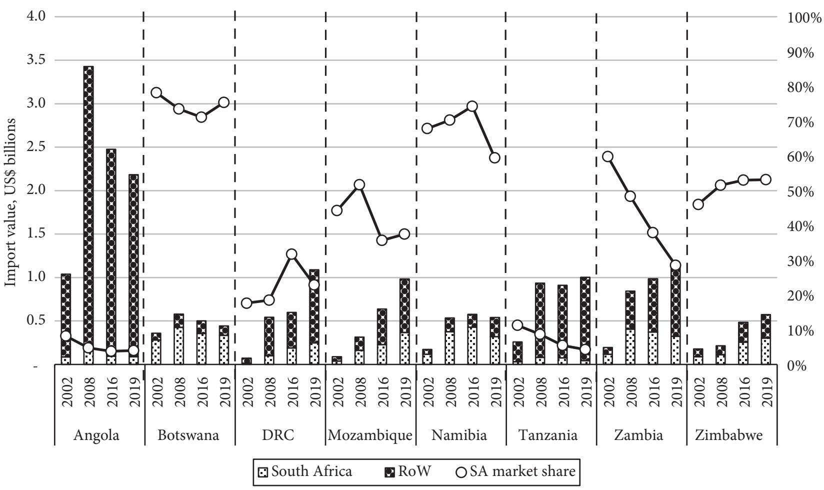

Figure 3.3 Machinery and equipment imports of selected SADC countries from South Africa versus the rest of the world, in US$ billions

Note: Due to lack of data, Angola import values for 2002, 2008, and 2019 are represented by 2004, 2009, and 2019; and Tanzania import values for 2019 are represented by 2018 import values.

Source: ITC Trade Map (https://www.trademap.org/); authors' calculations.

and Zimbabwe, but these are smaller markets. In the largest importer in the region, Angola, South Africa's share of machinery imports is very small, as it is too in Tanzania.

South Africa's poor performance in the Southern African Development Community (SADC) has been especially concerning as, in 2019, other SADC countries collectively accounted for a larger market in terms of mining activity than South Africa itself. This suggests the need to urgently build strong regional value chains for South Africa to regain the lost ground in machinery and equipment exports.

The lack of structural transformation at the downstream segments represents lost opportunities for these industries to move towards higher-value and relatively complex products. While there have been businesses with existing islands of competitiveness, overall, the downstream industries have failed to build on these capabilities.

3.3 Steel and Metal Products: Industrial Policies, Power, and Governance

To assess how interests have shaped policies to maintain economic power, this section involves an examination of the industrial policy, power, and governance dynamics along the value chain from steel producers to fabricators of metal products. In particular, the grand bargains struck by government with the steel industry and the implications for the supply of inputs to downstream industries are analysed. On the other side, the impact of procurement policies working through demand by state-owned companies for metals and machinery products are assessed.

The first democratic government in 1994 adopted a set of policies to support the manufacturing industry, including incentives and investment support programmes.[2] In reality, the greater share of these incentives went to the upstream basic industries (Mondi and Roberts, 2005; Roberts and Rustomjee, 2009; Black and Roberts, 2009). At the same time, the steel industry was facing very low international steel prices and the challenges of restructuring the local producers, while globally there were shifts from national to transnational ownership and consolidation.

The government's strategy for the steel industry in the late 1990s involved a grand bargain struck with the main steel producer, where low input costs in terms of energy and iron ore were ensured, along with support for investment and for

[2] Investment support programmes included the IDC's Global Player Fund, a tax holiday programme and accelerated depreciation allowance tax incentive scheme under section 37E of the Income Tax Act.

local consolidation. This competitive restructuring upstream was envisaged to be the foundation for growing downstream steel-using industries led by fabricated metal products and machinery. These industries were also supported in the later period by government preferential procurement policies, which are described and evaluated below. Against this background and in the context of the government's approach, a question that needs to be asked is why so little changed in the overall structure of the metals and machinery industries. Specifically, how does one explain the fact that, on average, upstream capital-intensive industries continued to grow more strongly than the downstream industries?

3.3.1 The Big Steel Bargain: Government Support and Conditionalities for Upstream Producers

As part of achieving a rapid restructuring of the basic steel industry in the late 1990s to improve production efficiencies, upgrade plant, rationalize employment numbers, and reduce the number of grades manufactured, the government supported acquisitions of strategic equity stakes by transnational corporations (TNCs). The government did this through its ownership in Iscor (held by the IDC) and different forms of industrial policy support. The rationale was to ensure the local acquisition of international technology, expertise, and capital essential for the rapid upgrade of local production.

Under this strategy, Lakshmi Mittal's LNM (later Mittal Steel) acquired a stake in Iscor, following the vertical separation of the steel-making from the mining parts of the business. The separation ensured the supply of iron ore for twenty-five years at cost plus a 3 per cent management fee which, along with cheap energy in the form of coal and electricity, meant Iscor's plants were among the lowest cost in the world (Roberts, 2008).

Government support for the Mittal acquisition represented the first 'grand bargain' (Rustomjee et al., 2018) and was linked to a business assistance agreement which provided various incentives, including additional shareholding related to investment and upgrading steps (Zalk, 2017). Through the agreement, Mittal gained sole control of an effective local monopolist in flat steel products in 2003, given the additional absorption of Saldanha Steel in 2002 in which Iscor had already held a 50 per cent stake. The acquisitions were approved based on the company moving to a 'developmental steel price' for local customers. However, the nature of the developmental steel price was not specified nor agreed with government.

Instead, it fell to competition law to discipline the exercise of market power over local downstream customers by Mittal Steel South Africa before it became AMSA.[3] The competition authorities duly uncovered various cartels in which

[3] There are other producers in long steel products.

AMSA had been engaging with its competitors, where it had them in long-steel products. For instance, the reinforcing bar price-fixing cartel, which lasted from 1999 to 2008, led to average prices being over 30 per cent above competitive levels (Mondliwa and Das Nair, 2019).

In most flat steel products AMSA faced no local competitor and explicitly priced at an import parity level until 2019, calculated as the landed price of imported steel, generally to inland customers, including all the imputed transport and related costs and a 5 per cent 'hassle factor' (Roberts, 2008). This was notwithstanding around 40 per cent of AMSA's production being exported, while the local import parity-based prices were around 40–60 per cent above the export prices being earned by AMSA for the same products. The high prices directly undermined the competitiveness of producers of downstream products using steel as an input. In March 2007, The Competition Tribunal found in favour of a complaint by two mining companies that this pricing was excessive and a contravention of the Competition Act. Two years later, The Competition Appeal Court overturned the decision on the grounds that the economic value against which prices needed to be evaluated had not properly been considered (Das Nair and Mondliwa, 2017).

Using competition law to address monopoly pricing by a business that had received extensive government support ignored direct policy levers which could have been used to discipline the conduct of AMSA. Mining licences were a potential tool as clause 8 of the standard mining licence in South Africa stated that minerals and derivative products were to be sold at competitive and non-discriminatory prices (Rustomjee et al., 2018). This, in effect, would have required factory gate prices for downstream steel customers of AMSA (given its production from local iron ore) to ensure it did not discriminate between local and export customers.

Conditionalities on investment incentives were a second industrial policy lever. In this regard, the upstream capital- and energy-intensive basic metals (and basic chemicals) industries had received the bulk of the benefits from generous tax incentive programmes and development finance, while the downstream industries received a fraction of this support (Mondi and Roberts 2005; Black and Roberts, 2009; Roberts and Rustomjee, 2009). The upstream firms, however, evaded conditionalities. For instance, the 37E tax incentive legally obliged the upstream firms to sell steel at non-discriminatory export-parity prices to the domestic market. This was side-stepped by Saldanha Steel, which elected to export its production in its entirety rather than sell locally (Roberts and Rustomjee, 2009).

The business assistance agreement reached with Mittal on the purchase of its initial stake and the commitment to a 'developmental steel price' proved not to be effective. In addition, after the initial restructuring, Mittal extracted profits from the South Africa business while funding acquisitions and investments in developed countries (Zalk, 2017). This meant that the expected benefits from Mittal's ownership in South Africa were not realized.

When global steel export prices dropped again to a ten-year low in 2016, the industry, led by AMSA, placed government under pressure to provide support once again. To support the upstream industry, government struck a second 'grand bargain' with AMSA. AMSA committed to adopt a production cost-based formula for local pricing in exchange for the settlement of unresolved competition-related matters, increased tariff protection, and a policy directive that only South African steel be utilized in publicly funded infrastructure projects. The rationale for government included the protection of the remaining jobs in the steel industry and the importance of a local steel producer for value chain linkages upstream and downstream.[4]

The agreement favoured AMSA. Steel prices turned upwards in 2016, while AMSA's local monopoly power was further entrenched (as other small domestic producers were in or close to bankruptcy) and the agreement was only binding until 2022. The settlement of the anticompetitive charges across multiple competition cases for R1.5 billion (US$115 million) in 2016 was generous relative to the likely penalties, especially for the collusion charges. The steelmaker also received an additional steel tariff of 10 per cent that effectively increased the steel industry's safeguard measure to 22 per cent. While the pricing commitment was meant to protect local buyers, there is considerable scope for interpretation as to its terms (Rustomjee et al., 2018). Meanwhile, the labour-absorbing downstream industry was not protected by tariffs in the same way as the upstream industry.[5]

The concentration of employment in a few upstream firms supported the lobbying efforts by large steel companies, despite the much higher number of jobs in the relatively disorganized downstream industries. Tackling these inherent power dynamics is central to structural transformation.

3.3.2 The Effects of Poorly Enforced Public Procurement Policy

Public procurement is a significant source of demand in most economies and can be a key lever for industrial development. In South Africa procurement by state-owned companies is very important for the metals and machinery industry. Procurement policies can thus be effective industrial policy instruments for supporting local industry development, innovation, and technological upgrading (Edler and Georghiou, 2007; Georghiou et al., 2014; Lember et al., 2014; Tiryakioğlu and Yülek, 2015).

[4] See the DTIC presentation to the joint portfolio committees on trade and industry and economic development on 23 August 2016: https://www.thedti.gov.za/parliament/2016/Steel_Industry_Interventions.pdf.

[5] There is a lack of tariff support for the downstream industries, with 90 per cent of capital equipment duty-free (Rustomjee et al., 2018).

South Africa has leveraged public procurement, including by state-owned enterprises, through the designation of sectors and products for local content under the Preferential Procurement Policy Framework Act (PPPFA) of 2000 and the Competitive Supplier Development Programme. This followed the earlier National Industrial Participation Programme in 1995. Under the PPPFA the Department of Trade, Industry, and Competition is enabled to designate certain sectors whereby tenders will only be awarded to locally manufactured products with a prescribed minimum threshold of local content. The PPPFA also has BEE objectives to support businesses owned and controlled by black South Africans (Chapter 9). In 2007, the Department of Public Enterprises introduced the Competitive Supplier Development Programme (CSDP) to specifically support the development of local industrial capabilities.[6] While these different policy instruments were meant to complement each other, evidence suggests that their enforcement was weak (Mohamed and Roberts, 2008; Crompton et al., 2016). Instead of realizing the intended outcomes, weak enforcement also enabled significant rent extraction. A striking example was state-owned enterprise Transnet's procurement of 1,064 locomotives and its infamous outcomes.

3.3.2.1 The Case of Transnet: A Cautionary Tale

Transnet was supposed to be implementing the CSDP approach when it started to plan a major procurement of locomotives for its freight business in 2012. In July 2012, it issued a tender for 1,064 locomotives for its general freight business division, both electric and diesel. The procurement was required to comply with the earlier stated PPPFA's local content requirements, with thresholds of 55 per cent local content for diesel and 60 per cent for electric locomotives.

In 2014 Transnet placed the very large order for the 1,064 locomotives with four companies: Bombardier Transportation South Africa, China South Rail Zhuzhou Electric Locomotive Company (CSR), General Electric South Africa Technologies, and China North Rail Rolling Stock South Africa (Pty) Ltd (CNR).[7] All four had BEE partners. The two Chinese firms, which subsequently merged, secured permission to build a relatively large number of locomotives outside of South Africa for an initial period. However, while Transnet had developed an ambitious three-phased approach for localization, by the end of 2019 there was limited evidence of investments being made in South African manufacturing, while costs had escalated substantially.

Widespread issues of corruption and non-compliance were subsequently uncovered and subject to scrutiny at the Zondo Commission of Inquiry into State

[6] The Competitive Supplier Development Programme (CSDP) provided for SOEs to design supply and demand side measures with government for OEM suppliers to develop localized first- and second-tier suppliers, so building the domestic supply chain. The CSDP was coordinated by the Department of Public Enterprises (Crompton et al., 2016).

[7] The order was for R50 billion (around US$5 billion at the time).

Capture, which started in the middle of 2018 and was due to wrap up in early 2021. In January 2018, Transnet made attempts to remedy instances of non-compliance in agreements with the Bombardier and General Electric suppliers, while in December 2019 Transnet launched a court case to declare the contracts with the Chinese suppliers as being unlawful and set aside.[8]

Through this procurement, the foreign OEMs held the potential to develop industrial capabilities and improve manufacturing suppliers in South Africa, as the procurement terms required supplier development initiatives that would encourage technology transfer, skill transfer, and improved quality standards (Crompton et al., 2016). However, in addition to the concerns about corruption, the incentives for OEMs to invest to establish South Africa as a platform and innovation hub were also undermined by Transnet Engineering's own ambition to become an OEM. This placed Transnet in a conflicted position as it was both customer and competitor. (Mondliwa and Das Nair, 2019)

The procurement process was fraught with problems that reflect the underlying challenges in developing effective industrial policy (Crompton and Kaziboni, 2020). Public procurement involving such large sums requires a number of institutional conditions to be in place, which were largely lacking in South Africa. These include a lack of clear guidelines, weak verification and enforcement processes, insufficient coordination between the relevant government departments, and capacity constraints at the governing department (Rustomjee et al., 2018). The ongoing changes to procurement rules, to the BEE codes,[9] and to incentive procedures greatly increased the risks and uncertainty for investment, while making it easier to capture rents through the procedures being bypassed. And the verification of local content requires a competent and well-resourced verification agent to conduct verification checks at various points in the process. If non-compliance at any stage is detected there needs to be a functional enforcement agency with the necessary policies and procedures to address it.

3.4 Mining Machinery and Equipment: Technological Capabilities, Power Asymmetries, and the Missing Ecosystem Ingredients

The mining machinery and equipment segment is the most significant part of the machinery and equipment industry in South Africa, and includes niches of technological excellence. The downstream industry has established capabilities thanks to the backward linkages from mining to local producer, and lateral

[8] https://www.news24.com/fin24/companies/industrial/transnet-wants-court-to-clear-r54bn-unlawful-contract-for-1064-locomotives-20,191,217. As of September 2020, the extensive allegations relating to corruption and state capture including relating to this contract were still under inquiry.

[9] These were last revised in 2017; see Chapter 9 for more on this.

migration of capabilities of generic technologies used in other sectors such as construction, agriculture, and general manufacturing (Walker and Minnitt, 2006; Dolo et al., 2018).

By drawing on extensive firm-level research, this section examines the impact of technology changes, notably digitalization, and the relationships with the governance of production systems. In particular, engineering, procurement, and construction management (EPCM) companies which provide full package solutions to mining companies have grown in importance while the larger South African engineering businesses have been divested from the industrial conglomerates (Jourdan, 2014). These changes have coincided with increased international consolidation in the industry and the growing importance of large multinational enterprises in the Southern African markets. As the developments in the global industry affect companies in all countries, some governments have supported their domestic companies to capture domestic value addition, technology spillovers, and the employment dividend. Considered against selected international examples, it is clear that in South Africa there are a number of missing ingredients, coupled with poor policy design.

3.4.1 Technological Capabilities and the Digitalization of Mines

The technological changes with the digitalization of production, design, and coordination along supply chains (see Chapter 12) have had major impacts on machinery and equipment for the mining industry. The developments encompass advanced capabilities in design, additive manufacturing, and rapid prototyping and sensor technologies for predictive maintenance and conditional monitoring. These technological advancements potentially open the way for more effective supply-chain integration, process efficiencies, and collective upgrading for both larger and smaller firms. The lead mining machinery and equipment firms in South Africa have developed advanced capabilities, improving supply-chain integration and upgrading, to offer customized solutions to enhance the performance for the end users, that is, the mines.

In mineral processing equipment the customization often depends on the environments and mineral being mined. This means that, when coupled with the analysis of data on performance in different settings (including through machine learning), additive manufacturing can drastically reduce the time to upgrade machinery for specific requirements. For example, one company managed to reduce the time for customization from six to eight weeks to not more than three days (Kaziboni et al., 2019).

Digitalization extends beyond product design, testing, and customization to integrating sensors across businesses, allowing remote monitoring and real-time data collection. Together with cloud computing, big-data analytics and machine learning have made predictive maintenance of these machines and consumables possible, allowing for the rate of wear and tear to be tracked (Barnes et al., 2019). Thanks to these innovations, mining companies can prevent unplanned downtime and reduce operating costs, while lead firms can pre-determine consumable requirements by customers, thereby reducing stock-holding and manufacturing waste. This is especially valuable as after-market services and components represent the most profitable segment of the value chain (Fessehaie, 2015). Realizing the benefits requires connectivity and bandwidth at reasonable cost; personnel with specific skills such as data analysts, scientists, and artisans with IT capabilities; and an appropriate policy environment governing data. South Africa faces challenges in each of these (Chapter 12).

While lead firms have developed integrated supply-chain systems and structures, smaller firms are lagging. Smaller manufacturers of mineral process equipment are still in the early stages of integrating their supply chain and their challenges are seldom about the implementation of advanced applications, but more around basic elements of internal systems and processes related to ordering, standardized quoting, and stock-taking applications. Optimizing linkages between firms requires an integration of systems that allows access to information and data across firms within a single ecosystem to support capability upgrading. This shows that capabilities are not limited to technologies and skills, but also include internal systems, structures, routines, and working practices.

An example of the potential benefits from digitalization across a lead firm and its suppliers and customers is the case of Multotec, an international OEM of South African origin that engineers minerals processing machinery. Multotec has built its capabilities based on customized solutions for mines in South Africa (Gostner et al., 2005). Working with customers and suppliers it has demonstrated how an internationally integrated firm can be an important source of demand-driven innovation back to components manufacturers. Its suppliers have become globally competitive (and certified) to service both the lead firm and other clients (Kaziboni et al., 2019). Such experience is, however, not common and it has required the company to build internal technical training and testing facilities which would not be viable for smaller businesses to develop.

Power asymmetries and fragmentation in the South African mining equipment value chain have further limited the opportunities for collaboration and technological upgrading (Rustomjee et al., 2018). The discussion turns to these implications.

3.4.2 Power Asymmetries: Global Consolidation and Domestic Fragmentation

Similar to other advanced manufacturing industries, the 2000s and 2010s saw significant consolidation in the machinery and equipment industry. Already in

2009, the six global leading companies accounted for one-quarter of total world production of these mining technologies. In the decade 2010–20, intense M&A activity drove consolidation along global value chains, and across the main industry segments, with signs of new competitive pressure coming from China globally in segments such as yellow metal vehicles (Andreoni and Torreggiani, 2020). Chinese producers also increased their penetration into Southern African markets, including in areas such as castings (components of machines).

Against this backdrop, mining machinery and equipment firms in South Africa have remained largely fragmented, while major multinational OEMs such as Sandvik, Epiroc, Caterpillar, and Komatsu continued to consolidate their market shares and leverage their global supply chain to provide mining houses with highly competitive solutions. In 2018, for example, in the underground equipment segment, Sandvik and Epiroc together held around 70 per cent of the local market (Smeiman, 2018), especially for certain mineral commodities; their regional presence in Southern Africa has been equally significant. The multinational OEMs have some fabrication and assembly in South Africa, but mining machines are mainly produced abroad: in Europe and the USA for high-end products, and in India and China for lower-end equipment, including over ground vehicles and basic mineral processing technologies, and components such as valves. Some local engineering companies manufacture components under licence for OEMs.

The power of the OEMs allows them to directly deal with mining houses, providing machines, customized financial packages, and after-sale services. In contrast, the relationship between small and medium-size South African OEM companies and mining houses is often intermediated by specialized engineering contractors under EPCM (engineering, procurement, and construction management) or so-called EPC (engineering, procurement, and construction) arrangements—with the main difference related to the allocation of cost risks. These specialized engineering companies are very powerful as they are responsible for making procurement decisions for the mining houses, as part of their design of the overall mining solution. Being excluded from their sourcing strategies means being excluded from the main source of demand in this market (Andreoni and Torreggiani, 2020).

There are a number of more established South African OEMs and local suppliers with high local content and export capabilities, which have both direct and mediated relationships with mining houses and junior mines (notable examples are AARD for underground equipment, Bell Equipment for surface equipment, and Kwatani and Multotec for mineral processing) (Andreoni and Torreggiani, 2020). They have a regional and international footprint in terms of markets, as well as strong supply-chain linkages with several tiers of components producers along the domestic metal value chain. They have also made domestic investments in new digital technologies and, in some cases, have managed to upgrade their domestic suppliers. Unfortunately, these are also the companies whose supply of metals is negatively impacted by the market power in supplier industries, discussed in section 3.3.

Within this ecosystem, with the exception of the very few leading South African OEMs, in the 2000s smaller and less well-established mining equipment companies operating as OEMs, or component suppliers and assembly, were located in fragmented production systems and became increasingly uncompetitive. Several key factors explain this (Andreoni and Torreggiani, 2020): limited cooperation between project houses and suppliers, particularly towards smaller equipment suppliers that could not supply at scale; the balance of power along the supply chains from metals inputs to machinery producers, often resulting in frequent and sudden price increases imposed on equipment manufacturers; insufficient financial resources on the part of local manufacturers to invest in formal R&D activities compared to large international OEMs; the unavailability or cost of local components which presented challenges in meeting local content requirements; and severe skills shortages in the sector and inadequate training provision.

The objectives of BEE and localization for the sector have presented several challenges. The Broad-Based Black Socio-Economic Empowerment Charter for the South African Mining and Minerals Industry, known as the Mining Charter, was introduced in 2004, with subsequent amendments and revisions to the targets. Its core objectives included building links between mining companies and suppliers, and supporting local capabilities and skills. The Mining Charter introduced a scorecard system for mining right holders which, as of 2018, had the following six criteria: (1) ownership participation by historically disadvantaged persons; (2) employment equity, promoting fair treatment and equal opportunities in the workplace; (3) human resources development and capacity building for employees and local communities; (4) procurement and enterprise development aimed at locally empowered businesses; (5) mine community development; and (6) housing and living conditions for mine employees. While targets can be met within a transition period, the non-compliance with any one of the above obligations can lead to the withdrawal (or the suspension) of the mining permit. The 'procurement, suppliers and enterprise development' requirement alone accounted for 40 per cent of the 2018 scorecard. The 2018 revision tightened the requirements for local content and established conditions on domestic sourcing of capital equipment, consumables, and services (80 per cent with preferential conditions), as well as a minimum of 70 per cent of total R&D budget to be spent on South Africa-based R&D entities.

The promotion of local sourcing in the Charter, along with a number of other government and industry-led initiatives to support increased domestic value addition and boost R&D activities, have been undermined by the exploitation of loopholes. The provisions have to a large extent been met by intermediaries who may be sourcing imported products (possibly assembled in South Africa)

(Rustomjee et al., 2018). In addition, the tariff schedule that the South African government negotiated for equipment and components used in mining operations tended to protect a number of key industrial components for domestic OEMs raising their local costs (such as tyres and some steel components). In doing so, trade policy undermined the cost-competitiveness of the local machinery and equipment manufacturers. By comparison, final products, such as assembled machinery and equipment, were generally given access to the domestic market at zero or very low tariffs.

There is also a lack of appropriate skills in the sector. Skills development has been largely managed through the relevant Sector Education and Training Authority (SETA), that is, the Manufacturing, Engineering, and Related Services Authority (MERSETA), and, more specifically, the Metal Chamber of MERSETA. It is responsible for quantifying occupational shortages, identifying skill gaps, determining skills priorities, and developing an appropriate educational offer for specific clusters of industries. However, as discussed in Chapter 12, institutional challenges in delivering appropriate skills, especially in the digital space, remain.

3.4.3 Missing Ingredients: Comparative International Insights for Better Ecosystem Development

Important insights into the key missing ingredients are provided by comparisons with other countries which have successfully supported machinery equipment clusters. These include Chile and Australia, where South African companies are also active, as well as Finland. The comparative assessments help to evaluate alternative policies and institutional forms used to support local content, effective trade policy, and R&D efforts (Steuart, 2019; Andreoni and Torreggiani, 2020).

In terms of procurement and local content, by ensuring commitments on the part of buyers, supply industries have been incentivized to make the investments required to upgrade capabilities. Australia's local-content policies have been defined at the national as well as the state level. This has enabled strong growth in the country's Mining Equipment, Technology, and Services (METS) industry. The overarching principle guiding the framework has been to offer 'full, fair and reasonable' access to employment and tendering opportunities to Australian firms and individuals (World Bank, 2015). The emphasis has been on equitable opportunity, and on monitoring and reporting, which means that procurers are effectively held accountable. This has been supported by funds for suppliers to work with project developers to identify supply opportunities for 'capable and competitive' Australian firms, especially SMEs. Finland has an even more hands-on approach to local content under its green-mining objectives. It requires foreign companies to establish affiliates in Finland and access to funding from public sector bodies is conditional on firms being registered in Finland. There are detailed requirements on firms including domestic value addition, technology transfer, and local R&D spending. This is also a preferential price premium for local suppliers (OECD, 2017).

Local procurement priorities have mostly required an aligned and strategic trade policy. In Australia, for example, there were arrangements under the Enhanced Project By-Law Scheme (EPBS) from 2002 to 2016 for duty-free importation of eligible goods identified as strategic and not produced in Australia. In a quid pro quo, these concessions were, however, contingent on the project houses developing and implementing approved Australia Industry Participation plans. This contrasts with South Africa, where, despite advanced technological capabilities, trade policy has not protected final products, such as assembled machinery and equipment.

R&D tax incentives have been widespread across all countries, with some having targeted incentives linked to the upgrading of suppliers. In Chile, for instance, the economic development agency (CORFO) has granted incentives to large companies participating in supplier development. In the Antofogasta region this has supported a collaborative effort across the stakeholders in the ecosystem, including ten large mines and two regional universities, the establishment of an industry association, a vendor qualification system, and a supplier database. By 2015 this vendor model was being used by twenty purchasing companies in mining, oil, and gas industries, and accounted for over 2,500 suppliers (World Bank, 2015). The model has evolved to a hybrid incentive and procurement scheme with mining companies and potential suppliers who could form a collaborative cluster to work on solutions together with local universities and public institutions.

In building R&D-rich ecosystems, intermediate technology and business services are the capabilities 'glue'. Local 'intermediate technology institutions' are essential for this glue to stick. These include institutional arrangements interfacing with universities, engineering and design services businesses, and hybrids supporting advanced manufacturing. In Australia a whole range of encouragement activities were offered for the evolution of collaborative institutional arrangements, such as through accelerators, hackathons, challenge platforms, and cluster programmes. These supported the establishment and growth of a network of public-private technology intermediate institutions in the ecosystem.

3.4.3.1 South Africa's Attempts to Address the Constraints

In the context of R&D and skills, as part of the Mining Phakisa initiative launched in 2015, the Mandela Mining Precinct was established in Johannesburg as a central hub for industry-specific R&D initiatives, alongside the promotion of the Mining Equipment Manufacturers of South Africa (MEMSA) association in 2016. MEMSA is an industry cluster body supporting the absorption and diffusion of technologies and collaborations across local OEMs and their suppliers and promises to impact on the fragmentation of the local industry.

With the establishment of the Mandela Mining Precinct, South Africa started equipping the industry with an important institutional solution to some of the binding constraints noted above in terms of technological innovation and upgrading. An intermediate technology institute like the Precinct can support companies in achieving appropriate functional, technical, and performance specifications, by innovating on several technologies and solutions offered by local OEMs. It may also provide support in the standardization process, making sure local OEMs develop solutions to capture the value of post-sale services. The extent to which these initial steps in the right direction are going to be effective in South Africa will depend on their sustained support, and the adoption of a full package of aligned measures cutting across the Mining Charter and relevant institutions.

3.5 Conclusions and Opportunities for Industrial Policy in the Metals and Mining Machinery and Equipment Industries

The metals, machinery, and equipment industries are at the heart of South Africa's industrial economy. The performance in these industries over the 1994 to 2019 period has demonstrated the challenges facing the country in redirecting the path of structural transformation and points to the key reasons why it has largely failed to overcome these challenges. As the 'big steel' case highlights, the entrenched power of the upstream firms continued to drive the agenda and shape the overall development of the industries. Downstream in the value chain, as is evident in the mining machinery and equipment industry, there was extensive international integration, in terms of ownership, technology, and trade. However, this was accompanied by increasing import penetration, persistent industry fragmentation, and ineffective and poorly coordinated policy and institutional support.

The industry record underlines the importance of understanding how and through what mechanisms power is exercised. A significant proportion of the support directed at strengthening the metals, machinery, and equipment value chain has benefited the capital-intensive upstream businesses, despite the potential to build on downstream capabilities and the opportunities which digitalization has presented. Additionally, the absence of a cohesive downstream industry able to lobby for government support has undermined the industry-level cluster efforts aimed at bolstering the industry. Lead firms can play a critical role in learning and building capabilities across their supplier networks. The lead upstream firms (in basic metals) have been instead largely oriented to protecting rents, particularly in the context of the challenges posed by international volatility (Rustomjee et al., 2018). Conditionalities needed to be strongly enforced along with moves to ensure cost-based mining inputs to steel-making and the removal of tariff protection.

At the same time, some lead firms in machinery and equipment have managed to sustain capabilities thanks to efforts to continuously invest in infrastructure, skills, and technology, including adopting digitalization. However, these have represented islands of capabilities rather than anchoring wider clusters of competitive capabilities. After 2008, the South African domestic market for machinery and equipment also started to shrink with the end of the commodities boom, while import penetration continued to be high despite various local content and procurement policies.

There was clearly a lack of an overarching strategy in this period that would locate procurement policies within the wider ecosystem as well as appropriate policies to increase domestic value addition, technology development, and upgrading (Andreoni and Torreggiani, 2020). This would require overcoming the fragmentation of policies being pursued by different departments and targeting the policies based on a thorough assessment of the products and services in order to impact on quantity, quality, and price competitiveness parameters. Monitoring compliance is also clearly important. Exports became increasingly significant for the companies that managed to sustain themselves through the prolonged slump. Export performance should have been incorporated into the targets in order to impact on the production decisions of the international and domestic OEMs affected by local content requirements. The international OEMs should also have been able to 'link back' local suppliers into their exclusive supply chains, thus 'powering' the local company.

Tariffs need to be consistent with the assessment of the local supply-chain capabilities and specific product segments for which domestic producers have a chance to be competitive internationally. This assessment should start from the analysis of the additionality of the current tariff, that is, the identification of the real beneficiaries of tariffs along the extended metal, mining equipment value chain. Trade policy should prioritize those intermediate and final product segments in which existing companies have already developed distinctive capabilities and are close to the international price competitiveness benchmark.

Rebuilding overarching institutions of industrial development is a central means to integrating fragmented initiatives and building a strong coalition for the downstream industries. The Mandela Mining Precinct has the potential to be elevated to a specialized intermediate technology institute focusing on the opportunities offered by the mega trends in global mining, addressing the challenge of scaling up national OEMs and their suppliers, and promoting collaboration across domestic players, including collaborative challenge-driven efforts for diversification. As discussed in section 3.4, effective engagement with digitalization is essential, including building the specialized digital skills base. The institute can provide this combined technology and skills development functions, focusing on the targeted training of task forces of specialized technicians and engineers in collaboration with universities and technical and vocational education and training (TVET) colleges.

Capturing the opportunities offered by the global technology and industry megatrends is conditional on increasing the scaling-up capability of the domestic OEMs and suppliers. This includes the lateral migration of capabilities in processes common to machinery and equipment across different applications such as food processing. These scaling-up challenges can be addressed by providing dedicated technology services as well as providing companies with access to quasi-public good technologies such as data systems, testing facilities, and pilot lines for virtual design and prototyping of mining solutions, complemented by the financing and skills for investing in capabilities.

While policy instrument design and governance frameworks are critical, the effective implementation and enforcement of any industrial policy will depend on the extent to which the policy is able to promote the emergence of a new coalition of productive interests, or offer the existing powerful groups alternative and more productive ways to operate in the economy. This is the ultimate 'feasibility' test for the policy.

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