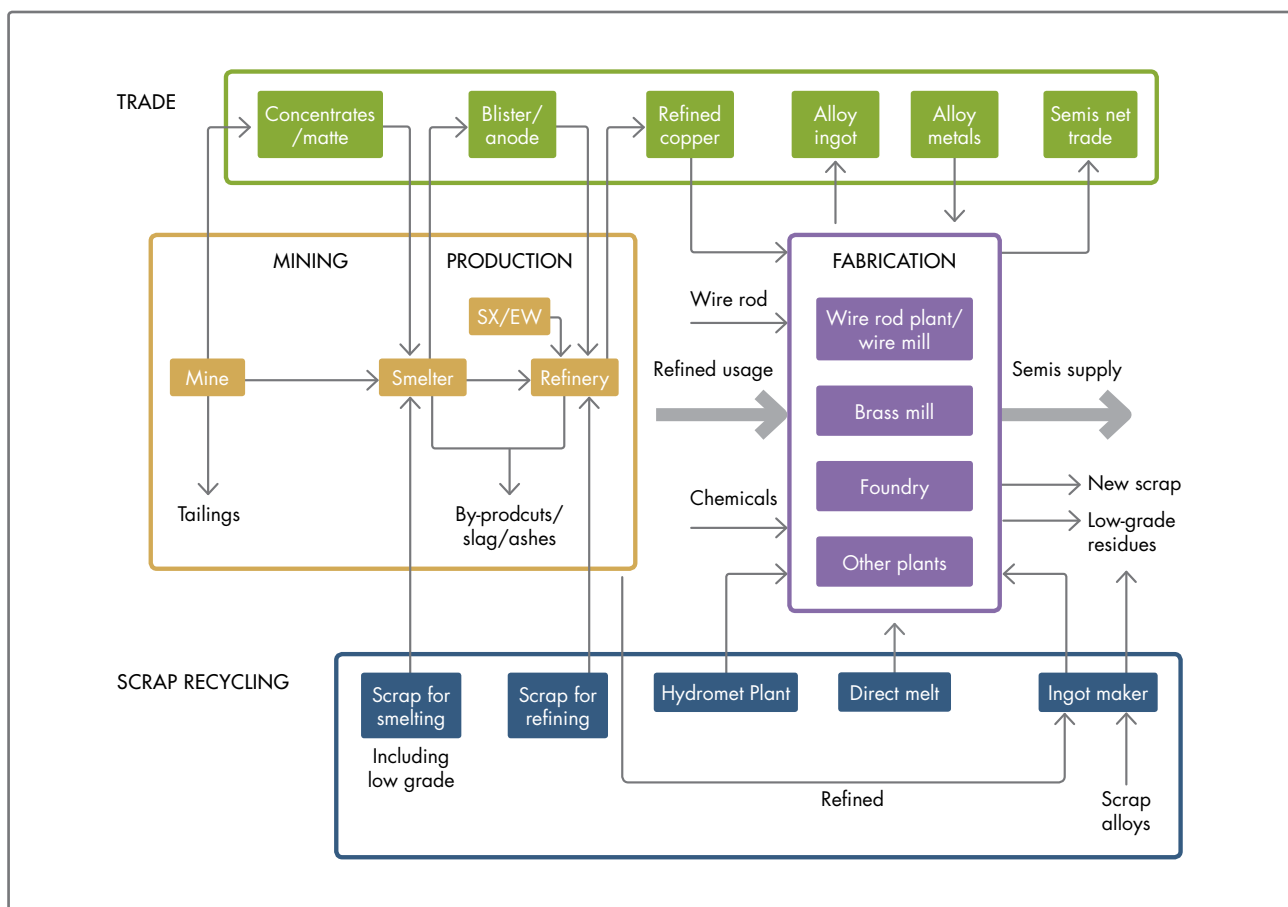


CASE STUDIES IN BASE METAL PROCESSING AND BENEFICIATION: LESSONS FROM EAST ASIA AND THE SADC REGION

ROMAN GRYNBERG & KEDIBONYE SEKAKELA



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EXECUTIVE SUMMARY

This research report first considers the industrial policy debate on beneficiation and its context within the broader policy debate on the appropriate role of industrial policy. Over the past decade, beneficiation as a policy has generally been supported by mineral-rich developing countries but opposed by the World Bank and international finance institutions. African countries have consistently been advised not to attempt to beneficiate their minerals and base metals. While the report looks at base metals it concentrates on copper, given its importance to Zambia, Botswana and Namibia, and considers industrial policy on copper in Japan and China. These two countries have successfully beneficiated copper concentrate produced in other countries. The report examines their respective trade and industrial policies in this area and what effect these policies have had on African efforts at beneficiation. It argues that concomitant with the increase in commodity prices driven by Asian demand there has been a ‘Great Compression’ in smelting, refining and semi-fabricate margins since 2004–05, directly as a result of China’s industrial policy on beneficiation, which has facilitated a subsidised over-capacity in the sector. It goes on to document the experiences of Mozambique, Namibia, Botswana and Zambia in base metal processing and beneficiation. Botswana has only progressed to exporting copper and nickel matte. Mozambique and Namibia export refined aluminium and zinc – both ostensibly because of electricity prices and tax policies in the sector. Only Zambia has progressed beneficiation beyond refined metal, and the report looks at what measures can be employed to accelerate beneficiation should governments wish to do so and pay the cost of such policies. It concludes that in the case of base metals, without active Chinese assistance in moving down the value chain, base metal beneficiation in Africa is unlikely to occur in the near future.

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ABBREVIATIONS & ACRONYMS

AAC	Anglo-American Corporation
ACP	Africa, Caribbean and Pacific group of states
AGOA	African Growth and Opportunity Act
AMAX	AMAX Nickel Refining Company
BCL	Bamangwato Concession Limited
BFS	bankable feasibility study
BIDPA	Botswana Institute for Development Policy Analysis
BPC	Botswana Power Corporation
CAPEX	capital expenditure
CNMC	China Non-ferrous Metal Mining Co. Ltd
DAs	development agreements
ECDPM	European Centre for Development Policy Management
EPCM	engineering, procurement and construction management
EPZ	export processing zone
GATT	General Agreement on Tariffs and Trade
IDC	International Data Corporation
IFI	international financial institution
IFC	International Finance Corporation
IRR	internal rate of return
LME	London Metal Exchange
MIIT	Ministry of Industry and Information Technology
MITI	Ministry of International Trade and Industry
Mozal	Mozambique Aluminium
NCS	Namibian Custom Smelter
NFCA	Non-Ferrous China–Africa
NPV	net present value
PGM	platinum group metals
RST	Roan Selection Trust
SACU	Southern African Customs Union
SAP	structural adjustment programme
SMEs	small and medium enterprises
SMELP	Small and Medium Enterprises Linkage Programme
SOE	state-owned enterprise
TCRC	Treatment and Refining Charge
VAT	value added tax
WTO	World Trade Organization
ZAMEFA	Metal Fabricators of Zambia
ZCCM	Zambia Consolidated Copper Mines

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INTRODUCTION

The purpose of this research report is to examine the experiences of several SADC and Asian countries with base metal¹ beneficiation and the lessons that can be learned from relevant policies, given that beneficiation is one of the central pillars of regional industrial and development policy.² The SADC countries chosen for the analysis are Mozambique, Namibia, Botswana and Zambia, all which have attempted to beneficiate their aluminium, zinc, nickel and copper respectively. The study also discusses the trade and commercial policies of East Asian countries that have stimulated local beneficiation industries that would otherwise not exist. The report begins with a discussion of the meaning of beneficiation as it pertains to base metals. Mining engineers and industrial economists have quite different interpretations of the concept, which often leads to policy confusion. While the report focuses on several base metals, the detailed examples used are drawn largely from the copper industry. The second section of the report considers the theoretical arguments for and against beneficiation and the World Bank's reticence regarding the concept. The continuing appeal that forward linkages hold for a generation of African industrial policymakers who were raised in the shadow of Hirschman³ is considered. This is placed in the context of the broader industrial policy debate exemplified by the Lin–Chang exchange,⁴ which is considered along with the current but narrower policy debate over forward versus backward linkages in African development.

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- 1 Base metals as defined in the Harmonized Tariff System include iron and steel, copper, nickel, aluminium, lead, zinc, tin, tungsten (wolfram), molybdenum, tantalum, magnesium, cobalt, bismuth, cadmium, titanium, zirconium, antimony, manganese, beryllium, chromium, germanium, vanadium, gallium, hafnium, indium, niobium (columbium), rhenium and thallium. Its use contrasts with that of 'precious metals', which include gold, silver and platinum.

- 2 SADC Secretariat, 'SADC Industrial Development Policy Framework', 2012, p. 21, http://www.sadc.int/files/2013/8969/0505/Final_SADC_Industrial_Development_Policy_Framework.pdf, accessed 5 April 2014:

The Southern African region produces significant quantities of major metals and minerals such that it contributes substantially to world production to the extent of about 53% of vanadium, 49% of platinum, 40% of chromite, 36% of gold, 50.1% of diamonds, 20% of cobalt. Given this remarkable contribution to world production, it is imperative that these minerals are beneficiated in the region. Value-added processing, or beneficiation, involves the transformation of the raw material using local factors (labour and capital) into a semi or finished product that has a higher value than the sale of the raw material.

- 3 Hirschman A, 'The political economy of import–substituting industrialization in Latin America', *Quarterly Journal of Economics*, 82, 1, 1968, pp. 1–32; Hirschman AO, *Essays in Trespassing: Economics to Politics and Beyond*. New York: Cambridge University Press, 1981.
- 4 Justin Lin & Ha-Joon Chang, 'Should industrial policy in developing countries conform to comparative advantage or defy it? A debate between Justin Lin and Ha-Joon Chang', *Development Policy Review*, 2009, 27, 5, pp. 1–20.

In the third section the development of the copper industries of Japan and China is considered. This is done for several reasons. First, it is necessary to understand how countries without significant mining assets import large volumes of concentrate and blister from what are often remote locations in order to supply industries further downstream and, despite the absence of the resource domestically, are able to make beneficiation a source of commercial advantage for their producers. In some cases local beneficiation is undertaken purely in order to increase the competitiveness of the economy as a whole, while in others a narrower commercial advantage is sought to provide copper users with domestically produced and often low-cost inputs. While domestic security of supply has played a major role in the policies of both countries, the commercial benefits of domestic beneficiation for downstream users were more immediate. Second, the study of Japan and China shows how countries conduct trade and commercial policies that stimulate local industries that may otherwise not exist.

Third, the analysis is undertaken because these policies have significant and often negative effects on the development of any potential for the beneficiation of African raw materials.

Fourth, the question arises as to whether these successful beneficiation policies in Asia were primarily driven by the factor endowments and technical capacity of these Asian countries, as would be argued by Ricardo Hausmann, or by the use of industrial policy.

The main empirical section of the report reviews the experiences of Botswana, Mozambique, Namibia and Zambia in beneficiation and base metal processing. These countries have either attempted or to a greater or lesser degree succeeded in beneficiating base metals. None, as will become apparent, has succeeded in creating the sort of linkages, either backward or forward, that their national policies initially aimed to achieve. This is in part a direct result of the absence of broader industrial policies that makes use of the final product, as was so evidently the case in Japan. It will be argued in the final policy section that the progress that African governments have to make towards base metal beneficiation will require a much fuller and better informed planning of their future interventions along the value chain and the application of resources for the industrial upgrading of existing firms or foreign firms than has been the case in the past. The prospects for beneficiating these metals outside the Chinese value chain seem limited, as China's expansion of its own capacity has lowered processing margins in the middle of the value chain. As a result, without a concerted intervention, African miners are unlikely to move beyond the export of unprocessed raw materials and, at very best, refined product.

BENEFICIATION AND INDUSTRIAL POLICY

THE MEANING OF BENEFICIATION IN THE BASE METAL SECTOR

Almost all of the important base metals, including bauxite, copper, zinc, nickel and most iron ores, normally undergo some measure of what engineers call beneficiation or mineral processing in the country of origin. Only the highest grades of ores are shipped without any processing, thereby incurring the cost of transporting concentrates containing residues and waste material.⁵ Almost invariably the base metal goes through an initial stage of processing; eg, in the case of copper, to concentrate before it is further processed to matte, blister and then tradable cathode. Figure 1 depicts the process of copper production and beneficiation, which moves from a mineral process (production of concentrate)⁶ to an industrial process (production of matte and refined copper) to the production of semi-fabricates.⁷

In large measure the initial and generally local beneficiation of base ores is a direct result of the transport costs associated with moving large quantities of waste or gangue over long distances. This, as we shall see in the case of Zambia, has largely but not entirely protected the country from the effects of the compression of smelting and refining margins caused by China's commercial policy in the sector. Each stage of the production process requires different factor intensities, with some being highly capital intensive and others, such as aluminium and zinc, being highly energy intensive. However, the processing of

5 In the case of iron ore of particularly high quality export grade direct shipping ore, ores are generally in the 62–64% Fe range and can be used directly in furnaces.

6 The World Customs Organization's (WCO) Harmonized Commodity Description and Coding System (HS) classifies copper and nickel concentrate (HS 26) as mineral ores but matte (HS 74) is considered a manufactured good. However, in the Standard International Trade Classification (SITC) – UN (unstats.un.org/unsd/cr/registry/regcst.asp?cl=14) both concentrate and matte (SITC 283 and 284) are considered to be mineral ores. The essential difference between the two products is the degree of purity of the metal, with copper concentrate containing as much as 40% copper and copper matte containing approximately 70% copper. According to the HS system there is a clear delineation between ores and concentrates and minerals that are further processed. However, the UN's International Standard Industrial Classification, ISIC Rev4, <http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=27> states '[t]his division includes mining for metallic minerals (ores), performed through underground or open-cast extraction, seabed mining etc. Also included are ore dressing and beneficiating operations, such as crushing, grinding, washing, drying, sintering, calcining or leaching ore, gravity separation or flotation operations. This division excludes manufacturing activities such as the roasting of iron pyrites (see class 2011), the production of aluminum oxide (see class 2420) and the operation of blast furnaces (see classes 2410 and 2420).'

7 Copper semi-fabricates are normally defined as products falling in the HS headings HS 74.06–HS 74.11.

ore is industrial as opposed to extractive, and thus requires different skills and is classified differently in the UN taxonomy. It is invariably seen as an industrial process and not one that is extractive in nature.

Mining engineers clearly understand that beneficiation begins once the ore is extracted from the ground, as depicted in the copper flow chart in Figure 1. However, this definition of beneficiation is not accepted by some economists, who create an artificial distinction⁸ between processing and beneficiation:⁹

[W]e distinguish the processing of commodities from the beneficiation of commodities. Processing involves a deepening of value added, as a commodity is refined or processed prior to being passed on to user industries. For example, iron ore is processed into steel, copper is smelted, and cotton is carded before spinning can take place. In this sense, the 'processing' of raw materials occurs in a technologically related industry. By contrast, beneficiation describes a process of transformation in which the processed commodity is converted into an entirely different product, generally in an unrelated manufacturing activity. For example, aluminium may be transformed into engine cylinder heads or into pots and pans, and gold is used in semiconductors.

It is not simply from a taxonomical standpoint that this issue is significant. Copper ore, concentrate, blister, matte and cathode are classified, ambiguously and often differently, according to the UN (International Standard Industrial Code) and World Customs Organisation (Harmonised System) industrial and trade classification systems. More importantly, the technical nature, inputs required and degree of technical and industrial sophistication required are different with each stage of the processing, production and beneficiation of base metals. For example, the process of producing copper concentrate requires fundamentally different factor intensity from that of refining. While both are capital intensive, refining requires both capital and relatively high-energy intensity.¹⁰ The refining of zinc and aluminium requires, depending on factor prices, more energy than raw material and is a different process from the production of bauxite or zinc concentrate. It is therefore perhaps most useful to accept the engineering definition that beneficiation starts when the ore is removed from the ground and, in the case of copper, is processed into the first traded item along the copper value chain, ie, concentrate. As will be shown, it is not necessarily the level of technological sophistication of any of the production

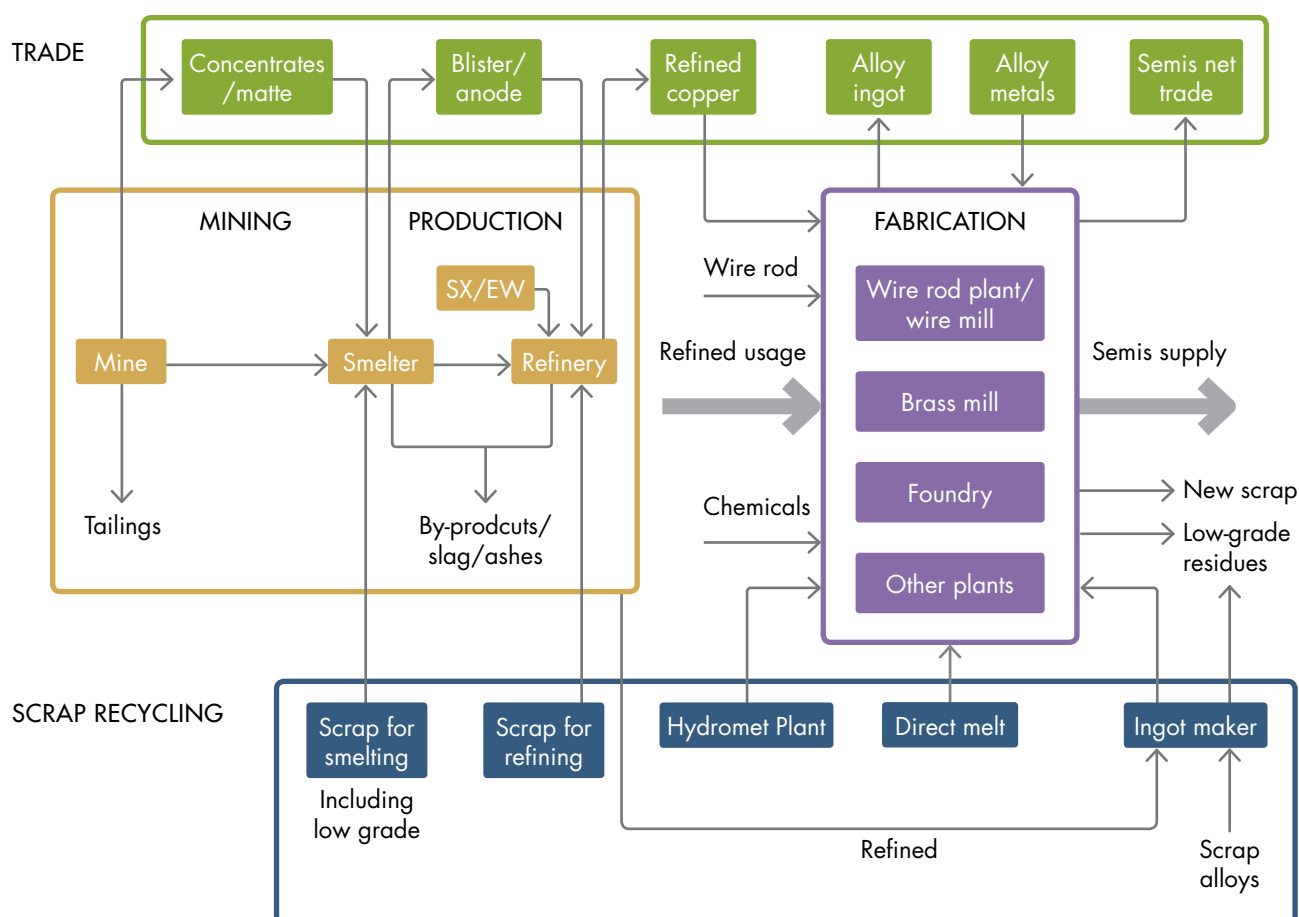
8 The process of smelting and refining copper, for example, requires entirely different factor intensities of land, labour, energy and capital. To argue that refining is not beneficiation while creating semi-fabricates is beneficiation overlooks the fact that each stage requires different factor intensities. Each stage adds value or beneficiates the raw materials.

9 Morris M, Kaplinsky R & D Kaplan, 'One Thing Leads To Another: Promoting Industrialisation by Making the Most of the Commodity Boom in Sub-Saharan Africa', Open University Commodities Programme, 2012, p. 24, <http://www.commodities.open.ac.uk>, accessed 12 December 2012.

10 For a description of the economics of the process of copper production from mine to refinery, see McKern R, 'The industrial economics of copper processing', *Natural Resources Forum*, 5, 3, 1981, pp. 227–248.

processes that inhibits developing countries from moving down the copper value chain, but rather the economic forces at play along the value chain.

FIGURE 1 THE FLOW OF COPPER



Source: ICSG (International Copper Study Group), *World Copper Fact Book*, 2013

BENEFICIATION AND THE INDUSTRIAL POLICY DEBATE

The policy debate on the role of resource beneficiation in industrial policy is a sub-set of a much broader policy debate on the role of the state and the development of comparative advantage, which has been recurrent in economics and development theory for at least two centuries. The issues have re-emerged in the last two decades since the 'Asian Miracle' debate of the mid-1990s, where the World Bank initially depicted the transformation in

East and South-East Asia as a product of market forces.¹¹ The recent debate between Lin¹² and Chang¹³ on the appropriate role for the state vis-à-vis the development of a country's comparative advantage is part of this two-century-long dispute between economists that sporadically reappears and is currently at the heart of industrial policy debates. It is clear that there has been a subtle but important shift in orthodox thinking after the successes of interventionist government industrial policies in East Asia. Orthodoxy, as expressed by the shift in the development and industrial policies of the World Bank and its publications, has concluded that the state has, at least in Asia, played a positive role in economic transformation, although there are quite different interpretations as to whether the state should simply enhance the existing comparative advantage, à la Lin. This constitutes a fairly dramatic shift in policy thinking from that of the 1980s and early 1990s on whether the state needs to lead the process in the areas of development and transformation, as has been argued by Chang.

An important subset of the greater policy debate about the role of the state pertains to the type of industrial policy that is most appropriate in resource-abundant African countries. This debate has mostly emerged over the issue of forward as opposed to backward linkages in the mineral value chain. The specific issue of beneficiation reflects the divergence in thinking in economics as to whether trade patterns, as they are currently observed, are a result of factor endowments or industrial policy measures. As will be shown, in the case of base metals, industrial policy has been central to the observed growth of first the Japanese and then the Chinese sectors.

In SADC regional industrial policy, the concept of beneficiation is central.¹⁴ Beneficiation is the first policy objective of the strategy and is such a central part of economic thinking on industrial development throughout Africa that it can proceed to being the basis of the SADC policy almost without further debate. Yet beneficiation is now at the core of the debate on industrial policy since Hausmann's work on the subject. Hausmann argues against the beneficiation of diamonds and other minerals in Southern Africa. His work has not yet shaken the foundations of industrial policy in Africa, where it is commonly

11 World Bank, 'The East Asian Miracle: Economic Growth and Public Policy', vol. 1, 1993. The report argued that an absence of price distortions was essential in explaining the rapid growth rates of East Asian economies in the 1980s and 1990s:

First, it is essential to get the fundamentals right. High levels of domestic saving, broad based human capital, good macroeconomic management, and limited price distortions provide the basis for growth. Second, careful policy interventions to accelerate growth produce very rapid growth.

12 For a fuller explanation of Lin's work in the area, see Lin JY, 'From Flying Geese to Leading Dragons: New Opportunities and Strategies for Structural Transformation in Developing Countries', World Bank Policy Research Working Paper, 5702, 2011; Ju J, Lin JY & Y Wang, 'Endowment Structure, Industrial Dynamics, and Economic Growth: Development Economics', World Bank, 2011; Kojima K, The 'flying geese' model of Asian economic development: Origin, theoretical extensions, and regional policy implications', *Journal of Asian Economics*, 11, 2000, pp. 375–401.

13 Chang HJ, *Kicking Away the Ladder*. London: Anthem Press, 2002.

14 SADC Secretariat, *op. cit.*

held that the path to development lies, at least in part, in beneficiating the continent's raw materials. The arguments for beneficiation are predicated on the fact that few other economic activities are viable in most African countries, especially SADC countries, which are mostly relatively high cost,¹⁵ small and landlocked. The beneficiation of raw materials that are physically present in the country and do not have to be imported seems a rational policy of industrial development. If the price of those resources is based only on the international market price, their only benefit is the lower logistic and transport costs. However, policy instruments such as export taxes can create a commercial advantage.¹⁶

BENEFICIATION AND THE WORKS OF HIRSCHMAN

Hirschman was one of the most erudite thinkers in economics in the 20th century. He wrote widely in a number of fields and developed several important concepts during his long career in economics.¹⁷ His is the single most important work on the relationship between commodity sectors and industrialisation, and he shaped the thinking of an entire generation of policymakers in developing countries. Hirschman¹⁸ developed the concept of unbalanced growth and linkages, which remains at the centre of industrial policy in much of Africa. His theory of linkages between the commodity sector and the industrial sector delineates several different types of linkages. The first type stems from increased consumption, which arises from the increased incomes of those benefiting from a mining or commodity sector. This is by its nature temporary and will only continue as long as the income is generated from the sector. The second linkage is that which exists as result of the taxation of resource rents earned in the mining sector. Here the policy that develops is to take these rents and cross-subsidise the development of sustainable sectors, which include industry and agriculture. This policy of sectoral cross-subsidisation has also become a central tenet of the development strategy of many mineral-rich economies.

But it is the third set of linkages – production linkages, both backward and forward (commonly called beneficiation) – that has been Hirschman's most enduring intellectual legacy to industrial policy throughout the developing world, and in Africa in particular.

15 It is not only the transport costs that are high – SADC countries also face high costs stemming from poor services.

16 There is a presumption that the physical presence of a commodity in a country can be advantageous if the price of that commodity is not linked directly to the global price. This is normally assumed to be the case, but is not necessarily true for a wide range of commodities where world markets are residual and not central. Certainly at the time that Hirschman was writing, many commodities were traded under offtake agreements, which were not necessarily linked to global prices. This remains so today, although being delinked from world market prices is becoming less common.

17 The Herfindahl-Hirschman Index has its origin in the work of Hirschman. See Hirschman AO, 'The paternity of an index', *American Economic Review*, 54, September 1964, pp. 761–762.

18 Hirschman AO, 'A generalized linkage approach to development, with special reference to Staples', in Hirschman AO, *Essays in Trespassing – Economics to Politics and Beyond*. Cambridge, UK: Cambridge University Press, 1981, pp. 59–97.

Hirschman argued that the strongest linkage that the resource sector can create is in the area of linkages to production of inputs for the mining process and the process of using the mineral for further production and processing, ie, beneficiation. However, for those who see Hirschman as purely an advocate of forward linkages it should be recalled that backward linkages were also a significant part of his thinking. At the same time, he was keenly aware of the effect of economies of scale in the question of whether resource-rich countries would have deposits that would support those types of linkages.¹⁹

HAUSMANN'S CRITIQUE OF BENEFICIATION

Hausmann has provided a detailed and sophisticated analysis of the process of industrial transformation globally.²⁰ The essence of his argument is that transformation does not occur through processing raw materials, but in specialising in activities that are close or proximate in terms of technology and factor intensity to existing areas of comparative advantage. It is a variant of the standard neo-classical theory of comparative advantage.²¹ Hausmann observes that very few countries that export raw materials also process them or ever make the transition to greater processing. He does not seek an explanation for this in either history or trade policy, but rather explains that it is a product of the resource endowment or the existing comparative advantage of the processing countries. His analysis is historical and devoid of any examination of the market- and sector-specific policy issues that determine what is produced and in what volumes in particular countries.

-
- 19 An extensive literature in industrial policy has developed of late based on several important studies of backward linkages that draws its intellectual inspiration in part from the works of Hirschman. See Morris M, Kaplinsky R & DE Kaplan, 'Commodities and Linkages: Industrialisation in Sub-Saharan Africa', MMCP (Making the Most of Commodities Programme) Discussion Paper, 13, Open University & University of Cape Town, 2011, [http://commodities.open.ac.uk/8025750500453F86/\(httpAssets\)/E5E74403EAAFB831802579270046EBC9/\\$file/MMCP%20Paper%2013.pdf](http://commodities.open.ac.uk/8025750500453F86/(httpAssets)/E5E74403EAAFB831802579270046EBC9/$file/MMCP%20Paper%2013.pdf), accessed 24 July 2014.
 - 20 See Hausmann R & B Klinger, 'Export Diversification and Patterns of Comparative Advantage in the Product Space', Harvard University Center for International Development Working Paper, 128, 2006; Hausmann R & B Klinger, 'The Structure of the Product Space and the Evolution of Comparative Advantage', Harvard University Center for International Development Working Paper, 146 (extended and revised version of 128), 2007; Hausmann R, Klinger B & R Lawrence, 'Examining Beneficiation', Harvard University Center for International Development Working Paper, 162, 2008; Hausmann R & R Rigobon, 'An Alternative Interpretation of the "Resource Curse": Theory and Policy Implications', NBER (National Bureau of Economic Research), Working Paper, 9424, 2002; Hidalgo C *et al.*, 'The product space conditions the development of nations', *Science Magazine*, 317, 5837, 2007, pp. 482–487.
 - 21 The theory of comparative advantage is an economic theory about the potential gains from trade for individuals, firms or nations that arise from differences in their factor endowments or technological progress. In an economic model, an agent has a comparative advantage over another in producing a particular good if he can produce that good at a lower relative opportunity cost or autarky price, ie, at a lower relative marginal cost prior to trade. See 'Comparative advantage', Wikipedia, http://en.wikipedia.org/wiki/Comparative_advantage, accessed 8 March 2015.

Hausmann's analysis does not consider the importance of existing trade preference regimes in explaining why often irregular and otherwise improbable transformations occur in small developing countries, eg, from sugar production to garment manufacturing.

The analogy commonly used by Hausmann is that firms are like monkeys swinging from trees in a forest. If they swing to remote trees that are far away they are likely to fall. Thus, it is the technological proximity of activities rather than trade or commercial policy that dictates transformation from one sector to into another. Hausmann concludes that the argument that lies at the very core of African industrial policy, ie, beneficiation, is fundamentally flawed.²²

[P]olicies to promote downstream processing as an export promotion strategy are misguided. Structural transformation favors sectors with similar technological requirements, factor requirements and other requisite capabilities, not products connected in production chains. There is no reason for countries like South Africa to focus attention on beneficiation at the expense of policies that would allow other export sectors to emerge. This makes no sense conceptually, and is completely inconsistent with international experience. *Quite simply beneficiation is a bad policy paradigm.* [emphasis added]

Annex 2 considers Hausmann's proposals for Botswana, as well as the weaknesses in his sectoral analysis of transformation. It is argued that it is not the technical characteristics of production that determine the transformation from one sector to another but the economic rents and quasi-rents that are available in small countries.

22 Hausmann R, Klinger B & R Lawrence, 2008, *op. cit.*

CHAPTER 3

JAPANESE AND CHINESE POLICY TOWARDS COPPER

This section considers the development of policies on smelting and refining capacity in the two most important Asian copper-producing countries – China and Japan. First, early Japanese policy in the sector is discussed, and not because of the importance of the policy per se or of Japan's current impact on global copper markets. Japan is now a major but by no means dominant player in the global copper market for smelted and refined product. Its importance lies in the fact that Japanese policy on the development of its own copper industry is in so many ways a precursor for that of other Asian countries, especially China some 30 years later.

China, the world's second-largest mined copper producer, still has to import 75% of its basic copper needs. Its approach to industrial policy is profoundly different from that of Japan, in terms of the dominance of the state as the largest producer of copper. The state-owned enterprises that continue to dominate the industry in China have been powerful and effective instruments in the unprecedented growth of the sector over the last decade.

From the perspective of the policy debate on the issue of beneficiation, what is common to both countries is not the existence of sizeable deposits of copper ore, although China is a substantial producer, but rather that beneficiation was a part of a larger industrial policy.²³ In the case of Japan, the intention was to gain competitiveness down the value chain. For China, beneficiation was a policy with multiple objectives. Assuring domestic supply, increasing employment and production and, from the perspective of the 12th Chinese Base Metal Plan, assuring a competitive global industry were among the objectives of Chinese firms and policymakers over the last decade.

JAPANESE POLICY ON COPPER SMELTING AND REFINING

In 2012 Japan was the world's second-largest exporter of refined copper and the world's second-largest importer of concentrate, while also being the world's third-largest producer of refined copper.²⁴ All this would be unexceptional if it were not for the fact that Japan has no copper mines,²⁵ imports virtually all of its concentrate from remote locations such

23 Beneficiation should proceed as an important ingredient in industrial policy. However, the objective of the industrial policy should be to gain commercial advantage along the value chain and develop products that are internationally competitive. It is by no means evident that the benefit of the beneficiation should be taken by the copper producer.

24 International Copper Study Group, 'The World Copper Fact Book', 2013, <http://www.icsg.org/index.php/press-releases/finish/170-publications-press-releases/1188-2013-world-copper-factbook>, accessed 24 January 2014.

25 In 1955 Japan was reported to be supplying 69% of its copper needs from domestic resources, although this went into rapid decline and Japan was 96% import dependent by 1980.

as Chile, Peru and Indonesia, has expensive unskilled labour and no domestic sources of supply of electricity. Despite these substantial economic disadvantages, its successful export record demonstrates that it has a clear comparative advantage in refined copper production, for both the domestic and foreign market.

How, and more importantly, why, did such a comparative advantage arise? The answer to the question of why the government put in place this policy comes from its need to develop a commercial advantage for its emerging manufacturers in the early part of its post-war industrialisation. Being able to procure an adequate supply of low-cost base metals in the 1960s and 1970s, which was when the policy began, was one of the reasons for the country's advantage in key sectors such as automobile production, shipping and steel over its main competitors in the US and Europe.

The government of Japan no longer needs to implement sectoral or industrial policies in the same way as it did 30–40 years ago, when the Japanese Ministry of International Trade and Industry (MITI) was a dominant player in Japanese commerce. Having established considerable commercial capacity and advantage, Japanese firms do not need the level of government support observed in the early stages of the industry's development. In Japan, the production of refined and smelted copper occurs within the context of the three great industrial enterprises: Sumitomo, Mitsubishi and Pan Pacific Copper.²⁶ All the companies involved in smelting and refining have backward linkages to mining companies in Asia and Latin America that supply concentrate, and either they or their principals have forward linkages to copper-using firms. Thus, while contemporary mainstream economic literature is opposed to the development of forward linkages, this has not been the case with modern Japanese enterprises. Within the context of the debate over beneficiation, Hausmann would almost certainly argue that the development of Japanese copper smelting and refining was a direct result of the technological sophistication of Japanese firms in the 1960s. However, the evidence is not consistent with such an interpretation. Japan's trade, industrial and technological policy measures were what spurred production to the levels currently observed. The technological sophistication to make such a leap may have been there, but it was MITI's policies that were the driving force.

While Japan is an efficient producer and exporter of refined copper, its development is a direct result of government policy. To understand Japan, and by extension China, Taiwan and Korea, a brief look at the policies that the government maintained for several decades is crucial.

26 Pan Pacific Copper was established in 2001 as a subsidiary of Nippon Mining and Mitsui.

TRADE POLICY IN SUPPORT OF COPPER REFINING

Japan still maintains a World Trade Organization (WTO) bound tariff of 3% on the value of refined copper (HS²⁷ 74.02) with what it refers to as a ‘temporary tariff’ of JPY²⁸ 500 (\$5.82)²⁹ – the value for customs duty/kg when the price of refined copper is above JPY 485/kg (\$5.64/kg).³⁰ This so-called temporary duty has been in place for many years. Japan also protects its industry against the most important Asian and Latin American competitors with which it has trade agreements (1.2% duties on imports from Chile and 0.8% from Indonesia). Generalised System of Preferences (GSP) countries pay 2.4% on refined copper. It should also be noted that these margins fell during the Tokyo and Uruguay Rounds from what were considerably higher levels. When one keeps in mind that the treatment and refining charges (TCTR) margin in 2013 was approximately 5%, this constitutes an important advantage in the domestic market. However, other developed countries such as the US also maintain this level of protective margins for refined copper. While the Japanese margin only protects the domestic market, it remains a vital part of any trade policy that provides domestic protection, thereby permitting exporting firms to earn profits domestically and price at the margin on exports.

FINANCIAL MEASURES IN SUPPORT OF COPPER MINING AND MANUFACTURING

Japan only allowed local companies to own foreign mines in the early 1970s, and the sector where this first occurred in base metal mining was in copper. The competitive advantage obtained from its early policy on iron ore and bauxite had limited effect on the copper sector, where there seems little evidence that price margins were substantially

27 The Harmonized Commodity Description and Coding System, generally referred to as ‘Harmonized System’ or simply ‘HS’, is a multipurpose international product nomenclature developed by the WCO. It comprises about 5 000 commodity groups, each identified by a six digit code, arranged in a legal and logical structure, and supported by well-defined rules to achieve uniform classification. The system is used by more than 200 countries and economies as a basis for their customs tariffs and for the collection of international trade statistics. Over 98% of the merchandise in international trade is classified in terms of the HS. See WCO, ‘What is the Harmonised System?’, <http://www.wcoomd.org/en/topics/nomenclature/overview/what-is-the-harmonized-system.aspx>, accessed 19 August 2015.

28 Currency code for the Japanese yen.

29 The exchange rate for US dollars to Japanese yen used was for 2013. 1USD = 85.96 Yen. See Bloomberg, <http://www.bloomberg.com/quote/USDJPY:CUR>, accessed 27 July 2015.

30 See Japanese Customs code, chapter 74, http://www.customs.go.jp/english/tariff/2014_1/data/i201401e_74.htm, accessed 7 March 2014. It has been alleged in the past that Japan used variable levies to subsidise its industry. The subsidisation is a Japanese tariff policy that imposes a duty on refined copper imports into Japan when the world (LME) price falls below a minimum intervention level. As a result, it is claimed that the Japanese domestic prices of refined copper are consistently above LME prices. See also *Metal Bulletin*, ‘Germans query Japan Cu subsidy’, 18 March 1980, p. 20.

different from that of the US³¹ in the early period. Japanese mining companies, with the assistance of the government, were permitted to acquire interests in foreign copper mines and began to enter into partnership agreements much earlier than with other non-ferrous metals. The first of these investments was in the Philippines in the 1950s, and by 1975 60% of the Japanese concentrate supply was funded by state institutions.³² In the 1960s, 1970s and 1980s Japan developed a host of institutions that subsidised³³ the development of off-shore investments in the copper sector, a policy emulated by China over the past decade. The main bodies that were created included the Metallic Minerals Exploration Agency, the Overseas Economic Co-operation Fund and the Overseas Mineral Resources Development Company. The Japanese EXIMBANK also worked closely with private banks such as Mitsui and Sumitomo to fund mining projects. Therefore, as a result of its policies, the risk associated with these mining exploration projects was in part absorbed by the Japanese government.³⁴

Loans to raw materials companies which lead to profitable investments must be repaid at the usual market rates of interest, whereas costs of credit for unsuccessful exploration are socialized: that is to say the loans do not have to be paid back. The state also offered a number of insurances which were intended to reduce the risks of private capital invested in foreign mining ventures.

Thus the government absorbed a substantial portion of the downside risk in mineral exploration to which Japanese companies were exposed in their early attempts to procure copper concentrate as their own national resources dwindled and domestic demand for copper expanded with the expansion of infrastructure and electronics in the 1960s and 1970s.

COLLUSION AMONG JAPANESE FIRMS

Japan has a history of cartelisation in its procurement of a range of base metals. The discounts from world prices that Japan achieved during the 1960s and 1970s helped, in part, explain its commercial dominance in the automobile and steel industries. By buying iron ore and bauxite for aluminium at heavily discounted prices Japan was able to gain a competitive advantage over US producers and thereby feed its downstream commercial advantage. There had long been complaints about the conduct of Japanese firms and their impact on the price at which EU firms could procure copper. These complaints dated back to the 1960s and reached their peak in the 1980s.³⁵ However, by the time the director general of the General Agreement on Tariffs and Trade (GATT) conducted

31 See Rodrick D, 'Managing resource dependency: The United States and Japan in the markets for copper, iron ore and bauxite,' *World Development*, 1982, pp. 541–560.

32 See Tsurumi Y, *The Japanese Are Coming*. Cambridge, MA: Ballinger, 1976.

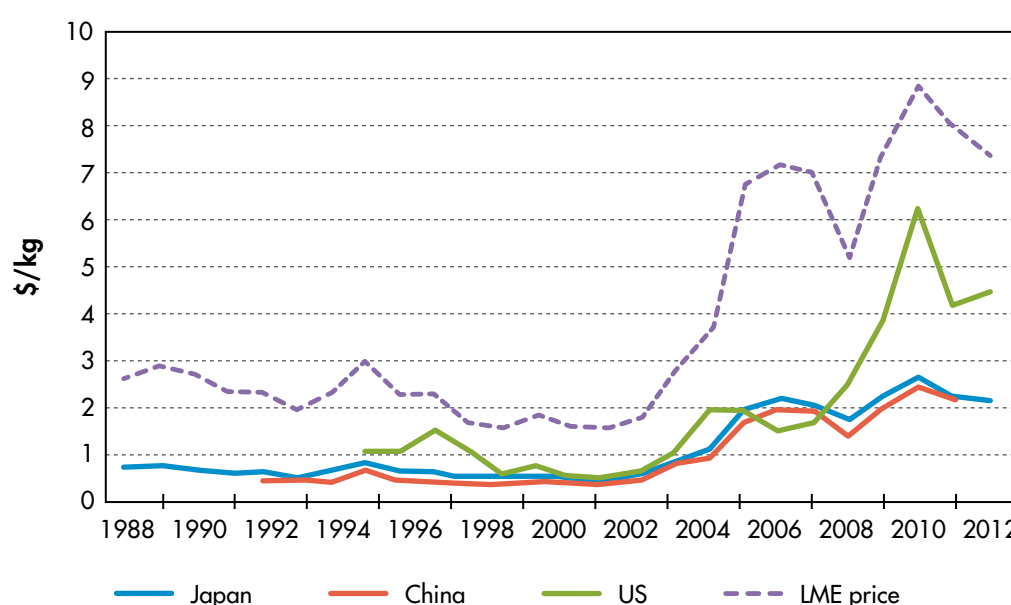
33 Hausmann R, Klinger B & R Lawrence, 2008, *op. cit.*

34 Mezger D, *Copper in the World Economy*. London: Heinemann, 1980, pp. 165–166.

35 See SUNS (South North Development Monitor), 'EEC, Japan advised to settle copper dispute bilaterally', 23 February 1989, <http://www.sunsonline.org/trade/process/during/uruguay/disputes/02230289.htm>, accessed 8 March 2014.

an inquiry he found that despite Japanese companies' having near monopolistic power in the concentrate market in the 1960s and 1970s, there was no evidence of a cartel³⁶ in the industry. Academic studies³⁷ confirmed that there was little evidence that prices were significantly lower in the 1970s and 1980s. More recent data suggests that Japan's commercial access to copper concentrate was at unit import prices well below those of the US.³⁸ It would appear that with the beginning of the super-cycle, US unit import values followed the London Metal Exchange (LME) prices more closely than those of Japan and other importers.

FIGURE 2 LME COPPER CATHODE PRICES AND US, CHINA AND JAPAN CONCENTRATE AND MATTE UNIT IMPORT VALUES



Source: Author's calculations based on comtrade, 'Unit import values on HS2381 concentrates and HS2382-matte', <http://comtrade.un.org/db/dqBasicQuery.aspx>, accessed 25 January 2014; World Bank, 'Commodity prices', <http://data.worldbank.org/data-catalog/commodity-price-data>, accessed 24 January 2014

36 See GATT (General Agreement on Trade and Tariffs), 'Analytical Index', 1994, p. 714, https://www.wto.org/english/res_e/booksp_e/analytic_index_e/gatt1994_e.htm, accessed 24 January 2014.

37 See Rodrick D, *op. cit.*, pp. 541–560.

38 The interpretation of unit import values, even where the data is accurate, is fraught with risk, as there are numerous reasons why it cannot readily be used as a proxy for price. The most important, in terms of vertically integrated industries such as copper, is that transnational firms will use transfer price manipulation depending on optimal advantage to the company.

TECHNOLOGICAL POLICY ON SHIPPING

Despite its remoteness from mineral supply sources, Japan led the way in the 1960s and early 1970s in technological developments in bulk commodity transport, which lowered the price of concentrate coming from Latin America and Asia.³⁹ In the 21st century massive bulk commodity carriers have become ubiquitous in the international trade in minerals, and Japan was at the forefront of the development of these vessels in the 1960s and 1970s. This diminished Japan's commercial disadvantage in having to import copper concentrate and other base metals from distant continents. This lowering of costs caused by the development of bulk carrier systems was one of the factors that made smelting and refining copper and other base metals so footloose. The government of Japan carefully constructed a series of interventions in the shipbuilding sector to assure rapid but steady growth throughout the 1960s.⁴⁰ By lowering transport costs it further facilitated the development of copper processing in locations far from the mine site, ie, in Japan.

CHINESE POLICY ON COPPER BENEFICIATION

Whereas understanding Japanese industrial policy on copper production involves a review of measures implemented from the 1960s to the 1980s, in the case of China the policies are a product of the 1990s that continued in the 21st century and, in comparison with Japan's policies, were established on a far grander scale. Japanese industrial policy aimed to develop and then sustain a commercial advantage in non-ferrous metals that fed downstream into the commercial advantage it enjoyed in the production of consumer and industrial products, which are intensive in their use of these non-ferrous metals, for example automobiles and electronics. This set an important example for China as a latecomer to the sector. Japan's mercantilist policies were most successful in iron ore and bauxite and least successful in copper because, unlike the former, the Japanese appear to have been unable to cartelise the importation of copper concentrate. This policy of ensuring domestic supply at advantageous prices, and thereby gaining commercial advantage, has been emulated by China. However, it uses quite different industrial policy instruments to achieve what is ostensibly the same trade policy objective.

GROWTH OF CHINESE COPPER PRODUCTION

Figure 3 depicts the expansion of China's copper industry from its relatively humble beginnings in the 1990s to its global dominance of production over the past decade.

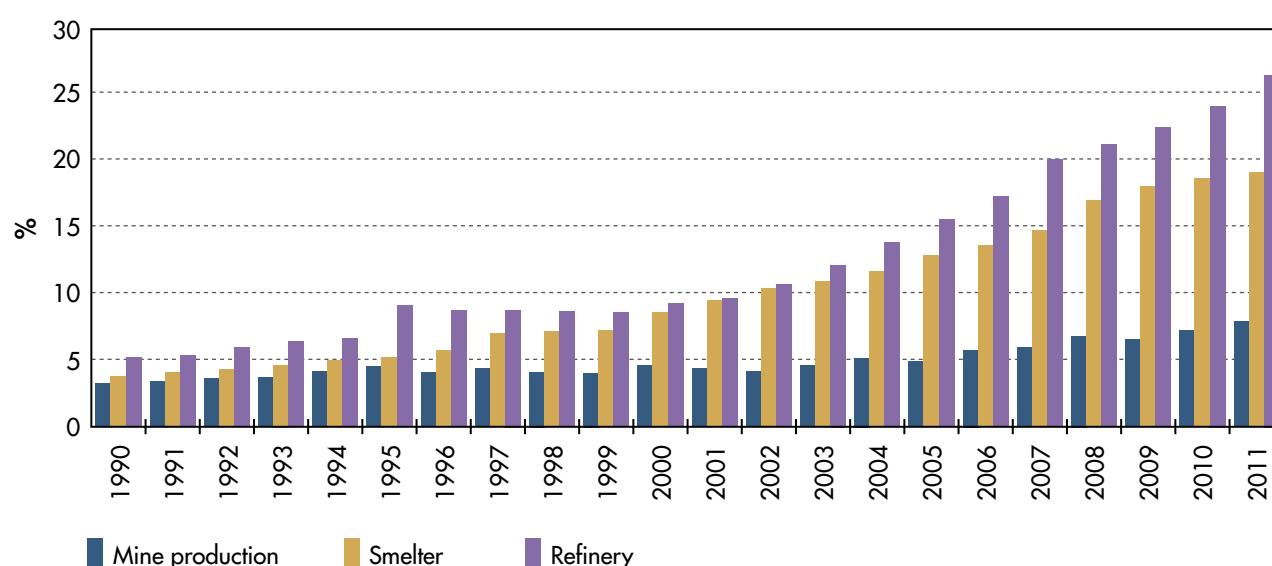
39 Bunker SG & P Cicantell, *East Asia and the Global Economy: Japan's Ascent with Implications for China's Future*. Baltimore: John Hopkins University Press, 2007, pp. 76–78.

The government heavily subsidised the development of its shipping industry, which by 1975 had grown to account for over 50.1% of world production. The most significant technological development introduced by Japan was the systematic growth of ship size, which allowed for substantial economies of scale in the shipment of bulk cargoes.

40 Chida T & P Davies, *The Japanese Shipping and Shipbuilding Industries: A History of their Modern Growth*. London: Athlone Press, 1990, p. 81.

Table 1 shows that production from traditional producers has tended to stagnate. China's rise as a producer is the dominant fact of the last decade in the copper sector and many other industries. By any global standard, its copper production has exhibited an unprecedented upward trend, with its mine, smelter and refinery production's shares in world production being 8%, 19% and 27% respectively for 2011. Since 2004, China has been the world's largest producer of blister and refined copper. In 2012, China accounted for around 28% of the world's refined output, followed by Chile (16%), Japan (7%) and the US (5%). In the same year it also accounted for 19% of the world smelting output, followed by Chile (9%), Japan (9%) and Germany (4%). Figure 3 shows the shift of world production by smelters and refinery to China.

FIGURE 3 CHINA'S SHARE OF WORLD COPPER PRODUCTION 1990–2011



Source: USGC (US Geological Survey), 'The mineral industry of China (various)', <http://minerals.usgs.gov/minerals/pubs/country/asia.html#ch>, accessed 20 January 201

Table 1 demonstrates that even in the area of mine production, China expanded from being a mid-level but significant producer in 2002 to being the world's second-largest producer of mined copper in 2011. However, while mine production more than doubled in this period, China maintained a conscious state policy of expanding its smelting and refining capacity far beyond that of the needs of domestic supply of concentrate.

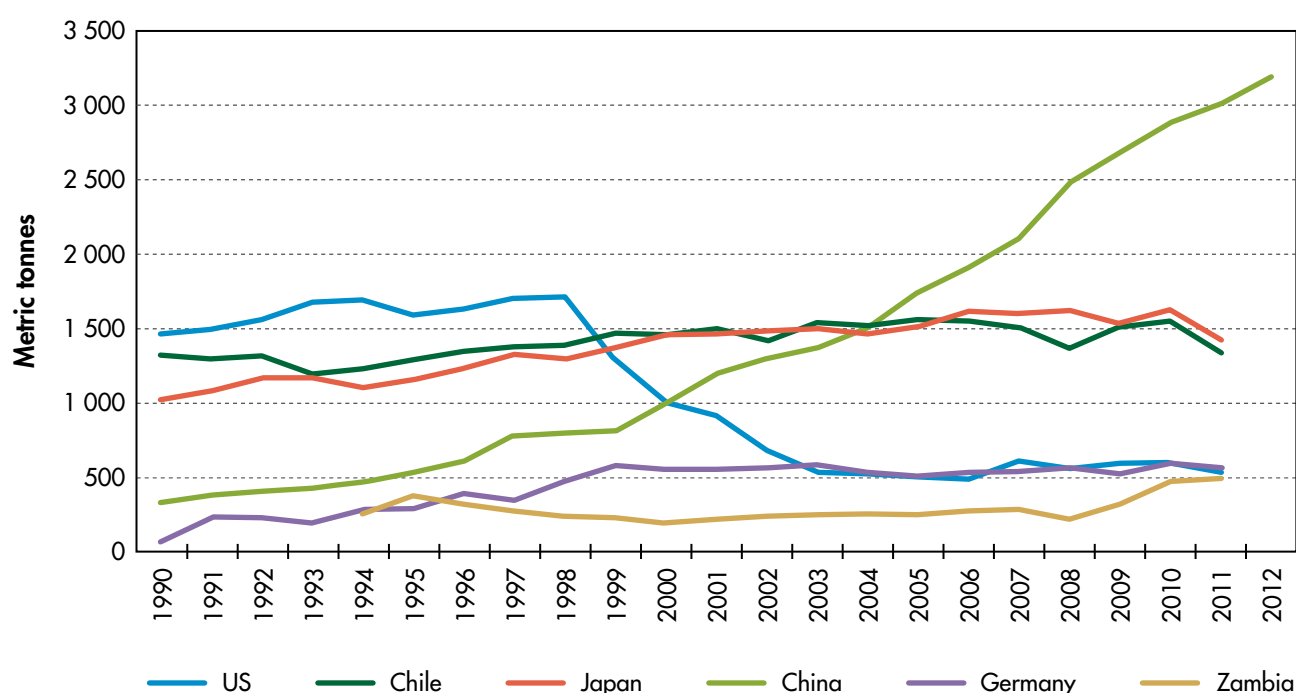
TABLE 1 MINE PRODUCTION BY COUNTRY (TONNES), 2002–2011										
Country	2002	2003	2004	2005	2006e	2007	2008	2009	2010	2011
Australia	868	840	854	916	859	870	886	854	870	958
Chile	4 581	4 904	5 413	5 321	5 361	5 557	5 328	5 394	5 419	5 263
China	593	620	752	777	889	946	1 090	1 070	1 200	1 310
Indonesia	1 172	1 006	840	1 065	816	797	633	999	878	543
Kazakhstan	490	485	461	422	457	440	465	455	427	417
Peru	845	863	1 036	1 010	1 049	1 190	1 268	1 276	1 247	1 235
Poland	503	495	531	523	512	452	429	439	425	427
Russia	695	675	675	700	725	740	750	676	703	713
US	1 140	1 120	1 160	1 140	1 200	1 170	1 310	1 180	1 110	1 110
Zambia	330	349	427	423	476	509	534	698	686	668
World total	13 600	13 800	14 700	15 000	15 100	15 500	15 600	16 000	16 100	16 100

Source: USGSC (US Geological Survey Copper), The Mineral Year Book', <http://minerals.usgs.gov/minerals/pubs/commodity/copper/>, accessed 17 January 2014

SMELTING AND REFINING

As a result of these changes, smelting and refining capacity had to be predicated on increased imports of concentrate and blister. This in turn meant that China would have to procure more concentrate, which in turn resulted in a displacement of other producers, most notably (see Figure 4) the US. This was also accompanied by a decade-long stagnation in smelter production in Chile, Japan and Zambia. Only in the last few years has Zambian smelting and refining capacity, for example, begun to increase rapidly to meet the growing demands of its expanding mining sector. As smelter and refinery production expanded and Chinese firms began experiencing excess capacity, there was a significant contraction of smelting and refining margins.

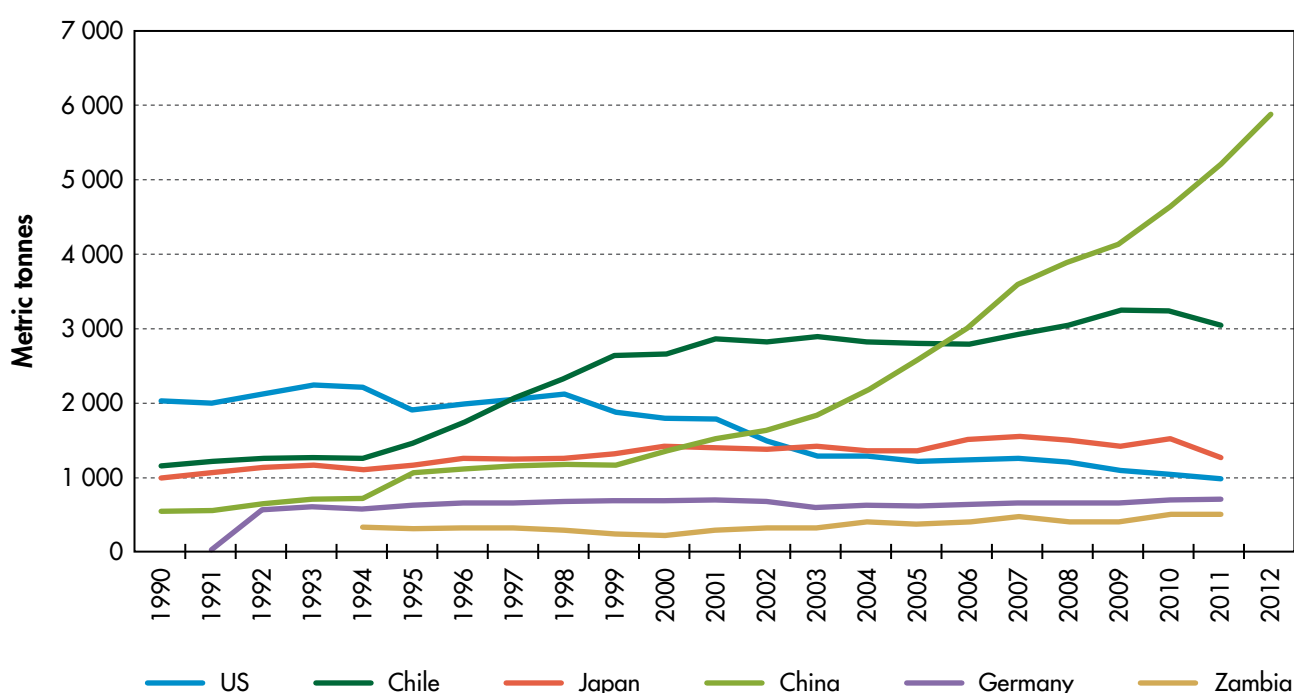
This raises the obvious policy question as to why China has implemented a policy that has contracted smelting and refining margins so severely and thereby decreased profitability in the sector. The motivation of policymakers remains a matter of speculation. However, if China wanted to attract concentrate to its own processing industry, declining TCTR margins would assure more production occurred locally and would eventually mean that other producers in relatively high-cost locations, eg, the US, would increasingly be excluded from the market, as was ultimately the case.

FIGURE 4 COPPER SMELTER PRODUCTION BY COUNTRY (THOUSAND METRIC TONNES), 1990–2012

Source: USGSC, 'The Mineral Year Book', <http://minerals.usgs.gov/minerals/pubs/commodity/copper/>, accessed 20 January 2014

Chinese refining capacity increased far more rapidly than either smelting or mining. In the last few years some refineries in China have become mega-refineries, such as the Jiangxi Copper Corporation Guixi refinery, which has a capacity of 900 000 tonnes a year. The world's second largest refinery is also in China – the Jinchuan Refinery – with a capacity of 650 000 tonnes a year.⁴¹ As can be seen from Figure 5, growth in refined copper production far outstripped the growth in mined production and smelting. Over the last decade China pursued a conscious policy similar to that of Japan three decades earlier of assuring local supply of refined copper. This, however, was to be met by supplies of blister to refineries rather than transporting large quantities of waste in concentrate from remote locations for the purpose of smelting.

41 ICSG (International Copper Study Group), 'ICSG World Copper Fact Book 2013', p. 23.

FIGURE 5 COPPER REFINERY PRODUCTION BY COUNTRY (THOUSAND METRIC TONNES), 1990–2012

Source: USGSC, 'The Mineral Year Book', <http://minerals.usgs.gov/minerals/pubs/commodity/copper/>, accessed 20 January 2014

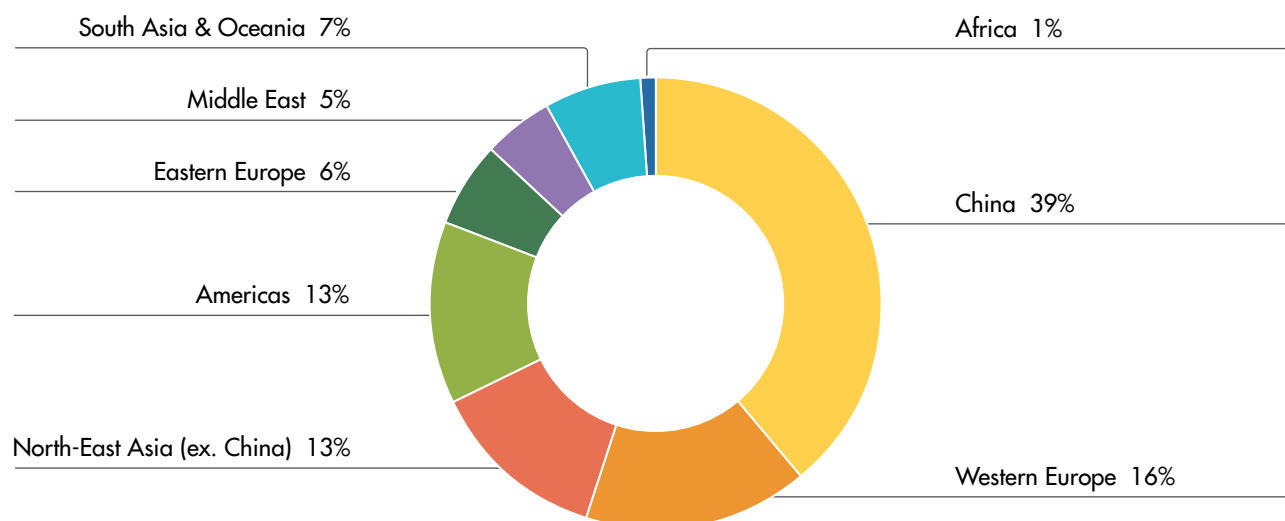
SEMI-FABRICATES

The first stage in the production of copper and alloy products is the production of semi-fabricates from cathodes of copper and other minerals. This particular range of products is particularly important to African beneficiation, as only one country in the sample that is examined ie, Zambia (see Figure 6), has managed to advance value addition to the point of producing its own semi-fabricates. While production is limited and geared towards African markets, the countries in the sample have not moved beyond the production of refined products, with some such as Botswana confined to the production of concentrates.

By 2013, China's production capacity of copper semi-fabricates had increased well beyond the growth of the economy and was responsible for some 39% of global production of semi-fabricates – making it the world's largest producer by far (see Figure 6). However, with its dominance in the global market for semi-fabricates there has also arisen a substantial excess capacity in the sector. The excess capacity is even more pronounced in the semi-fabricate part of the value chain than it is with cathode and blister. While the government of China has, at least nominally, pursued a policy of attempting to rein in excess production capacity, this was always done with the intention of assuring that the remaining firms in the industry employed the most modern technology. Moreover, where policy has been geared towards production limits, this has normally been associated with

relatively minor downward adjustments in capacity through the elimination of production facilities that used outdated technologies.

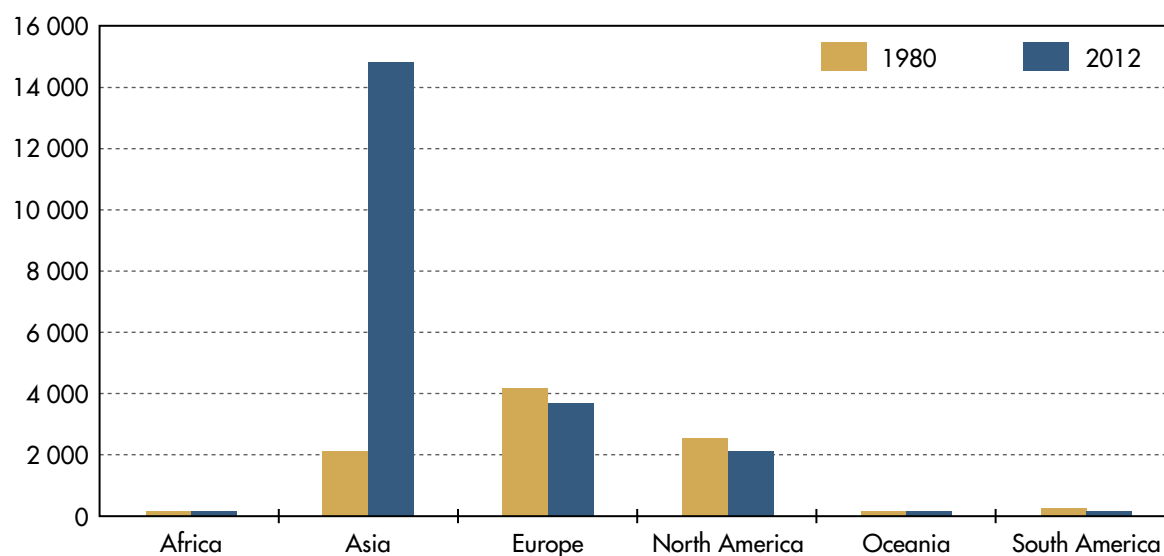
FIGURE 6 DISTRIBUTION OF SEMI-FABRICATE PRODUCTION BY REGION (2012)



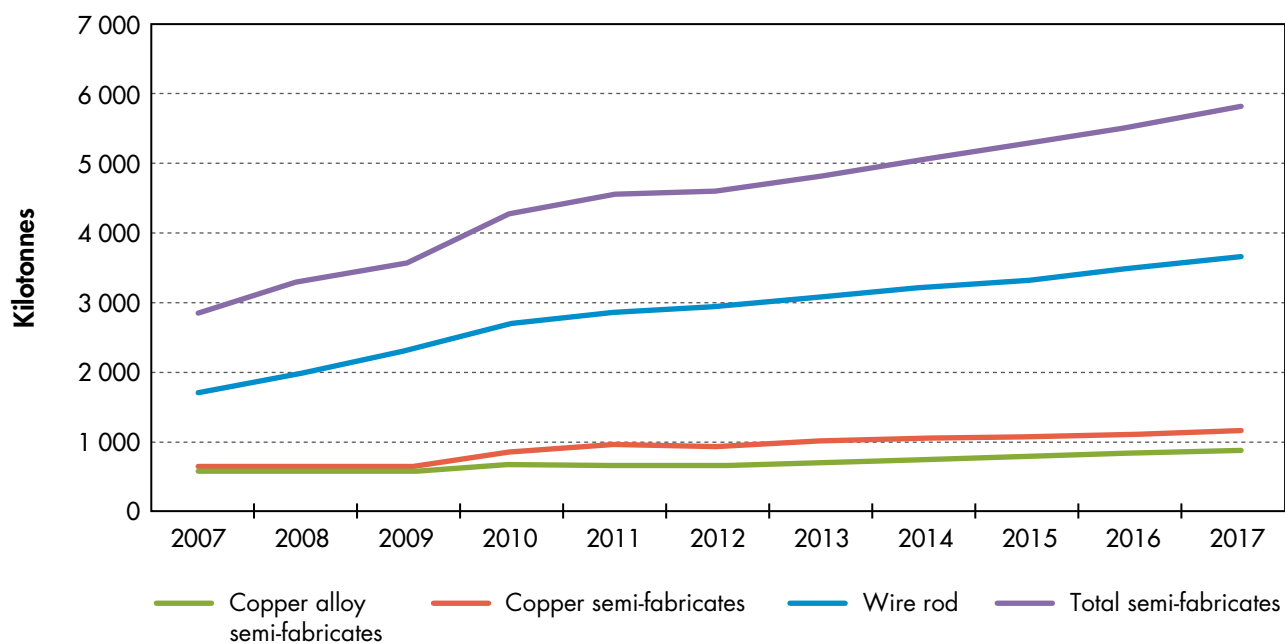
Source: ICSG (International Copper Study Group), 'World Copper Factbook', 2013, <http://www.icsg.org/index.php/press-releases/finish/170-publications-press-releases/1188-2013-world-copper-factbook>, accessed 20 January 2014

Comparing the growth of producers over the period 1980–2012 it becomes apparent that Asia now dominates in the production of semi-fabricates. This growth has not been entirely from China, as expansion in semi-fabricate production has also occurred in Japan and Korea, although the vast bulk of the observed expansion has been a result of production growth in China. As can be seen from Figure 7, this has been largely at the expense of production in other regions such as Europe and North America, which have seen an absolute decrease in production along with significant decreases in market share. This has also been true of the relative contraction of semi-fabricate production in Chile and other Latin American producers.

Not only has China moved rapidly into expanding its production of semi-fabricates and alloy semi-fabricates, but industry estimates in China also suggest that it is planning to expand these even further in the years to come. The consumption of copper for the purposes of producing copper and copper alloy semi-fabricates is set to increase by 25% from the actual levels of 2012 to the projected levels of 2017. Yet it should be noted that Chinese government policy in the last five-year plan has been to at least nominally contract excess capacity in the sector. However, as mentioned previously, the exact opposite has occurred and in the case of wire rod, excess capacity is set to increase in the coming years.

FIGURE 7 THE GROWTH IN ASIAN PRODUCTION OF SEMI-FABRICATES

Source: ICSG, 'World Copper Factbook', 2013, <http://www.icsg.org/index.php/press-releases/finish/170-publications-press-releases/1188-2013-world-copper-factbook>, accessed 20 January 2014

FIGURE 8 ACTUAL (TO 2012) AND PROJECTED SEMI-FABRICATE PRODUCTION IN CHINA, KILOTONNES (KTS)

Source: Industry estimates, anonymous, Beijing

TRADE AND INDUSTRIAL POLICIES IN CHINA STIMULATING THE GROWTH OF THE COPPER INDUSTRY

The shift in smelter and refinery capacity to China and the general unprecedented growth of the copper industry to some degree reflects the Chinese trade and industrial policies in the copper processing and fabricating industry. If copper concentrate, blister and cathode are all being purchased at world market prices there is no obvious or immediate commercial benefit in locating the facilities in China, yet Chinese policies remain geared to the domestication of production along the value chain. Unlike Japanese policy, which existed with the sole objective of assuring a commercial advantage for end users of the base metal (which were often the same firms), Chinese policy is far more complex, reflecting not only the commercial advantage of downstream users but also national objectives on employment and growth.

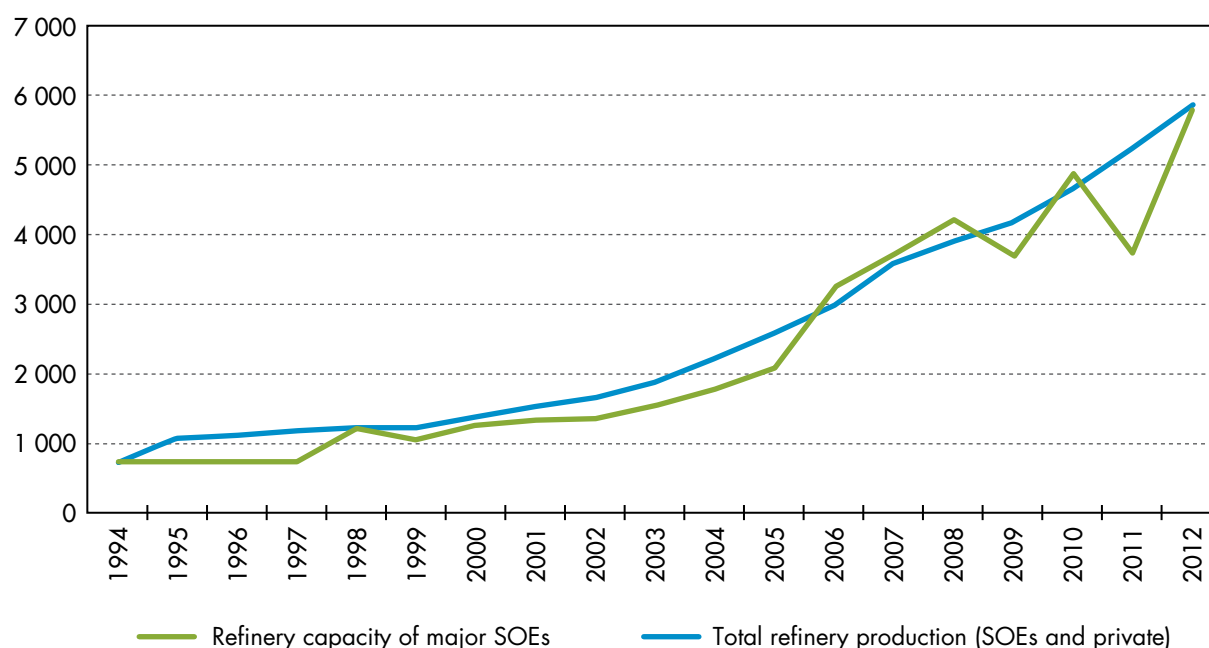
Chinese policies in the copper mining and processing sector include the following aspects.

State ownership of the means of production and national planning

Perhaps one of the most important measures that supported the unprecedented growth of the Chinese copper industry over the last decade has been state ownership. The state, as the principal shareholder in state-owned enterprises (SOEs), can by fiat determine production and capacity levels. The government policy as determined by the 12th Non-ferrous Metal Plan was aimed at consolidating these enterprises and creating large, technologically sophisticated firms that could readily compete on the international copper market. The expansion in refining capacity (compared to total Chinese refined production) is presented in Figure 9. It clearly shows that refinery expansion in SOEs over the last decade has been sufficient to cover almost the entire increase in the country's capacity. Thus Chinese expansion has been a direct result of SOE policy. In 2012 total Chinese capacity was approximately 8 million tonnes, and SOEs constituted some 74% of total refinery capacity. This unparalleled expansion in refining capacity by China in such a short period of time would have been considerably more difficult without the state as the principal investor. This state ownership distinguished China's industrial policy on copper from that of its immediate industrial precursor, Japan. When combined with substantial state subventions and other financial incentives⁴² for expansion, it has also resulted in capacity well beyond sustainable production.

This state ownership of firms operating in the mining and mineral processing sector is more than just a remnant of China's communist past; rather it forms part of a consistent policy in the BRICS of using SOEs as an instrument of state commercial policies. These SOEs have become increasingly significant actors in the global minerals and energy market. While these firms' motivation may differ radically from that of the private sector,

42 Many of the measures that were implemented to expand production and investment were counter-cyclical measures that were internationally agreed to in 2009 following the onset of the global economic crisis. At this time China substantially increased lending for SOEs in order to facilitate further investment. This countercyclical investment compounded the structural tendency to over-capacity that has been observed.

FIGURE 9 SOE REFINING AND TOTAL CHINESE REFINED COPPER PRODUCTION

Source: Author's calculations based on USGS (US Geological Survey), 'The mineral industry of China', <http://minerals.usgs.gov/minerals/pubs/country/asia.html#ch>, accessed 20 January 2014

their development and use by BRICS countries cannot be dismissed as an anachronism. SOEs often behave in a commercial manner, and this has been one of the characteristics of modern SOEs and firms with some state holding, such as Vale in Brazil or Statoil in Norway.⁴³

Prior to the expansion in production capacity that occurred after 2004–05, China instituted a policy of helping its copper (and other) companies to go global and acquire the assets needed. This was akin to the policy of Japan's MITI of facilitating Japanese ownership of Asian, Australian and Latin American mines almost half a century earlier. The strategy was formalised in 2001 and included in China's 10th Five-Year Plan (2001–2006). The strategy targeted 'inward-oriented outward investment', ie, investments geared towards domestic goals such as securing scarce resources⁴⁴ and creating favourable

43 Musacchio A & SG Lazzarini, *Reinventing State Capitalism: Leviathan in Business, Brazil and Beyond*. Cambridge MA: Harvard University Press, 2014.

44 It is worth noting that these strategies have goals other than securing scarce resources in foreign countries.

conditions for enterprises to establish overseas operations.⁴⁵ Government support⁴⁶ takes the form of financial incentives, provision of market intelligence and co-ordination through the Ministry of Commerce.⁴⁷ China Non-Ferrous Metal Mining Co. Ltd (CNMC) is a significant beneficiary of the 'going global strategy'. In Zambia it is the owner of Non-Ferrous China-Africa (NFCA), which acquired the Chambishi copper mine. In Zambia, Chinese companies were found to be less sensitive to operating risks, and to be guided by natural resources- and market-seeking motives.⁴⁸ During the 2008/2009 financial crisis, NFCA showed a counter-cyclical expansion with the acquisition and re-capitalisation of a new copper mine and continuing in the Multi-Facility Economic Zone. NFCA reduced neither production nor investment development projects and did not retrench workers.

China's key policy statements in the non-ferrous sector in the last 10 years have been the 11th (2006–2010) and 12th (2011–2015) non-ferrous metal plans, which accompanied the more general economy-wide Chinese plans for the country. In January 2012, the Ministry of Industry and Information Technology (MIIT) published China's 12th Non-ferrous Five-Year Plan, which projected an annual growth for copper of 5.2% over the planning period, reaching a level of output of refined copper of 6.5 megatonnes (mt) by 2015.⁴⁹ This was to be approximately half of that achieved during the 11th plan.

When China first promulgated its 12th plan it was clear that the intention in terms of copper was to increase domestic supply, yet there was also support for limiting the growing excess capacity in both copper and other non-ferrous metals. Whereas production of copper during the 11th plan had increased by double digits, the intention of the 12th plan was to drastically reduce both copper production and capacity. However, this was

45 Premier of the State Council Mzhu Rongji reported on the 'Outline of the 10th Five-Year Plan for National Economic and Social Development (2001)', at the Fourth Session of the Ninth National People's Congress on March 5, 2001, http://www.gov.cn/english/official/2005-07/29/content_18334.htm, accessed 14 March 2014. He is quoted as saying:

We need to implement a 'going outside' strategy, encouraging enterprises with comparative advantages to make investments abroad, to establish processing operations, to exploit foreign resources with local partners ... We need to provide a supportive policy framework to create favorable conditions for enterprises to establish overseas operations. We also need to strengthen supervision and prevent the loss of state assets.

46 A survey conducted by Broadman found that the government support to be the second-most important reason for going global. See Broadman HG, 'Africa's Silk Road: China and India's New Economic Frontier', World Bank, 2007, <https://openknowledge.worldbank.org/bitstream/handle/10986/7186/378950Africas0silk0road01PUBLIC1.pdf?sequence=1>, accessed 24 January 2014.

47 Not all Chinese companies that have investments abroad have access to government support. See Li P, *The Myth and Realities of Chinese Investors: A Case Study of Chinese Investments in Zambia's Copper Industry*. Johannesburg: SAIIA (South African Institute of International Affairs), 2010.

48 *Ibid.*

49 Commodities Research Unit, 'Implications from China's 12th Non-Ferrous Metals Five Year Plan', 24 April 2012, <http://www.crugroup.com/about-cru/cruinsight/chinanonferrousmetalsFiveYearPlan>, accessed 4 April 2014.

never realised and by 2013 refined production in China had grown to 6.8 mt, exceeding the planned levels with a growth rate of 13.6% in 2013, up from 11% in 2012.⁵⁰ If the MIIT had seriously wished to pursue a policy of limiting excess capacity in the copper industry it could have instructed SOEs to halt further expansion, as was done in 2010 with the aluminium industry.⁵¹ However, a reasonable hypothesis pertaining to the policy preferences of China's planners is that they never wished to risk hampering national self-sufficiency along the copper value chain, as long as the excess capacity did not result in a catastrophic meltdown in industry profits. The planners would not rein in the expansion – which had been occurring at a double-digit pace for a decade – because it would limit growth and employment in the copper industry.

Trade policies in support of copper refining and fabrication

China has a WTO bound tariff of 1.5% on the value of refined copper (HS7403) imports, an average bound tariff of 5.9% on the value of semi-fabricates (HS7405–HS7411) imports and an average bound tariff of 11.7% on the value of copper products (HS7412–HS7418).⁵² The average Most Favoured Nations applied tariff rates on the value of refined copper, semi-fabricates and finished copper products by China are 1.3%, 5.6% and 9.7% respectively. This arrangement encourages downstream projects and protects local firms from global competition. China also adjusts excise tax and value added tax (VAT) rebate rates as part of its industrial policies, to control, restrict or otherwise 'manage' the export of certain products. In particular, on 15 July 2010 China eliminated VAT rebates on exports of steel, starch, ethanol and semi-finished copper products, covering 406 tariff lines.⁵³ It has used various forms of preferential VAT refunds on imported raw materials, which acted as a means to lower costs for its industries. The VAT rebate was eliminated to assure a decline in copper exports, allowing local demand to be satisfied.

Subsidies and other government assistance

China maintains a two-tier system of providing subsidies and assistance to the development of its industry, at the central and sub-central level. Assistance is implemented on the basis of circulars issued by the state council (on its own or jointly with relevant ministries

50 Reuters, 'Weak prices to pressure China copper producers' bottom line in 2014', 1 April 2014, <http://www.reuters.com/article/2014/04/02/china-copper-results-idUSL4N0MN13M20140402>, accessed 4 April 2014.

51 The National Development and Reform Commission in China has the authority to limit production expansion where it sees over-capacity constituting a threat. In did this in April 2010 to limit the production of aluminium. See 'China releases 5 year nonferrous metals plan', *China Mining*, 6 February 2012, <http://www.chinamining.org/News/2012-02-06/1328488943d53981.html>, accessed 4 April 2014.

52 These figures are based on the WTO (World Trade Organization), China import tariff schedule 2011, <http://tariffdata.wto.org/TariffList.aspx>, accessed 27 July 2015.

53 WTO, 'WTO Trade Policy Review: China, Report', 2012, WTO document WT/TPR/OV/W/5/Rev.1, 7 September 2011.

and agencies), which announce policy guidance or sector-specific industrial policies. These circulars usually do not provide details of assistance, but indicate which level of government (central or sub-central) will finance the programmes. When a programme is financed mainly by the central government, the sub-central governments may provide facilities and other supplementary support.⁵⁴ For example, under the ‘torch programme’, aimed at promoting new and high-end technologies,⁵⁵ the central government provides tax benefits and financial assistance to qualifying projects, and local authorities provide supplementary financial assistance.

The main instruments of support are direct grants; subsidised loans; tax benefits, which include VAT exemptions or reductions; enterprise income tax; and import duties. Such government measures are outlined in the industrial revitalisation plans. For example, the major measures in the 2009 industrial revitalisation plans⁵⁶ for the development of 10 sectors (iron and steel, automobiles, shipbuilding, petrochemicals, textile and clothing, light industry, non-ferrous metals, equipment manufacturing, electronics and information industry, and logistics) included lowering the taxes levied on enterprises by adjusting VAT rebates on the exports of certain products; and providing preferential loans or other financial assistance to enterprises within an industry structure to encourage consolidation through mergers and acquisitions, and to other enterprises in the industry structure to encourage innovation.

However, with the two-tier system, the range of subsidies and government assistance is not entirely transparent, particularly at the provincial level. The type and size of sub-central programmes, the financial outlays involved and the objectives of the programmes, as well as their expected results, are often unknown.⁵⁷ The unavailability of detailed information on China’s subsidies and other government assistance prompted the US, for example, in 2011 to request China to submit information on 200 measures by its central and provincial governments to the WTO’s committee on subsidies and countervailing measures. (See Annex 3, which shows the general measures of Guangdong Province requested by the US.)

54 *Ibid.*, pp. 69–72.

55 The programme is managed by the Ministry of Science and Technology, in accordance with the administration measures of the National Torch Programme Project.

56 The reasons put forward by the US Geological Survey on why China developed and implemented the 2009 revitalisation plan for the 10 sectors are that the existing structures of most industries were no longer meeting the requirements of the modern business world; and enterprises in these industries were considered to be weak in independent innovation, had low measures of competitiveness and productivity, depended heavily on external demand, and had undiversified product lines. See US Geological Survey, ‘The Mineral Industry of China Report’, 2009, p. 9.2.

57 See WTO, *op. cit.*, WT/TPR/S/264/REV.1’, p. 69.

It also appears that there is no coherence in the abolition of such measures at the central and sub-sector level.⁵⁸

Ownership of foreign assets to secure sufficient supply of raw materials (ie, copper)

Guided by domestic policies and strategies such as the non-ferrous metals five-year plans and the 'Going Global Strategy',⁵⁹ Chinese companies, including those in the copper industry,⁶⁰ have invested in foreign assets, in either greenfields or mergers and

58 In WTO, *op. cit.*, p. 71, under the heading 'Other assistance', it is outlined that The authorities issued a number of circulars related to China's export brands. It would appear that the measures described in those circulars have been abolished; some incentives appear to exist at the sub-central level, mainly cash awards, for locally registered enterprises to apply for famous brand recognition. It was not clear to the Secretariat whether all measures at the sub-central level have been abolished along with the abolition of measures at the central level.

And in US Geological Survey, *op. cit.*, p. 9.2, it is stated that:

In 2007 the Government (of China) had discontinued the practice of giving preferential power rates to energy-intensive users, such as those that produced aluminum, ammonia, caustic soda, cement, copper, ferroalloys, yellow phosphorus, and zinc. In July 2008, the NDRC [National Development and Reform Commission] increased the price of electricity by 25 Yuan per million watt-hours. Owing to the global financial crisis and the decrease in the demand for electricity, some local governments went against the policy of the Central Government and reinstituted the preferential power rates for energy-intensive users as a way to stimulate the local economy.

59 'The going global strategy encourages outward investments that reflect China's competitive advantages, and expand the areas, channels and methods of international economic and technological cooperation ... Support overseas exploitation of resources for which there is a shortage in China through cooperation, promote the adjustment of domestic industrial structure and exchange of resources... Support capable enterprises to operate overseas and grow globally... create conditions for the implementation of the [Going Global] strategy in areas such as finance, insurance, foreign exchange, taxation, human resources, law, information service, and exit-entry administration ...'. See China, National People's Congress, '10th Five-Year Plan (2001–2005)', 2001, Chapter 17, Section IV, http://www.iisd.org/pdf/2012/chinese_outward_investment.pdf, retrieved and translated by IISD (International Institute for Sustainable Development), <http://www.people.com.cn/GB/shizheng/16/20010318/419582.html>, accessed 30 April 2014.

60 CNMC (The China Nonferrous Metal Mining Group Co. Ltd), a large state enterprise under the management of the state-owned Assets Supervision and Administration Commission of the State Council, is also at the vanguard of Chinese enterprises in implementing the strategy of going global and carrying out international investment and co-operation in the non-ferrous metal mineral resources field. Its major interests include the development of non-ferrous metal mineral resources, construction engineering, and relevant trade and technological services. See Sino-Swedish Corporate Social Responsibility Cooperation, 'CNMC: Replicating the success of development zone in China to achieve common development in Zambia–China cooperation zone', 15 April 2013, <http://csr2.mofcom.gov.cn/article/supply/201304/20130400089415.shtml>, accessed 15 April 2014.

acquisitions, to ensure sufficient supply of copper concentrates. According to the 2004 circular, investments abroad would be supported by preferential policies in funds, foreign exchange, tax, customs, and exit and entry.⁶¹ The concessional loans to overseas investment projects encouraged by the state were to be administered by the Export-Import Bank of China, by applying preferential export credit interest rates to what is referred to as 'special loans'. The special loans for overseas investments were mainly to be used to support overseas resource development projects, which could compensate for the relative insufficiency of domestic resources.⁶²

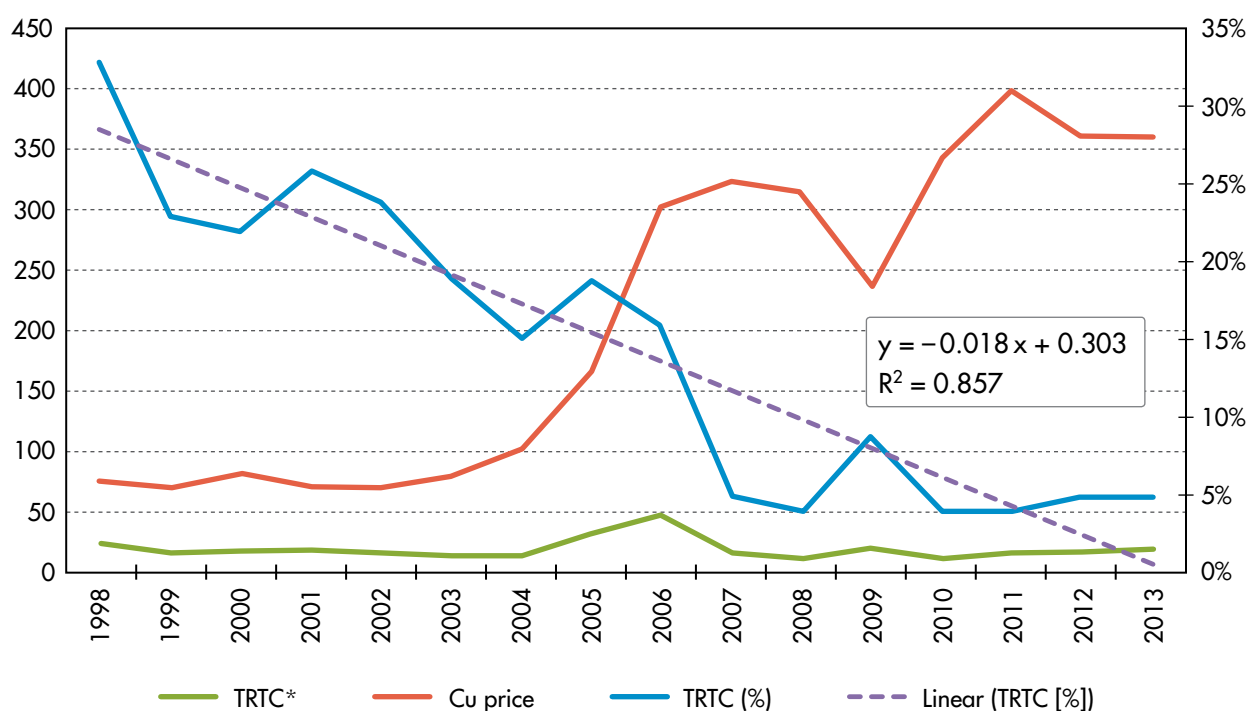
THE 'GREAT COMPRESSION' AND THE IMPACT OF CHINA'S INDUSTRIAL POLICIES ON AFRICA'S BASE METAL BENEFICIATION EFFORTS

Developing countries in Africa that produce base metals, especially copper, are being advised that they should not attempt to beneficiate since the prospects are not favourable in the short to medium term.⁶³ However, the arguments against beneficiation involve discussions about production beyond that of refined products such as LME-grade copper. Increasingly, the commercial advice being offered is that African countries should not even move to producing refined product but should export concentrate.⁶⁴ The reason for this commercial advice is because the average treatment and refining charges (TRTC) margins

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- 61 The support is only directed at companies that meet the requirements of the 'Guide Catalogue of Countries and Industries for Investment Abroad'. The guide is formulated by the Chinese Ministry of Commerce and Ministry of Foreign Affairs in accordance with related instructions of the State Council. See MOC (Ministry of Commerce) & MFA (Ministry of Foreign Affairs), 'Distributing Guide Catalogue of Countries and Industries for Investment Abroad', 22 July 2004, <http://english.mofcom.gov.cn/article/policyrelease/domesticpolicy/200407/20040700252775.html>, accessed 26 April 2014.
 - 62 NDRC (National Development and Reform Commission) & China ExIm Bank, 'Notice of the National Development and Reform Commission, the Export-Import Bank of China on Giving Credit Support to the Key Overseas Investment Projects Encouraged by the State/ Circular on Supportive Credit Policy on Key Overseas Investment Project Encouraged by the State', No. 2345 [2004] of the Foreign Investment Dept. of the NDRC, October 2004, <http://www.lawinfochina.com/display.aspx?lib=law&id=3765>.
 - 63 Rielander J, Shimeles A & HR Solignac-Lecomte, 'Bridging Africa's Transformation Gap: Could Natural Resources Do Good After All?', ECDPM (European Centre for Development Policy Management), Great (Governance, Regional Integration, Economics, Agriculture and Trade) Insights, 2013; World Bank, 'What is the Potential for More Copper Fabrication in Zambia?', 2011, <https://openknowledge.worldbank.org/handle/10986/2812>; Creative Commons Attribution CC BY 3.0, 2011, outline the factors affecting copper fabrication in Zambia and developing countries rich in non-ferrous metals in general.
 - 64 See World Bank, 2011, *op. cit.*; and World Bank Zambia, 'How Can Zambia Increase the Fabrication of Copper Products? Dispelling the Myth that Domestic Production of Copper is an Advantage', Draft Report, 2012.

are declining. The compression of the TRTC margins is in turn a direct result of Chinese expansion and over-capacity.⁶⁵

FIGURE 10 CUSTOM SMELTING AND REFINING MARGINS – LONG-TERM BENCHMARK RATES, 1998–2013



* TRTC = Average treatment & refining charges of copper

Cu Price = Average LME copper price

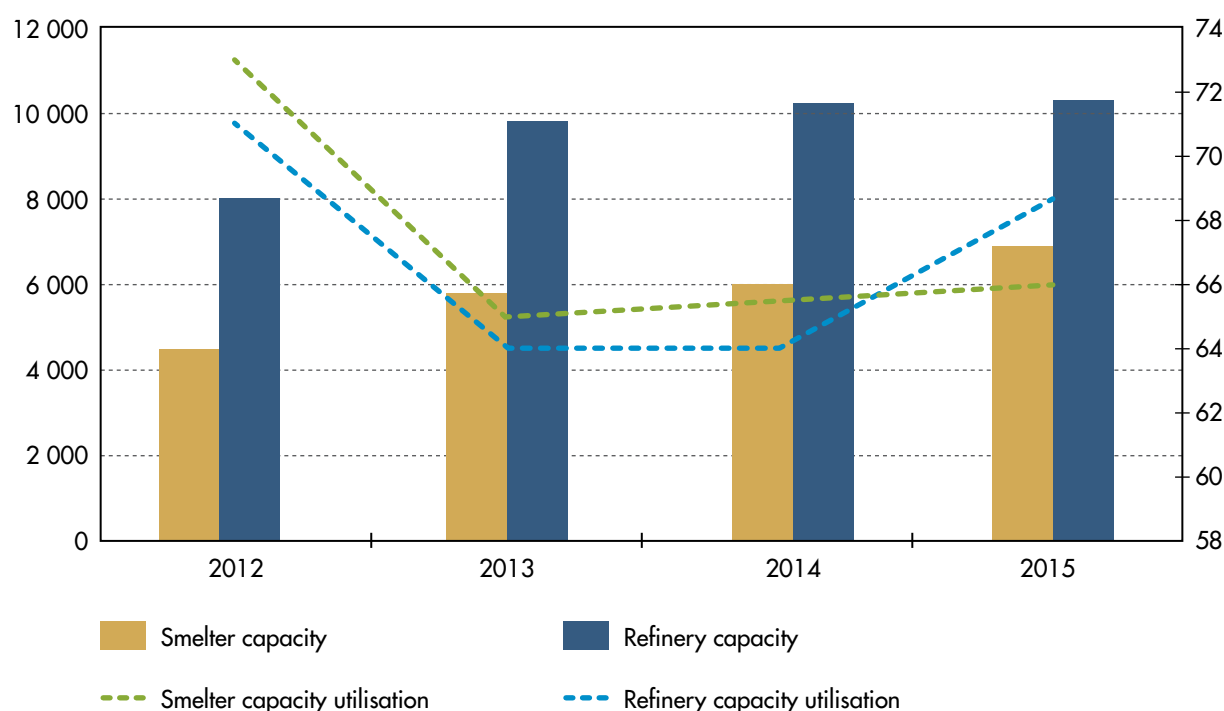
TRTC (%) = TCRC as % of Cu price

Source: Author's calculations based on *Indexmundi*, copper prices data, [indexmundi.com](http://www.indexmundi.com/commodities/?commodity=copper&months=120), <http://www.indexmundi.com/commodities/?commodity=copper&months=120>, accessed 20 January 2014; Wood Mackenzie Company

⁶⁵ It has been suggested that the Chinese over-capacity in base metal processing in the middle of the value chain stems directly from the 2009 stimulus package initiated by the Chinese government in the wake of the global economic crisis. While the stimulus package certainly provided even more financing for further expansion and therefore exacerbated the problem, the condition was pre-existing, at least in the case of copper, as over-capacity in the sector was observable from 2001 onwards.

Perhaps the most important commercial relationship is that between China's industrial policy and the commodity super-cycle that commenced in 2004.⁶⁶ For over 20 years China has been increasing its demand for copper, especially the concentrate used in its expanding industrial operations. Thanks to this growing domestic demand – as well as its policy of permitting the development of high levels of excess capacity in the processing sector in the middle of the copper value chain – the price of copper on the world market has increased. Thus China's policies have enriched the mining sector in source countries while resulting in a value chain where margins are so low that beneficiation becomes commercially unattractive. For Africa, China's industrial policies are a two-edged sword, enriching copper companies (and in the process state coffers, with mining revenues) while blocking the development of any African beneficiation in the base metal sector.

FIGURE 11 CHINA'S SMELTING AND REFINING CAPACITY FORECAST, 2012–2015



Source: Wang Z, 'Current Situation of China's Nonferrous Metals Industry and Development Trend', Beijing Antaike Information Development Co., UNCTAD (UN Conference on Trade and Development), Multi-Year Expert Meeting on Commodities and Development, 2013, http://unctad.org/meetings/en/Presentation/SUC_MYEM2013_20032013_Zhongkui%20WANG.pdf, accessed 20 January 2014

⁶⁶ See Farooki M & R Kaplinsky, *The Impact of China on Global Commodity Prices: The Global Reshaping of the Resource Sector*. London: Routledge, 2012.

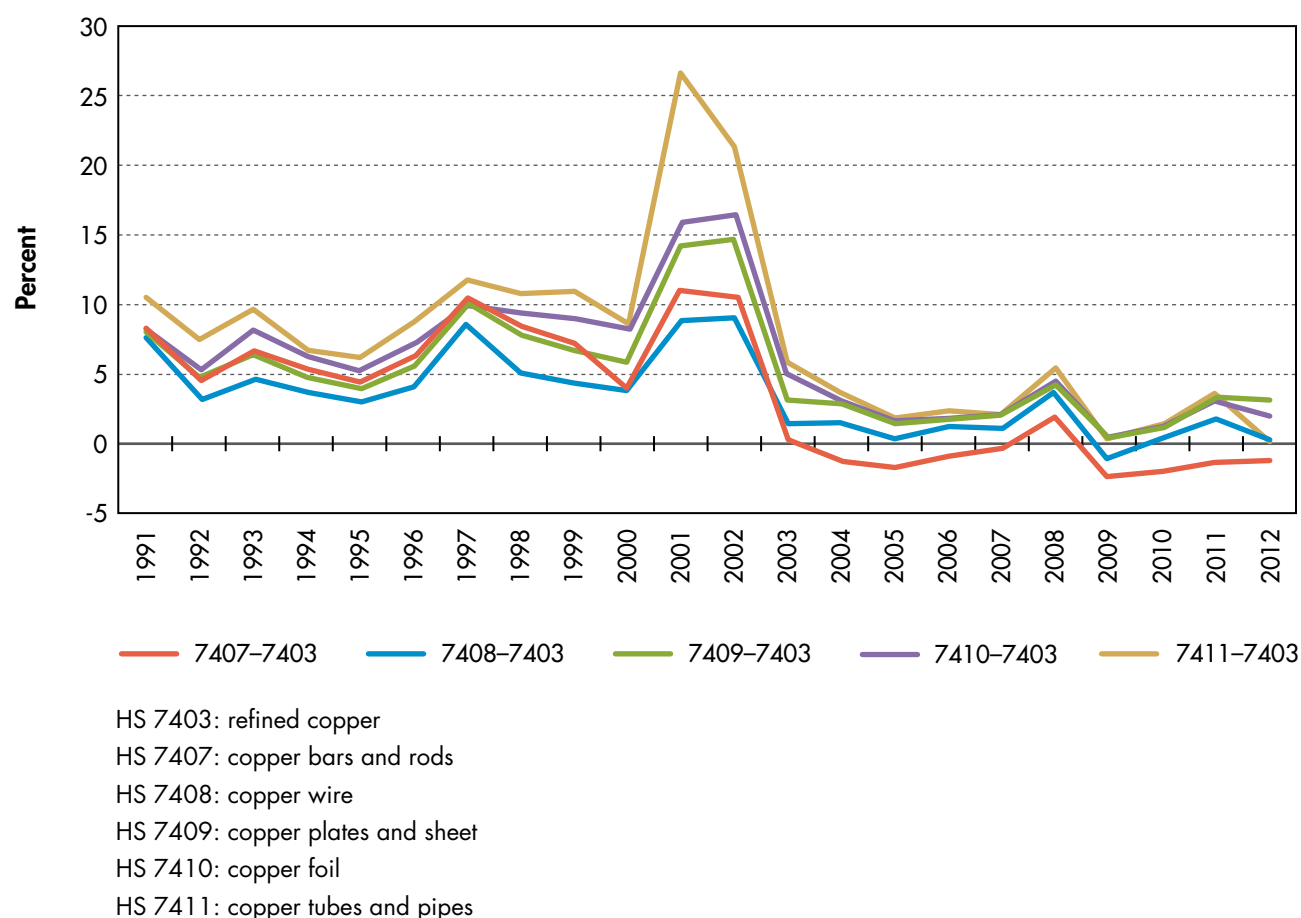
The decline in TRTCs over the last decade, as presented above, strongly correlates with the rapid increase in China's smelting and refining capacity. This continued addition of smelter and refining capacity in China, as its five-year plans have emphasised, has created excess smelter capacity world-wide, increasing the demand for concentrates to fill the smelters, which in turn gives miners more leverage in reducing TCRCs and eliminating the historical price participation feature of TCRC contracts.

Given the surging demand for copper and despite the efforts of the central government to rein in excess capacity, it continues to increase. As a result, the level of capacity utilisation is low, at between 64% and 66% of capacity in 2013.

DECLINING MARGINS IN THE PRODUCTION OF SEMI-FABRICATES

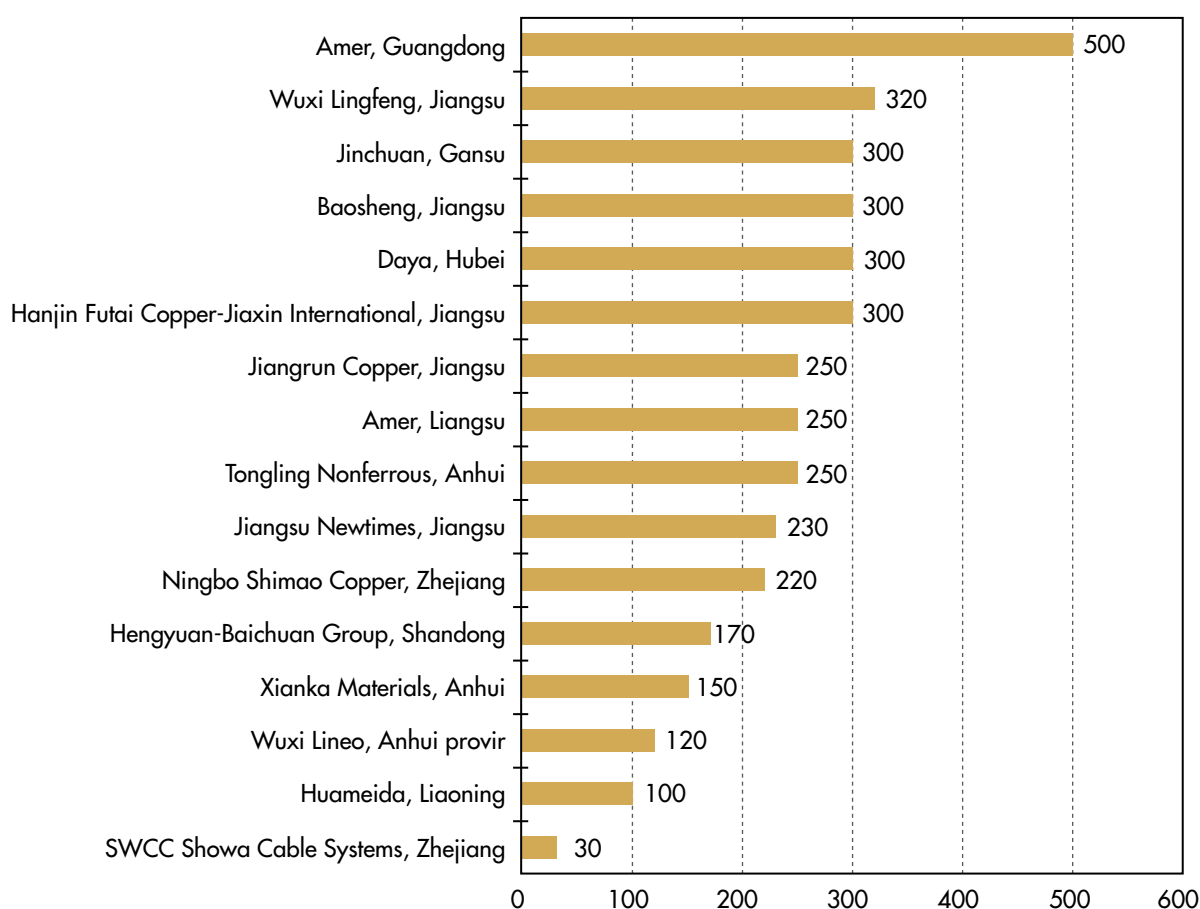
Not only has China grown rapidly in terms of its smelting and refining capacity but its production of copper semi-fabricates has also expanded in a way that has compressed margins at that point in the value chain. Whereas African copper producers have survived the compression of smelting and refining margins simply by virtue of the high cost of transporting the waste in concentrate to Chinese smelters, the expansion of copper production beyond cathode to higher value semi-fabricates has created a more serious problem. This is because the transport cost margin cannot be as readily arbitrated as with concentrate, blister or matte; ie, the net cost of a tonne of cathode from Zambia will be just as much as a tonne of fabricates, and therefore there is no transport cost advantage to production in Zambia. As a result, if there is a compression of margins in semi-fabricates, autonomous production further down the value chain from cathodes becomes less commercially feasible. When the margins are defined as the percentage difference between the unit export value of semi-fabricates and the unit export value of cathode, then the evidence of compression over time in all major semi-fabricate producers is clear. Figure 12 shows the secular decline in semi-fabricate margins received by Chinese exporters, and Annex 4 presents the same results for the other major semi-fabricate producers, ie, Chile, the US and Japan.

What is perhaps most striking is the dramatic compression of margins that occurred with the commodity boom in 2004. China's demand for base metals has been a huge plus for the mining sector in Africa, but its excess capacity up the value chain and compression of margins have simultaneously put an end, albeit temporarily, to hopes of beneficiation. This 'Great Compression' of margins should not be seen as accidental, a merely transitional product of state policy overshoot above equilibrium copper capacity, but rather as a direct product of Chinese policy to dominate the sector, lower prices and develop a commercial advantage for those industries using copper in further processing. Annex 4 shows that all the other major producers, forced by competitive market pressures, have followed suite.

FIGURE 12 CHINA: SEMI-FABRICATE MARGINS BY HS CLASSIFICATION (HS 7407–7411)

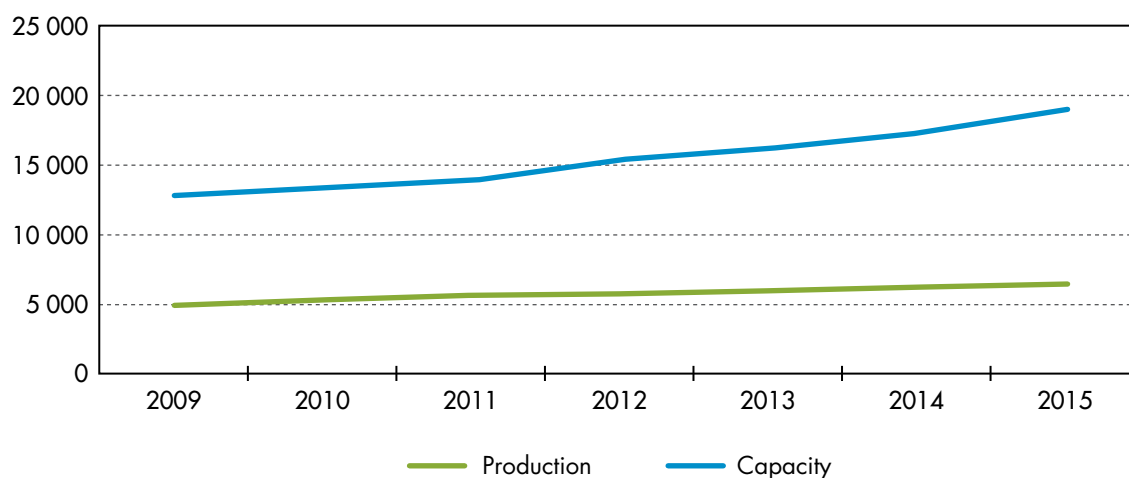
Source: Author's calculations based on Comtrade, 'China's copper imports and exports data at Hs 4-digit level', <http://comtrade.un.org/db/dqBasicQuery.aspx>, accessed 20 January 2014

There has been a secular compression of copper's trading and production margins at all stages of the production process, up to semi-fabricates. As has been noted, China's policy in the 12th Non-ferrous Metal Plan has been, at least nominally, to decrease excess capacity in the industry, yet this has not occurred. In fact, the data in Figure 13 indicates the exact opposite, namely that Chinese firms are purposely increasing capacity well beyond their production needs and what is outlined in the 12th Non-ferrous Metal Plan. Figure 13 shows the estimated future growth in copper wire rod capacity. These estimates were made in 2012 and based on 2011 output. If they are correct, China's wire rod capacity will be more than double national production by 2015.

FIGURE 13 NEW AND PLANNED WIRE ROD PLANTS PIPELINE, 2013–2014 CAPACITY KT

Source: ICSG, 'The role of recycling in feeding Chinese demand for copper', <http://www.eisourcebook.org/cms/July%202013/China,%20Role%20of%20Recycling%20in%20Feeding%20its%20Demand%20for%20Copper.pdf>, accessed 30 March 2014

Taking just the case of one, albeit important, semi-fabricate – wire rod – the internal Chinese projections on excess capacity demonstrate that, based on 2012 actual levels of excess capacity, this is set to increase. In 2009 excess capacity for wire rod was 40% and this is set to increase to 49% by 2015. This raises the question of whether these observations can be construed as either a systematic error by SOEs and planners or a conscious attempt by the government to assure investment growth and employment generation in the short term. Excess capacity also has an effect on margins, which assures the dominance of Chinese producers in the global copper market.

FIGURE 14 PRODUCTION (TO 2012) AND EXPECTED CAPACITY OF WIRE ROD IN CHINA TO 2015 (KT)

Source: Anonymous

THE NATURE OF CHINESE AND JAPANESE INDUSTRIAL POLICY IN THE BASE METAL SECTOR

It is not possible to view Chinese industrial policy in the base metal sector as a linear extrapolation of Japanese industrial programmes half a century earlier. There are several profound differences between the industrial policy pursued by Japan in the 1960s and 1970s and that of China in the 21st century. One of the most important is that Japanese planners did not have the power that state ownership provides, which has given Chinese planners the ability to increase production and capacity at will. This has to a certain extent allowed them to avoid issues of profitability. In addition, while they have only intervened, as in the case of the aluminium industry, when excess capacity threatened the commercial viability of the whole sector, this has not been the case generally. The power of the planners, as we have seen, has been asymmetric, with decreases in capacity being far more difficult to achieve than increases.

The most important difference is that when Japan embarked on its policies of base metal beneficiation it was with the specific objective of providing an immediate commercial advantage for its base metal end users. This could be readily achieved because at the time Japan was a classic small producer and could not affect the prices and margins in global base metal markets. This has not been the case with China over the last decade, as it has achieved global dominance and what it does domestically has global commercial implications. The massive excess capacity that China has developed has suppressed global and not just Chinese smelting and refining margins.

This in turn raises the following question: if the policy of copper beneficiation domestically has done little but suppress global prices and margins, how does it benefit

Chinese copper end users if they would be able to import the same product at the same price? In part this is the result of the short-term Chinese policy of banning copper cathode exports. In a situation of domestic excess supply this will create a commercial advantage for end users, as it should suppress prices to below global levels. However, in the longer term, with the growth of Chinese facilities into mega-smelters and refineries as envisaged in the 12th Non-Ferrous Metal Plan, the consolidation of firms should provide economies of scale that will further enhance China's domestic competitiveness. Yet this consolidation, so vital to providing a real long-term economic basis for its beneficiation programmes, has not occurred.

The failure to consolidate raises two fundamental questions regarding the conduct of industrial policy. First, why has China consistently failed to implement policies to rationalise its base metal sector? Second, can African countries pursue beneficiation in light of the effects of Chinese policy on margins? The answer to the first question goes well beyond the possible ambit of this report. Suffice it to say that China, unlike Japan 30 years before, is a relatively decentralised state and much of its industrial policy is conducted at the provincial level, where local interests and financial incentives allowing firms to expand appear more significant than national policy to do otherwise. In contrast, beneficiation in Africa, if it is conducted effectively with a broader industrial policy objective in mind, can deliver real outcomes. However, it is made all the more difficult because of China's massive excessive capacity in the base metal sector.

CHAPTER 4

SADC EXPERIENCE OF BASE METAL PROCESSING AND BENEFICIATION

This section considers the actual experience of beneficiation of four SADC countries, namely Mozambique, Namibia, Botswana and Zambia. Largely due to financial considerations, the analysis consists mostly of desk studies based on secondary data on Mozambique, Namibia and Zambia. For reasons of both cost and physical proximity, only the research on base metal processing in Botswana relies on more detailed primary sources. It is clear that without significant subvention the relatively modest efforts at beneficiation would either not have proceeded, as in the case of Botswana, or proceeded only on the back of very low electricity prices and tax-free status, as in the case of Mozambique and Namibia.

THE MOZAL PROJECT – MOZAMBIQUE’S PYRRHIC DIVERSIFICATION?

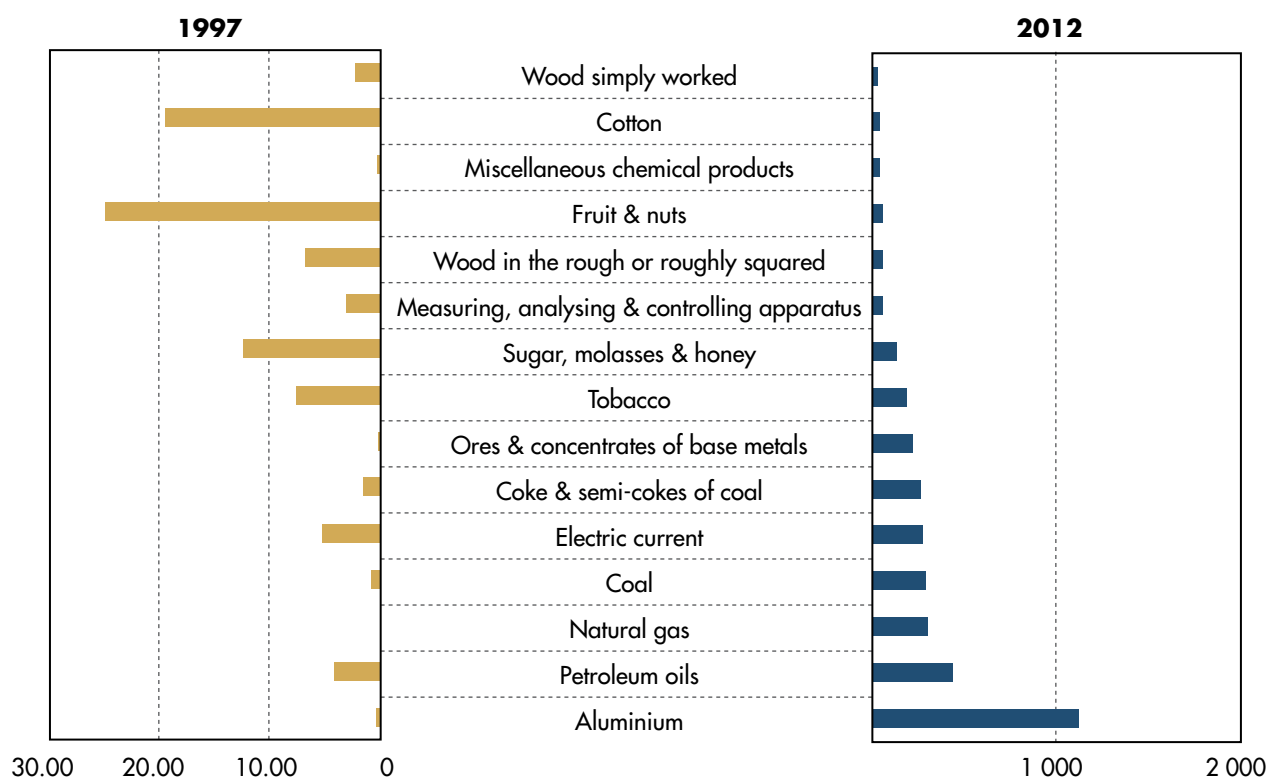
Mozambique is a large least-developed country that has only recently emerged from a generation of internal conflict. From the perspective of industrial policy and diversification of exports, Mozambique is the rarest of cases in Africa: a country that has successfully transformed and diversified its export base from that of a mono-crop agricultural producer of cashew nuts to an exporter of manufactured products. That experience is highly significant and points to the price that countries pay to make the transformation, and the range of measures necessary to assure that the diversification is both meaningful and integrated with the rest of the economy. However, Mozambique paid a high price to change its export base and while the shift is sustainable, the aluminium sector remains disconnected from the rest of the economy.

There has been extensive academic discussion of and literature on Mozambique’s transformation from agricultural producer to aluminium exporter.⁶⁷ In 2011 some 42% of Mozambique’s total exports were aluminium. No other country in the SADC region, apart from South Africa, can claim to have such a high level of exports of processed products. Thus, at least nominally, a country that, following the end of the civil war in 1993, was principally an exporter of cashew nuts has shifted its export base towards manufactured aluminium and subsequently to mining and energy exports. This shift to mega-projects in the mining and energy sector is a direct result of the impact that Mozambique Aluminium (Mozal) has had on global perceptions of Mozambique as a location for investment in

67 See Altenburg T, ‘Industrial Policy in Developing Countries: Overview and Lessons from Seven Country Cases’, DIE (German Development Institute) Discussion Paper, 4/2011. Bonn: DIE, 2011; Krause M & F Kaufmann, ‘Industrial Policy in Mozambique’, DIE Discussion Paper, 10/2011. Bonn: DIE, 2011; Sonne-Schmidt C, Arndt C & M Magaua, ‘Contribution of Mega-Projects to GDP in Mozambique’, II Conference of IESE ‘Dinâmicas da Pobreza e Padrões de Acumulação Económica em Moçambique’, 2009.

Africa. This should make it a showcase for diversification in Africa, but the Mozal project remains among the most controversial industrial projects in Africa.

FIGURE 15 COMPOSITION OF MOZAMBICAN EXPORTS, 1997 AND 2012 (\$ THOUSANDS)



Source: Comtrade, Mozambique's exports values, <http://comtrade.un.org/db/dqBasicQuery.aspx>, accessed 22 February 2014

In 1997 the government of Mozambique negotiated an agreement for the establishment of an aluminium smelter. The total investment in the Mozal project was approximately \$2.4 billion and the smelter employs 1 100 workers. The investment included not only the facility but also the upgrading of infrastructure. The initial ownership structure of Mozal was BHP-Billiton (66%), the South African Industrial Development Corporation (IDC, 20%), Mitsubishi (12%) and the government of Mozambique (2%). The agreement involved BHP-Billiton, other companies such as Mitsubishi and IDC, the government of South Africa and the International Finance Corporation (IFC).

There were a number of reasons why BHP in particular had sought to develop a smelter near Maputo, according to Kraus and Kaufman:⁶⁸

[T]he investors had a high preference for building the aluminium smelter near Maputo – not because of any comparative advantages or tax incentives that Mozambique had to offer, but rather due to the South African mineral-energy-complex's strategic interests: first, BHP-Billiton wanted to avoid having a competitor – Kaiser had first approached the GOM [government of Mozambique] with plans to build an aluminium smelter – succeed in expanding its production, so BHP-Billiton pursued an aggressive investment strategy; second, the South African electricity utility, Eskom, was very keen to provide the energy for the smelter and, by interlinking its grid with the Mozambican grid, to establish itself as a player in the Mozambican electricity market. The Government of South Africa supported this strategy by offering an attractive incentive package to MOZAL that included cheap electricity tariffs through Eskom, which is Government-owned.

The concessions offered by the Mozambican government included a 50-year tax holiday, whereby BHP would pay only 1% turnover tax. The other motivation, as indicated above, was the price of electricity. Eskom received direct current electricity from Cahora Bassa Dam and then resold alternating current electricity to Mozal. Mozambique remains a net exporter of electricity, principally to South Africa, and it is reported that the price of electricity paid by BHP at Mozal was set at approximately \$0.02/kWh until the renegotiation in 2010. This was following the electricity crisis that occurred in South Africa in 2008. Given that some 60% of the cost of aluminium is normally the electricity used in refining, the choice of location for refining is ultimately dependent upon the availability of cheap reliable energy. Thus while the contractual arrangement is between BHP and Eskom, the supply of electricity in net terms is from Mozambique. As noted above, the Mozal project integrated Mozambique's hydro-generating capacity into the South African grid and the Southern African Power Pool.

The export data and a large number of comprehensive studies demonstrate that, first, Mozambique has diversified its exports and second, Mozambique paid a heavy price in terms of revenues foregone in order to come to an agreement with BHP-Billiton. Mozambique has certainly considered its options to increase revenues from Mozal.⁶⁹ However, from an industrial policy standpoint the most interesting lesson is not the development of the Mozal refinery per se but rather what followed its construction and establishment. The government of Mozambique and the donor community, which had driven the project, attempted over a protracted period to develop backward linkages to the rest of the economy. In the final analysis, the IFC had advised the government on the terms of the agreement. These terms have been severely criticised by many economists as

68 Krause M & F Kaufmann, *op. cit.*, p. 53.

69 See Bucuane A & P Mulder, 'Fiscal Policy and Tax Incidence: Exploring an Electricity Tax on Mega Projects in Mozambique', Mozambique, National Directorate of Studies and Policy Analysis, Ministry of Planning and Development Discussion Paper, 39E, 2007, Chapter 17.

being unnecessary in order to close the deal with BHP Billiton.⁷⁰ The ultimate judgement on the success of the project will rest on whether the diversification of Mozambique's export base was a pyrrhic or numerical transformation or whether it had any significant effect on the rest of the economy.

To their credit, the proponents of Mozal and international financial institutions (IFIs) such as the IFC at least instituted a long-term programme to attempt to develop the capacity of small and medium enterprises (SMEs) to supply Mozal. There were three separate donor-driven attempts to develop linkages between SMEs and Mozal, all of which were more or less unsuccessful.⁷¹

SMALL MEDIUM ENTERPRISES LINKAGE PROGRAMME (SMELP) 2001

This programme was initially developed by the government of Mozambique and implemented by Mozal, the Centro de Integridade Pública and the IFC. The aim was to help local firms develop the capacity to win contracts during the construction phase of Mozal II. Significantly, in a scoping study prior to the commencement of the linkages work, it was found that of the 370 firms screened to participate in the programme '99% had serious problems with product quality, 95% did not have the required profile, experience and portfolio of projects, 92% operated with worn-out and out-dated equipment, [and] 90% suffered from serious management deficiencies and inadequate financial structure and capabilities'.⁷² The contracts offered by Mozal were simply too large for local firms to handle. All these problems are familiar to the private sector in less developed countries, especially in ones that had experienced serious armed conflict.

SMELP was essentially aimed at unbundling the large Mozal construction contracts so they could be taken on by small local firms. There was a reformulation of standards in order to allow local firms to compete and access information. Under SMELP 16 SMEs were trained and awarded 28 contracts worth more than \$5 million (the construction of Mozal cost \$2.4 billion).

MOZLINK I

The Mozlink I project was established to replicate the work of SMELP, but based on supplying the smelter's operations rather than its construction stage. The project not only developed the capacity of SMEs directly but also addressed other, related concerns of

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- 70 See Castel-Branco CN, 'Aid Dependency and Development: A Question of Ownership? A Critical Review', IESE (Institute of Social and Economic Studies) Working Paper, 01/2008. Maputo: IESE, 2008, http://www.iese.ac.mz/lib/cncb/MOZAL_and_economic_development.pdf, accessed 15 May 2012; Sonne-Schmidt C, Arndt C & M Magaua, *op. cit.*
- 71 The description of the programmes developed by the international community to establish linkages with Mozal draws heavily on the description in Krause M & F Kaufmann, *op. cit.*
- 72 Castel-Branco CN & N Goldin, 'Impacts of the Mozal Aluminium Smelter on the Mozambican Economy', IESE, Final Report. Maputo: IESE, 2003.

firms trying to supply the company. It also developed consulting capacity to assist SMEs. Under Mozlink I 'annual local purchasing from Mozlink affiliated companies rose from \$5 million in 2001 to \$13 million in 2005'.⁷³ Mozal has total annual local purchases of \$180 million, of which \$96 million is electricity and water.⁷⁴ Total aluminium exports were \$1.45 billion in 2008.

MOZLINK II

Mozlink II continued the work of Mozlink I but included large transnational firms such as Coca Cola, Sasol (gas) and Cervejas de Mocambique. Including firms that were already capable of supplying Mozal certainly improved the results of the project. In the end the SMEs that benefited from the various linkages programmes were confined to a limited range of services, including metallurgical services, transport, auto-mechanical services, construction, electrical products, catering, security and laundry.⁷⁵ At the end of the project in 2005 a 660ha industrial park enjoying tax-free zone status was established at the edge of the Mozal facility to help create a cluster associated with the smelter. Perhaps the most obvious criticism of the project is that there was no attempt to develop forward linkages. The argument has been made that Mozambican firms had no experience with working with aluminium and as a result downstream processing had no technological base. While this is an important factor, these are skills that can be developed and the advantages of being located close to an aluminium refinery would create logistical and other commercial benefits for aluminium processors. However, any such downstream activity would have to be associated with an appropriate industrial policy to develop those skills and provide financial incentives for firms to locate in Mozambique. Botswana exports aluminium boats to Mozambique but has no capacity to produce aluminium, which it imports at considerable cost from South Africa. This is a result of a local firm developing the capacity to process aluminium. In the case of Mozambique, forward processing could only be achieved within the context of a comprehensive industrial policy that facilitated investment and addressed domestic constraints. Such an approach to industrial policy cannot be donor driven but must ultimately emanate from national elites, as it did in East Asia. There the national elites were willing to accept both the criticisms from the donor community that such an approach attracted and the attendant costs and risk of failure.

In the final analysis, Mozambique had a \$2.4 billion investment that transformed and diversified its economy. It created approximately 1 100 jobs directly, and an additional 2 500 jobs were created through the linkages that were established. However, only 10% of Mozal's revenues stay in Mozambique. Castel-Branco⁷⁶ concludes that 'while Mozal's contribution to Mozambique's economy is important and it makes an important

73 Jaspers F & I Mehta, 'Developing SMEs through Business Linkages: The Mozlink Experience'. Washington DC: IFC (International Finance Corporation), 2008.

74 Macamo A, 'Characteristics of the Most Successful Supplier Development and Linkages Programmes: The Case of Mozambique', UNCTAD (UN Conference on Trade and Development), 18/19 October 2007.

75 *Ibid.*, p.63.

76 Castel-Branco CN, 2008, *op. cit.*

contribution to Mozambique's GDP, its impact is limited. The result is an isolated economic enclave that uses large quantities of scarce resources without returning revenue to the state.

Mozambique and Mauritius are the only countries in SADC that have since independence radically transformed their export base. In the case of Mozambique, this has occurred at a high cost in terms of revenue foregone to the state through concessions to BHP-Billiton and the sale of electricity to South Africa. However, the success of Mozal has allowed Mozambique to communicate to the rest of the world that it is open for business. It also has pushed Mozambique onto a particular mining and energy and intensive development path.

Should the Mozambique experience with Mozal simply be written off as a failure – a pyrrhic diversification – or has more been achieved? The government of Mozambique had multiple objectives in agreeing to the Mozal project. It created jobs and an entirely new export sector, but it remains almost exclusively a classic economic enclave with only the most limited backward linkages and, by design, no forward linkages whatsoever. This outcome, ie, the lack of backward linkages, is a direct result of the international community's policy, as discussed above.

In terms of foreign investment, following its bitter liberation struggle and civil war Mozambique was seen, to the extent that it was seen at all, as a toxic location with very limited prospects for investment. Mozal is a signal to the international investment community that the country is 'open for business', and in that sense it has proven to be a successful branding exercise. Many of the mining and resource sector investments that followed in the wake of Mozal were in part a result of the government's being able to show that a company the size of BHP-Billiton viewed location of the country as an acceptable location for a multi-billion dollar fixed capital investment. The government of Mozambique paid too high a price for the branding benefits that emanated from the BHP-Billiton investment, but that is clear only in hindsight. The lasting impact of the Mozal project was to shift Mozambique onto a new development path based on mega-projects in the mining and energy sector, and no doubt this will be among the largest part of its legacy.

NAMIBIAN BASE METAL PROCESSING AND BENEFICIATION – SEARCHING FOR A COMMERCIAL ADVANTAGE

One of the most important areas of economic diversification in Namibia has been the processing and refining of base metals, including zinc and copper. Namibia has smelted copper to the stage of blister, ie, just prior to refined copper cathode. As in other countries, base metal beneficiation in Namibia is a product of government policy to create local employment and domestic value added. Namibia has two base metal smelters/refiners. One is at the Skorpion mine, Namzinc, which smelts and refines zinc from the mine, and the other is in the north-west of Namibia – the Namibian Custom Smelter (NCS) at Tsumeb, which smelts some local but mostly imported copper concentrate. In many ways the Tsumeb smelter, like the Mozal refinery in Mozambique, attempts to process base metals by capitalising on Namibia's need for employment and the unique historical circumstances that gave rise to this project. Tsumeb is unique in Southern Africa as it is

the only copper smelter that regularly imports concentrate, which is the exact opposite of the experience of most SADC countries.

NAMIBIAN CUSTOM SMELTER – TSUMEB

This production facility smelts, but does not refine, copper concentrate from local mines, and imports large volumes of concentrate from Bulgaria. It is the only African producer that is a smelter of choice for European and potentially other producers, which reflects Namibia's willingness to accept health risks considered unacceptable elsewhere. According to its Canadian owner Dundee Precious Metals, the smelter is meant to process up to 240 000 tonnes of 'complex' imported copper concentrate when expansion is complete. The US Geological Survey estimates that Dundee processed 30 000 tonnes of copper blister (98.5% Cu) in 2010. This blister was then shipped to Europe for refining to cathode. The facility employs approximately 800 workers and is accorded export processing zone (EPZ) status, which means it pays no taxes. Tsumeb is located some 700km from the port at Walvis Bay. The concentrate is thus shipped from Bulgaria to the middle of the Namib Desert for smelting. Given the availability of copper smelters in Europe and North America, this is an unusual and expensive arrangement.

The smelter was originally built by Newmont mining in 1961–62 to process local 'complex' copper. The smelter had an integrated facility to produce refined copper and lead from similarly 'complex' copper concentrate found in the area. It also had smaller facilities that produced arsenic and cadmium as by-products. It had several owners, including Goldfields, which went bankrupt in 1998, and the company was taken over by Weatherly Mining International in 2006. In December 2008 Weatherly suspended all mining operations because of a major decline in the world copper price associated with the global economic crisis and only kept the Tsumeb smelter going. The Tsumeb smelter was converted to a toll smelter at the beginning of 2009. In March 2010, Weatherly sold the smelter to Dundee for NAD⁷⁷ 33 million (about \$4.4 million) in cash and shares, with Weatherly retaining all mining assets.

The plant is old and was taken over by Dundee in order to assure that it had access to a smelter able to deal with its 'complex' concentrate from Bulgaria. The smelter is one of few in the world that can treat arsenic- and lead-bearing concentrates. The Chelopech mine in Bulgaria is one of the largest elements in Dundee's investment portfolio, and therefore the acquisition of the Namibian smelter was essential to assure offtake from the Bulgarian deposit. The need for acquisition stems from the decision of the Bulgarian government to halt the copper processing, which was felt to have a serious health and environmental impact on the local workforce and population.⁷⁸

Prior to 1990, the Pirdop smelter, located seven kilometers east of Chelopech, accepted the

⁷⁷ Currency code for the Namibian dollar.

⁷⁸ Dundee Precious Metals, 'Chelopech Mine, Bulgaria: Overview', <http://www.dundeeprecious.com/English/operations/producing-mines/Chelopech/overview/default.aspx>, accessed 22 March 2012.

sulphide-rich concentrates from Chelopech and blended them with cupriferous concentrates from the nearby Elatsite Med and Assarel Medet mines. *The relatively high content of arsenic in the Chelopech copper concentrates led to the Bulgarian Government decreeing on April 1, 1990 that Chelopech concentrate could no longer be treated at the Pirdop smelter.* [emphasis added]

The Namibian government agreed to grant EPZ or tax-free status to Dundee's investment in the smelter. It also agreed to a legal limitation on historic liability from the tailings and smelter waste.⁷⁹ The smelter transfers an industrial process to Namibia that is no longer acceptable in Europe for health reasons, with all the attendant risks to workers and public health that this entails. In 2011 concerns over the health impact on workers and residents in the Tsumeb area posed by arsenic and sulphur dioxide emissions from the smelting process resulted in the government commissioning a report on the health and environmental consequences of the facility. The report is not in the public domain, but following the report NCS reported in a press release that:⁸⁰

The Namibian Minister of Environment and Tourism ('MET') has issued a letter to the Company relating to the operation of its Tsumeb smelter, owned and operated by its subsidiary, Namibia Custom Smelters (Pty) Limited ('NCS') ... Effective May 1, 2012, the MET has instructed NCS to reduce feed to the smelter by approximately half until the projects designed to capture fugitive emissions have been completed. These projects, which form part of NCS' Project 2012 currently underway, will be completed in the second half of the year ... In the interim, NCS will work to bring forward the particular components of Project 2012 that specifically address fugitive emissions ... In addition, the Minister has advised NCS to bring forward the installation of the sulphuric acid plant from 2014 to 2013. On its own initiative, NCS has started work on expediting the acid plant and determined that the fastest schedule possible, from the start of engineering to construction completion, is 26 months.

The plant at Tsumeb is a product of the colonial period, when health impacts on African workers and the local population were not a major policy consideration of the South African government, which administered South West Africa. However, given that Dundee had clearly indicated the Bulgarian government's objections on its own site, the Namibian government must have been aware that there was a ban on further processing the high arsenic copper concentrate in Bulgaria, and that Dundee could not readily conclude an offtake agreement for the concentrate given the attendant health risks. It granted Dundee EPZ status and in effect subsidised the company to renovate and expand operations at the NCS smelter at Tsumeb. The negotiations occurred when Weatherly was on the verge of closure at the height of the global economic crisis and hence the government was concerned about the loss of employment in the Tsumeb area.

79 Dundee Precious Metals, 'Namibia custom smelters', http://www.dundeeprecious.com/Theme/Dundee/files/Analysts%20Presentation%20NCS%20Nov10_web.pdf, accessed 22 March 2012.

80 Dundee Precious Metals, 'Dundee Precious Metals Receives First Contact from Namibian Government on Tsumeb Smelter Audit', 30 April 2012, <http://www.dundeeprecious.com/English/news-and-events/news-releases/NewsDetails/2012/Dundee-Precious-Metals-Receives-First-Contact-from-Namibian-Government-on-Tsumeb-Smelter-Audit1129195/default.aspx>, accessed 15 June 2012.

NAMZINC REFINERY

A less contentious example of the use of industrial policy in Namibia in mineral beneficiation has been refined zinc production at Vedanta Resources PLC's Skorpion mine and Namzinc refinery in south-west Namibia. Zinc is Namibia's third most valuable mineral export after diamonds and uranium. Production was 151 688 tonnes of 99.9% purity zinc metal in 2010, slightly below the previous year's 153 815 tonnes. This decrease in production was the result of load-shedding and equipment failures.⁸¹ The Skorpion zinc refinery was originally developed by Anglo American, which sold the facilities to Vedanta.⁸² The smelting and refining of zinc is, like aluminium, very energy intensive and it is estimated that energy costs make up approximately 50% of total costs.⁸³ A sizeable portion of Namibia's zinc production also came from the nearby Rosh Pinah mine, previously owned by Xstrata, which sent zinc concentrate for processing to facilities in South Africa.

The government provided assistance for the establishment of the zinc refinery when it was originally started in 2004. The refinery is one of the EPZ facilities operating in Namibia, which means that it pays no company tax. The government also provided other forms of unspecified industrial support for the refinery's financing. One important benefit has been that Skorpion has been able to purchase electricity directly from Eskom in South Africa. Electricity (and coking coal) costs are estimated to constitute roughly 50% of the cost of producing zinc and therefore having direct access to the Eskom grid provided the company with what was the cheapest electricity for processing in the world.⁸⁴ Skorpion benefited from the same kind of pricing agreement as Eskom had given the Mozal facility

81 *Mining Journal*, 'Namibia: A mineral cornucopia', 30 September 2011, http://www.mining-journal.com/reports/namibia-a-mineral-cornucopia?SQ_DESIGN_NAME=print_friendly, accessed 20 March 2012.

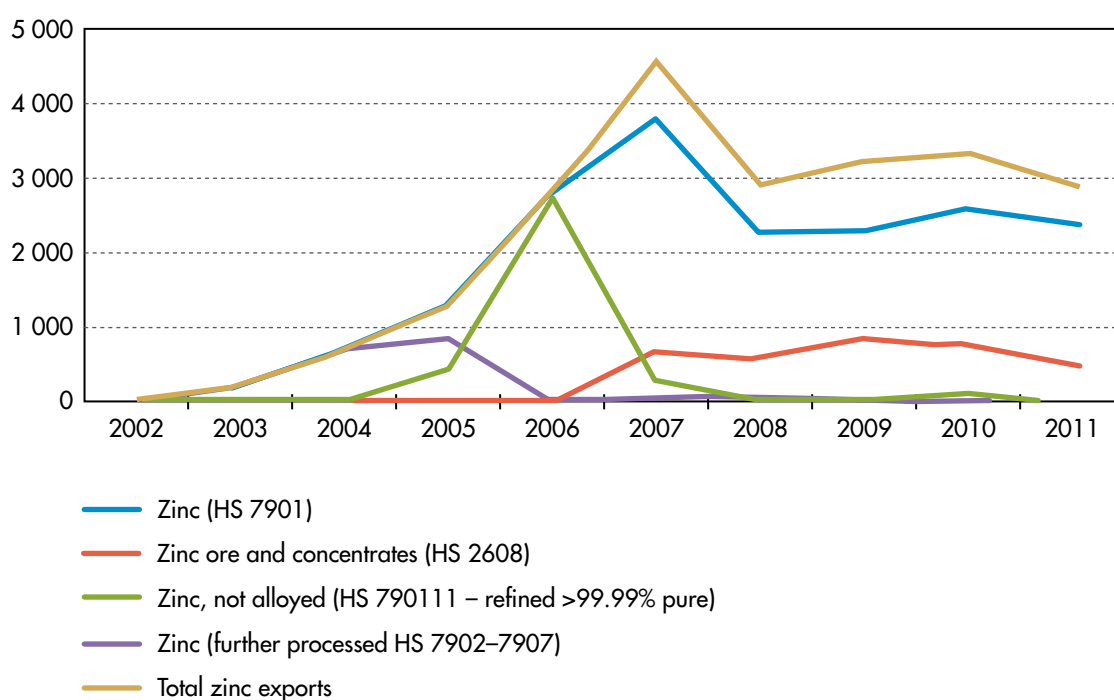
82 Mining-Technology.com, 'Skorpion zinc mine, Namibia', <http://www.mining-technology.com/projects/skorpion/>, accessed 24 March 2012.

83 Anderson J, 'The Economic Challenges of Zinc Smelting', Wood Mackenzie presentation, http://www.woodmacresearch.com/content/portal/energy/highlights/wk2__11/Zinc%20Smelting%20%20Economics%20for%20ILZSG.pdf, accessed 23 March 2012. At inauguration the project was reported to have an installed electricity capacity of 120MVA [market value added], which raised the total energy consumption of Namibia by 25%.

84 The US Geological Survey estimates a range of 3 000 to 5 000kWh/t of zinc metal is recovered using the electro refining process. The electrolytic zinc process is used for approximately 90% of the world's primary zinc production from concentrate. Zinc refining in Africa requires about 3 000–3 500kWh/t of concentrate. Bleiwas DI, *Estimates of Electricity Requirements for the Recovery of Mineral Commodities, with Examples Applied to Sub-Saharan Africa*, 2011, p. 99, <http://pubs.usgs.gov/of/2011/1253/report/OF11-1253.pdf>, accessed 16 January 2014.

in Mozambique, whereby prices were set at approximately \$0.02 per kWh.⁸⁵ The Eskom tariff was renegotiated in 2011.

FIGURE 16 ZINC AND FURTHER PROCESSED ZINC EXPORTS FROM NAMIBIA (NS MILLIONS)



NB: No data was available for zinc ore and concentrate (HS 2608) exports from 2002–2004

Source: Authors' calculations based on Namibia Statistics Agency, Zinc export data, 2014, <http://nsa.org.na/page/prices-and-trade-statistics>, accessed 27 July 2015

85 *Metal Bulletin*, 'Eskom will renegotiate power deal with Skorpion zinc mine', 3 June 2010, <http://www.metalbulletin.com/Article/2584133/Eskom-will-renegotiate-power-deal-with-Skorpion-zinc-mine.html>, accessed 4 May 2012. 'Skorpion directly imports 90MW of electricity from Eskom, or 0.2% of its total power generation. This equates to around 25% of the entire generation capacity of Namibian power utility Nampower. Eskom has been supplying Skorpion at a tariff below the cost of production after being locked into long-term contracts, MB understands. Skorpion, which has a supply agreement that expires in 2017, has benefited from rates of 43–50% lower than ordinary South African customers over the past decade.'

The evidence publicly available suggests that the Namzinc refinery has been highly profitable, as the ore is very high grade, at 11.6% head grade zinc.⁸⁶ The mine's initial capital cost outlay was slightly over \$450 million. However, from Figure 16, if the objective of the government was to encourage further processing of zinc products, the Central Statistics Office's data suggests that the process of beneficiation has not been successful with further processed zinc products (ie, HS 7905). A total of 97% of exports in the period 2002–2004 were further processed products, ie, zinc plates, bars and foil, while lower-purity zinc, concentrate and ores were a tiny fraction of exports. By 2011, however, the situation had been reversed and concentrate exports, together with lower-purity zinc (ie, <99.9%), constituted 99.3% of Namibia's total zinc exports.

A vital lesson on economic diversification for all African countries is that considerable prudence is needed in project selection when it comes to downstream processing. Diversification from unprocessed base metal production to that of refined product must ultimately depend on there being a commercial advantage for the company (Namibia is by no means an obvious location choice for such activities). However, it is not necessarily apparent that diversification through downstream processing is commercially impossible, as downstream processing rests on removing waste that would otherwise be transported to a distant location. Certainly, host countries cannot expect to be chosen as a location for that processing if there are no commercial advantages. Both Tsumeb and Namzinc were granted the normal range of commercial advantages, ie, tax-free status in the Namibian EPZ scheme. Namzinc was provided with a further advantage, namely electricity at prices close to those paid by Mozal, and Tsumeb was permitted to undertake processing that was prohibited in Europe for health and environmental reasons. It is these extra benefits that tip the balance in favour of what are otherwise remote and unfavourable locations.

Significantly, there is a possible market niche in SADC for processing high-risk ores and concentrates. However, it is doubtful that most governments would wish to publicly move in this direction. Another possibility is for African countries to attempt to develop in parallel with Chinese policies, which would see more of the energy-intensive activities in the base metal value chain – such as refining and the production of alloys and semi-fabricates – locate production facilities in Africa. Otherwise remote locations unable to attract investment could thus become centres for beneficiation, but this could only be effected as part of a comprehensive industrial policy. Namzinc offers a more prudent direction for the development of commercial advantage. Low electricity prices, which would give investors in high-energy downstream base metal processing a commercial advantage, are central to the development of the industry.

BOTSWANA'S EXPERIENCE WITH NICKEL AND COPPER BENEFICIATION

The experience of Botswana also provides invaluable lessons for any future strategy for the beneficiation of base metals in the SADC region. Botswana has beneficiated its copper and nickel to the level of matte, rather than exporting concentrate. Despite attempts to do

86 *Ibid.*

so, it has not progressed further up the value chain. Bamangwato Concessions Limited's (BCL) experience offers many important lessons on the management of large mining and smelting projects. Having witnessed the prosperity that large-scale copper mining projects brought to neighbouring Zambia during the high base metal price period (during the Vietnam War), Botswana embarked on a massive greenfield project to develop a local copper/nickel industry.

BAMANGWATO CONCESSIONS LIMITED

In 1959 the Botswana RST (Roan Selection Trust from the-then Rhodesia) signed an agreement to explore for minerals on Ngwato tribal lands with the then-Ngwato Kgosi Seretse Khama.⁸⁷ By 1966 BCL had identified two major ore bodies at Selebi and Phikwe. The total ores were estimated at 45 million tonnes of proven and probable ore with an average nickel content of 1.2% and an average copper content of 1.3%.⁸⁸ At the feasibility stage the project was expected to have a 22-year mine life, which was considered to be adequate for the development of a major mining project. After almost 40 years of copper and nickel mining in Selebi-Phikwe the reserves are physically larger than was thought at the feasibility study stage, although grades are significantly lower.⁸⁹

Under the provisions of the Mines and Minerals Act of 1977 the Botswana government was entitled to 15% equity in any mining venture in the country gratis, and it exercised this right.⁹⁰ In Botswana's early mining history the government chose to exercise that option with both diamonds and copper, with vastly different financial results. While the equity position taken by the government in Debswana (50%) and eventually in De Beers (15%) has proven very lucrative, the investment in the development of BCL has had negative financial returns.

The BCL copper-nickel project was at the time the largest in the history of the country and involved substantial injections of capital to develop both the infrastructure and the mine. Botswana's GDP was BWP⁹¹ 103 million (\$144 million) in 1971/72, while investment

87 This agreement predates the independence of Botswana, and under the constitution all mineral rights were vested in the state.

88 Lewis SR, 'The impact of the Shashe project on Botswana's economy', in Harvey C (ed.), *Papers on the Economy of Botswana*. London: Heineman, 1981.

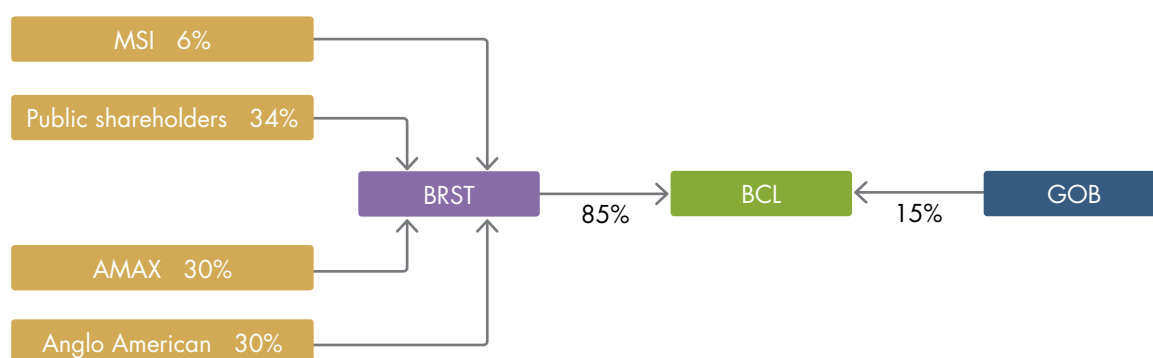
89 BCL completed a South African Mineral Resource Committee-compatible mineral resource estimate in 2011. The resource is clearly of lower quality than at the beginning of the project but well above the Ni cut-off of 0.3%. The official 2001 reserves are 54 million tonnes of ore with a grade of 0.61% Ni and 0.68% Cu. See BCL, 'BLC summary by source', 31 June 2011, <http://www.bcl.bw/assets/files/BCL%20Summary%20Resources%20&%20Reserves%20as%20at%20June%2031%202011.pdf>, accessed 10 January 2014.

90 These provisions of free equity were revised and subsequently removed under the terms of the Mines and Minerals Act of 1999.

91 Currency code for the Botswana pula.

in BCL's infrastructure and the mining project was BWP 162 million (\$226 million).⁹² The equity distribution of BCL's ownership was initially 15% to the government of Botswana and 85% to Botswana RST, which was owned largely by Amax and Anglo American (see Figure 17). However, soon after the first and second restructuring of BCL in the late 1970s and 1980s it became clear that the firm was unlikely to ever earn a net profit, although it continually generated an operating profit.⁹³ By 1993 AMAX sold its share, and in 2000 Anglo American sold its share of the project to LionOre for BWP1 (\$0.196). The company was in effect taken over by the Botswana government, with 6% belonging to LionOre. This 6% share was eventually bought by Norilsk in 2007 when it sought to acquire the Tati Nickel mine.

FIGURE 17 THE OWNERSHIP STRUCTURE OF BCL (CIRCA 1978)



Source: Salkin J & O Achieng, 'Benefits Streams Management: A Case of the BCL Copper-Nickel Mine in Selibe Phikwe', BIDPA (Botswana Institute for Development Policy Analysis), 2004

92 See Tibone MC, 'The Shashe nickel-copper project', in Oomen MA, Inganji FK & LD Ngcongco (eds.), *Botswana's Economy Since Independence*. New Delhi: Tata McGraw Hill, 1983, p. 242.

93 An operating profit is a profit from business operations (gross profit minus operating expenses) before the deduction of interest and taxes, whereas a profit is a financial benefit that is realised when the amount of revenue gained from a business activity exceeds the expenses, costs and taxes needed to sustain the activity. Any profit that is gained goes to the business's owners, who may or may not decide to spend it on the business.

In order to develop a greenfields project, the infrastructure cost BWP 55.1 million, which was funded by loans from Canada (CAD⁹⁴ 30 million, which was converted into a grant),⁹⁵ the US (a 40-year loan at 2–3%) and the World Bank (25 years at 7.25%). The mine and smelter cost BWP 102 million, with BWP 32 million in the form of equity from various shareholders, a Deutschmark-denominated loan (DEM⁹⁶ 222 million) from the German government and Anglo Amax (\$8.9 million), and BWP 13.5 million from the South African government through the IDC. However, by far the largest single subvention provided to BCL was from the revised Southern African Customs Union (SACU) revenue-sharing formula, which had seen small and declining payments due to a formula based on the share of total imports. With the massive surge in imports that occurred during the BCL construction phase from 1972–76, the contribution of BCL imports to increased SACU revenue during the 1972–1977 period was approximately BWP 25 million (\$30 million).⁹⁷

Almost from the outset the BCL project encountered serious difficulties, the results of which have plagued the project until the present. Probably the single largest economic cost of the project was the failure of the smelter to function properly despite input designs from Anglo, Amax and Finnish company Outokumpu Oy. This in turn meant that BCL had to redesign the smelter, and production was delayed. BCL had signed offtake agreements for sulphur and matte and, as a result of the delays in production, was sued. There were thus substantial cost overruns, which were all debt financed. The redesign of the smelter meant the project never developed a sulphur plant. This led to the project's having serious external effects on the region because of the sulphur dioxide emissions, which also had deleterious health effects on the workforce (the town was built downwind of the smelter).⁹⁸

The project was initially expected to bring in royalties (initially 7.5% of exports and lowered to 3% following restructuring), but until 2013 these were only paid on seven occasions. Profits from the project were supposed to be substantial but never materialised

94 Currency code for the Canadian dollar.

95 Canadian funding was specifically for the establishment of a 60MW power station at Selebi-Phikwe to service the mine. The loan from Canada required the BPC to purchase equipment from Canada. Tibone MC, *op. cit.*, p. 241, states:

[The] Canadian supplier did not normally build units of the size required for the Selebi-Pikwe [sic] power plant. This resulted in the equipment costing perhaps twice what it would have cost in the open market. But I hasten to add that if the Canadians had not come to our rescue we would probably have been compelled to secure power from South Africa.

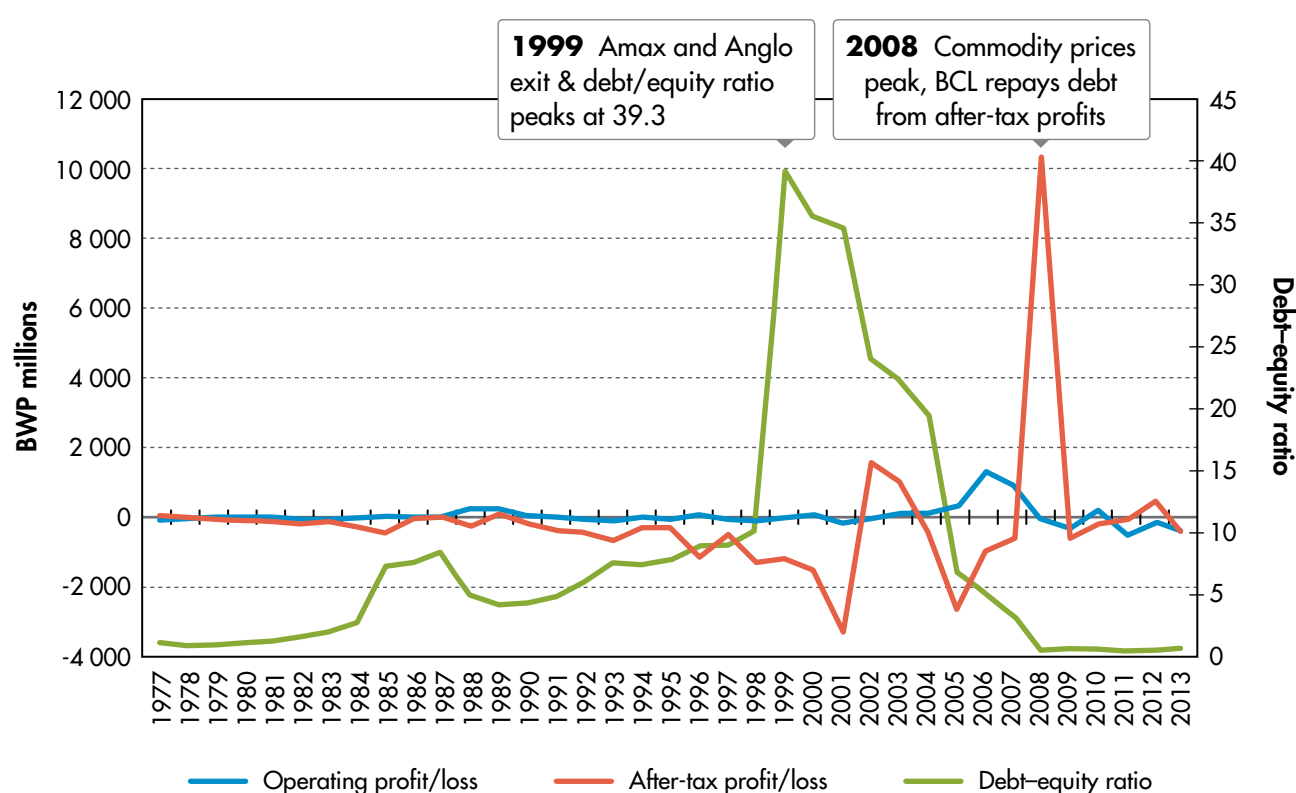
96 Currency code for the German Deutschmark.

97 See Salkin J & O Achieng, 'Benefit Streams Management: A Case Study of the BCL Copper-Nickel Mine in Selebi-Phikwe, Botswana', BIDPA (Botswana Institute for Development Policy Analysis), 2004, p 24.

98 A negative externality is a cost that is suffered by a third party as a result of an economic transaction. In a transaction, the producer and consumer are the first and second parties, and third parties include any individual, organisation, property owner or resource that is indirectly affected. Externalities are also referred to as spill-over effects, and a negative externality is also referred to as an external cost.

because of early production delays and errors and because BCL was so heavily burdened with debt.⁹⁹ The original debt–equity ratio of 2.25:1 was modest and not inappropriate for such a project, but was soon to increase to unsustainable levels. It is this debt–equity ratio that lies at the heart of the long-term problems of the company. While sound at inception, the debt–equity ratio deteriorated to 8:1 in 1979 and almost 9:1 in 1980.¹⁰⁰ This substantial increase in debt required restructuring, which dealt with many of the issues, but the shareholders refused to inject further capital into the project and as a result BCL has been under-capitalised since inception.¹⁰¹

FIGURE 18 OPERATING AND ANNUAL PROFIT, INTEREST ACCRUED AND DEBT–EQUITY RATIO OF BCL

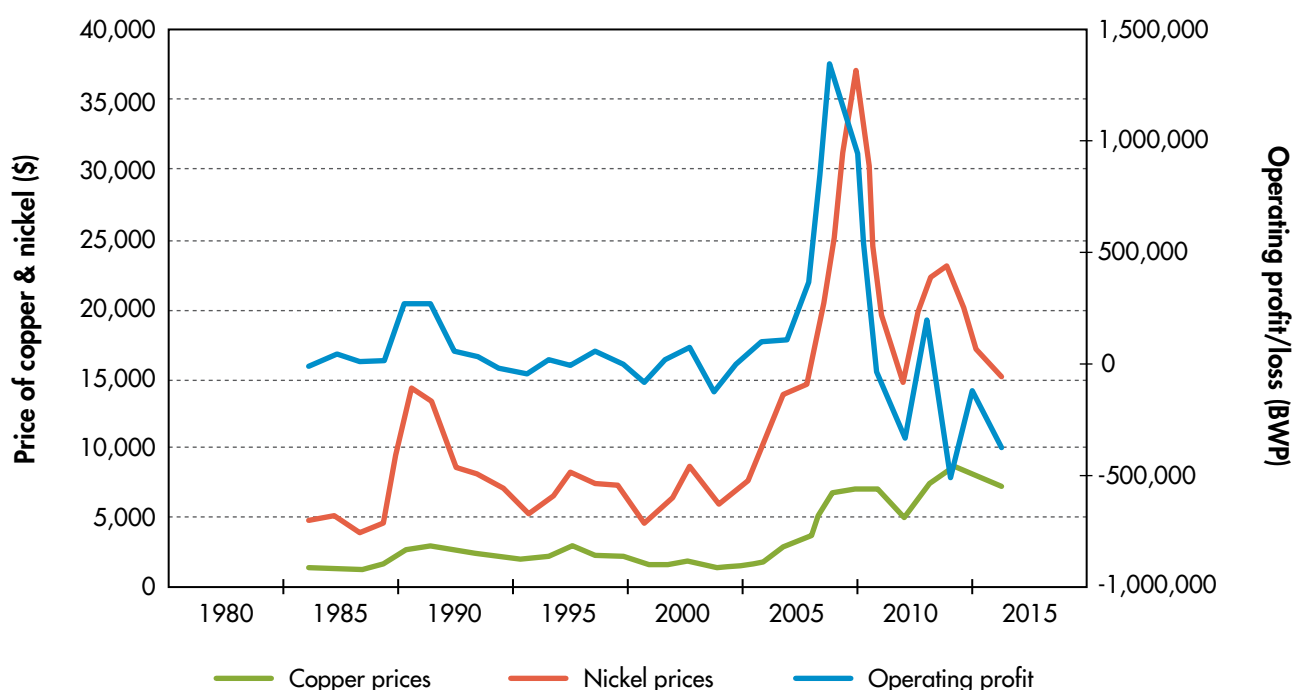


Source: Authors' calculations based on BCL (Bamangwato Concessions Limited) financial statements and management accounts

99 Salkin J & O Achieng, *op. cit.*, p. 27. 'During the planning process, it was estimated that Botswana would earn from P2 million to P5 million over the first 8 years of the project in form of taxes, royalties and dividends. Over the next 4 years of the project, Government was expected to get between P8 million to P11 million from the project. Government revenue to be obtained in the last 10 years of the project was estimated to be over P12 million.'

100 Tibone MC, *op. cit.*, p. 244.

101 The consensus regarding BCL has been that the project was not successful. See Mikesell RF, 'The Selebi-Phikwe nickel/copper mine in Botswana—lessons from a financial disaster', *Natural Resources Forum*, 8, 3, 1984, pp. 279–290.

FIGURE 19 COPPER AND NICKEL PRICES AND BCL OPERATING PROFITS (1984–2014)

Source: BCL, financial statements and management accounts (various); World Bank, 'Global Economic Monitor (GEM) commodities', [http://databank.worldbank.org/data/reports.aspx?source=global-economic-monitor-\(gem\)-commodities](http://databank.worldbank.org/data/reports.aspx?source=global-economic-monitor-(gem)-commodities), accessed 22 February 2014

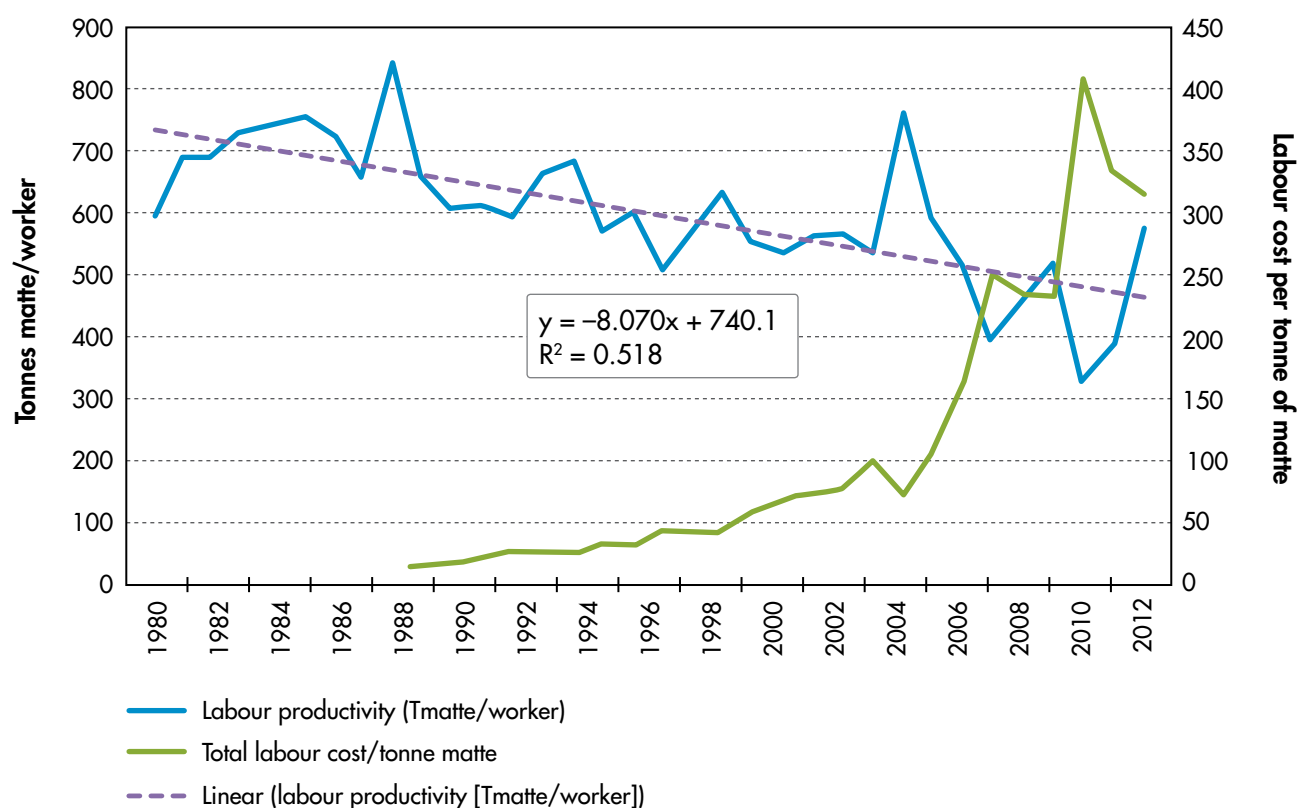
BCL has been consistently profitable when judged by its operating profits, with the company only having operating losses on six occasions between 1979 and 2009. However, looking at its annual profits, which include accrued interest payments, one finds a consistent negative rate of return, as depicted in Figure 18. In fact, the correlation between operating and annual after-tax profit for the period 1977–2013 was negative and statistically insignificant (-0.012). BCL's cumulative after-tax losses between 1977 and 2013 were BWP 4.26 billion (\$0.51 billion), but its cumulative operating profit was BWP 2.6 billion (\$310 million) over the same period. As can be seen from Figure 19, the BCL debt–equity ratio rose to 39:1 as Anglo American Corporation (AAC) and AMAX prepared to exit. This was in large measure a direct result of a debt-for-equity swap that occurred at the time of the government takeover in 1999/2000. This debt was, however, so sizeable that further broadening operations at BCL to include beneficiation activities was not financially possible. By 2008 BCL had accumulated interest arrears of approximately BWP 10.8 billion (\$1.58 billion). That year it paid after-tax profits, mostly to the government as the principal shareholder, of BWP 10.4 billion (\$1.24 billion).

While BCL had an operating profit throughout most of its life, it began to reverse that situation and incurred a significant operating loss during the last five years of the commodity super-cycle, with accumulated operating losses of BWP 1.1 billion

(\$131 million) from 2008–2013. The explanation given by BCL is that this is a direct result of declining commodity prices. However, while the price of nickel in particular is well below the 2008 and 2012 peaks, it remains above the trend prices, as depicted in Figure 19. Clearly nickel prices explain declining operating profits in part but not fully. In the earlier period prior to the commencement of the commodity super cycle, ie, 2004, BCL's operating profits were almost invariably positive and yet nickel prices were considerably below current levels. The explanation must partly lie in rising operating costs at BCL.

It was only after 2000, with the exit of Anglo and Amax, that BCL could change. It was the failure of shareholders to inject further capital that had left the company unable to consider real downstream processing until its debt situation had been addressed. By that time the quality and quantity of the remaining ore reserves were such that further attempts at downstream processing, even something as limited as a refinery, would have to await the discovery of more reserves or an offtake agreement with the mining companies developing copper deposits in the west of the country. In the meantime, rapidly rising labour costs emerged over the period 2010–2013. In the period 2008–2013 unit electricity costs at BCL

FIGURE 20 LABOUR PRODUCTIVITY AND UNIT LABOUR COST AT BCL



Source: Authors' estimates based on BCL financial statements and management accounts (various)

trebled and unit labour costs in effect doubled. Without addressing the issues of rising unit labour cost and decreasing productivity, which is the result of decreasing production at the end of mine life, the company could become a serious financial burden rather than evolving into a national champion in the base metal sector.

The marketing arrangement whereby BCL sells its matte for refining abroad on a toll basis has remained more or less intact over the last 40 years, with no refining capacity developed in Botswana. In large measure this is because BCL, even together with Tati, did not produce sufficient ore for the minimum efficient scale for a refinery until the Activox project, described below. It is understood that the BCL offtake agreement contains an exit clause whereby the arrangement would lapse in the event of Botswana's developing its own refining capacity. The matte was at first exported to Amax (one of the partners in the project), which was paid a refining toll, and then exported from the US to Germany, where Mettalsgesellschaft was paid a commission for selling the refined nickel and copper. Under the current marketing arrangements the matte is refined in Zimbabwe and Norway and then marketed in Europe. BCL has not moved further down the value chain of nickel-copper despite attempts by Tati Nickel to develop a nickel refinery in the country in 2007/8 (see following section).

The heavy debt burden imposed on BCL following the commencement of operations, as a result of the flawed restructuring that was not accompanied by an equity injection, shaped its development and in many ways explains why it has failed to become a national champion in the base metal sector. In such a context the project has been preoccupied since day one with the survival of the company rather than placing any focus on whether further processing is possible. It was not until 2000 with the exit of the two commercial investors that considerations of the future of BCL could focus on any substantive issue other than debt repayment. BCL is currently planning to develop a refinery, but this depends on adequate copper supply. A pre-feasibility study was undertaken and BCL has developed a programme called Polaris II whereby the company expects to develop refining capacity in copper, iron and steel. In October 2014 the government of Botswana announced the acquisition of Norilsk's assets in Africa for \$337 million.¹⁰² This gave BCL complete control of Tati Nickel as well as a 50% share in the Nkomati nickel-copper mine in Mpumalanga, South Africa. This will in turn increase the throughput on the Selebi-Phikwe nickel-copper smelter and increase profitability.

BCL's recent focus on the development of downstream processing is as much about the diversification of the Selebi-Phikwe region as the future of BCL. For 30 years the Botswana government has been aware that the future of the country's third-biggest town rested on either the discovery of further deposits in the area or the diversification of the town's economic base. The size of the deposits has expanded and production at BCL is likely to continue until 2020. However, with the decline of the neighbouring Tati Nickel, which is expected to close in 2015 and which smelted its ore at BCL's facilities, BCL's situation is

102 Reuters, 'Norilsk to sell African nickel stakes to Botswana's BCL for \$337 mln', 20 October 2014, <http://www.reuters.com/article/2014/10/20/norilskafrika-ma-bcl-idUSL3N0SF54920141020>, accessed 25 October 2014.

precarious. As a result the company has recently announced its intention to commence iron ore mining in neighbouring Palapye, with smelting continuing at the facilities at Selebi-Phikwe.

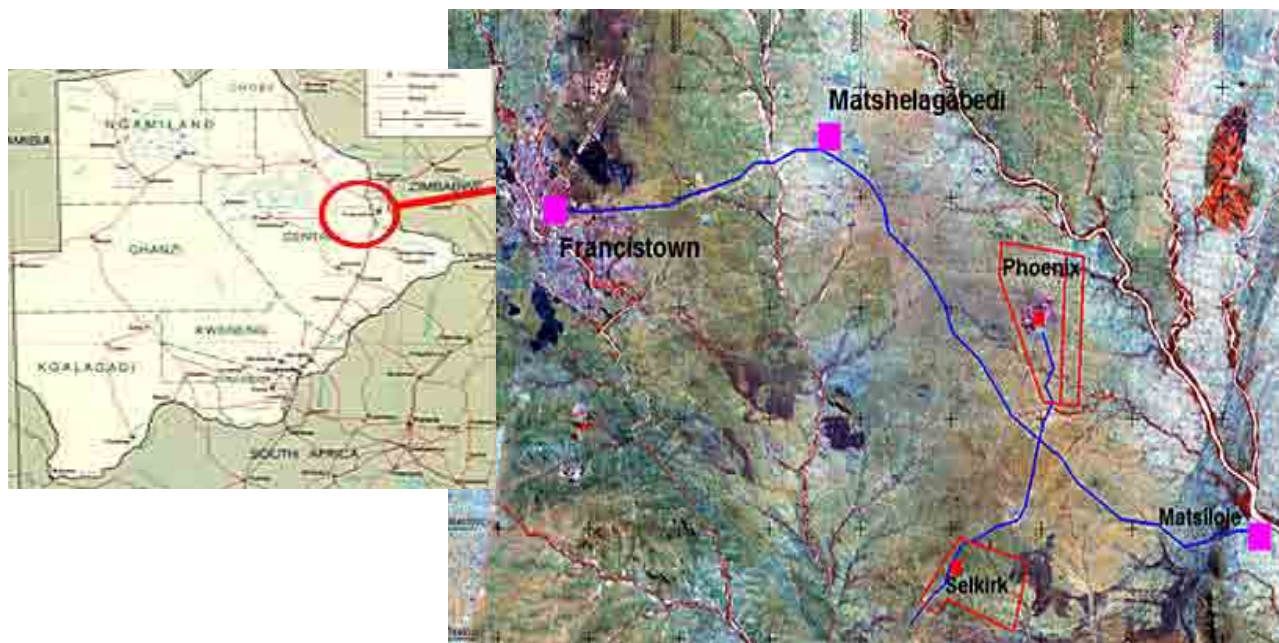
THE TATI NICKEL ACTIVOX REFINERY

This section examines Botswana's experience in the beneficiation of nickel at the proposed Activox refinery of Tati Nickel Mining Company (Pty) Ltd, and the reasons offered for its closure by its owner Norilsk in 2008. Botswana has considerable base metal deposits and the proven reserves are expanding rapidly, with new discoveries in Ngamiland, in the west of Botswana. Since independence policymakers negotiating with base metal mining companies operating in the country have tried to ensure beneficiation occurs in Botswana.¹⁰³ The various attempts to negotiate beneficiation agreements in the base metal sector have been unsuccessful (unlike the country's success in the diamond industry, where the agreement with De Beers in 2011 included a process of beneficiation). This project was thus an important milestone in the economic history and development of Botswana.

The Tati Nickel mine comprises two separate deposits which, at the time of writing (2014), are either under care and maintenance, as is the case with Selkirk, or very close to closure, as is the case with the Phoenix mine. The two separate deposits are situated about 45km east of Francistown and on either side of the Francistown–Matsiloje road (Figure 21). The Phoenix and Selkirk deposits were discovered in the 1960s through regional geochemical soil sampling and a combination of surface and trench mapping. The Selkirk operation was commissioned in 1989 to mine a shallow, high-grade portion of the deposit, which helped to get finance for the development of the Phoenix mine. At the time, the mine produced at a rate of 60 000 tonnes of ore a year for direct smelting at BCL, up to the year 2000. In 2002, production at Selkirk mine was mainly from partial extraction of high-grade pillars, which yielded 20 642 tonnes of ore. Selkirk was put under care and maintenance at the end of the third quarter of 2002, before reopening briefly in early 2006 to recover some of the remaining high-grade pillars. The Phoenix mine is also nearing the end of its life based on current reserves and design inputs.¹⁰⁴ Tati Nickel's audited financial results for the past five years show that metal sales in physical volumes of nickel from Botswana have gradually been decreasing.

103 See Colough C & S McCarty, *The Political Economy of Botswana: A Study of Growth and Distribution*. Oxford: Oxford University Press, 1980, p. 147. In the case of BCL, the other major copper/nickel mine in the country, the government of Botswana tried to negotiate for the establishment of a refinery. Yet the joint venture partner AMAX refused as it had an under-utilised refinery at Port Nickel in Louisiana, and as a result for 50 years Botswana has been a supplier of raw materials to the base metal sector.

104 Tati Nickel, 'Mining sites', <http://www.tatinickel.co.bw/mining-sites-0>, accessed 23 January 2014.

FIGURE 21 TATI NICKEL DEPOSITS

Source: Tati Nickel Mining Company, 'Mining sites', accessed 23 January 2014

Tati Nickel was formed in 1988 after the discovery of the Selkirk and Phoenix nickel and copper deposits by the Francistown Mining and Exploration Company, which had been formed in 1985. Tati Nickel was first owned by LionOre International, with a 41.65% ownership, and Anglo American, with a 43.35% ownership, with the remaining 15% held by the government. In 2002, LionOre bought out Anglo American and became the majority shareholder at 85%, with the Botswana government retaining its 15% share.¹⁰⁵ In 2007 LionOre was sold to the world's largest nickel producer, Norilsk, which is now seeking to sell all its non-Russian assets.¹⁰⁶

105 Tati Nickel, 'Journey', <http://www.tatinickel.co.bw/tati-nickel-journey>, accessed 17 January 2014.

106 Norilsk Nickel, incorporated under the laws of the Russian Federation, is the largest mining and metals company in Russia, the world's largest producer of nickel and palladium, and one of the world's largest producers of platinum and copper. In 2007, PricewaterhouseCoopers ranked Norilsk Nickel as the seventh biggest mining group in the world in terms of market capitalisation. The Norilsk Nickel group is involved in prospecting, exploration, extraction, beneficiation and the metallurgical processing of minerals; and in the production, marketing and sale of base and precious metals. See Norilsk Nickel, <http://nn.aplex.ru/en>, accessed 20 January 2014.

THE LIONORE ACQUISITION

The acquisition of LionOre was part of Norilsk's longer-term strategy to move from being a solely Russian (albeit first-tier) mining company to a transnational mining enterprise. Norilsk is similar to many other Russian companies that were 'privatised' at the end of the Soviet era in the mid-1990s and fell into the hands of Russian oligarchs.¹⁰⁷ By 2003 it was decided that it should move from being solely a Russian company to expanding into global nickel and platinum group metals (PGM) production. To that end, Norilsk acquired the PGM holdings of US-based Stillwater Mining in Montana for \$100 million in 2003. It then acquired the nickel interests of the Cleveland-based OM Group in 2007 and capped this acquisition with the acquisition of LionOre the same year. By 2008 the company had a market capitalisation of \$60 billion and had reduced its dependency on Russia for 98% of its revenue to 80%. By this time Norilsk was thus a global company, in scope if not in mindset. Its assets stretched from the Arctic and the US to Australia and Africa. It had in effect achieved its objective of becoming, at least in geographic terms, a transnational enterprise.

There were several motivations for the acquisition of LionOre by Norilsk. The company and its oligarch board members wanted to use its solid revenue base in Russia to expand globally. At the same time, Xstrata,¹⁰⁸ a major competitor in the nickel market, was also looking to acquire LionOre to become the lowest cost nickel producer in the world through its acquisition of the Activox technology.¹⁰⁹ While this may not have been the main reason for Norilsk's aggressive acquisition, acquiring the technology and stopping a competitor such as Xstrata from gaining access to it gave Norilsk considerable commercial

107 Humphrey D, 'Challenges of transformation: The case of Norilsk Nickel', *Resources Policy*, 36, 2, 2011, pp. 142–148. Also see Fortescue S, 'Rautio V. Noril'sk Nickel: A global company?', *Eurasian Geography and Economics*, 52, 6, 1 November 2011, pp. 835–856.

108 *Engineering News*, 'Xstrata to have lowest-cost chrome and nickel technologies', 27 March 2007, <http://www.engineeringnews.co.za/print-version/xstrata-to-have-lowestcost-chrome-and-nickel-technologies-2007-03-27>, accessed 22 January 2014.

109 Norilsk's website describes the Activox technology and its development in the following way:

Norilsk Process Technology, previously LionOre Technology and Western Minerals Technology, became part of Norilsk Nickel following the acquisition of LionOre Mining International Ltd from 1 July, 2007. Norilsk Process Technology holds numerous patents for key technologies required for the Activox® process. Western Minerals Technology was formed in 1998 as a specialist developer of hydrometallurgical technology with a major focus on commercializing the Activox® process, with 80% LionOre ownership and 20% Aqueous Metallurgy share. The company purchased intellectual property from Dominion Mining, including the Activox® technology, developed by Dominion in 1990–1998 for treatment of Yakabindie nickel concentrates. In 2006 LionOre acquired Aqueous Metallurgy and renamed the unit into LionOre Technology. Following LionOre acquisition by Norilsk Nickel, this asset was renamed to Norilsk Process Technology. Activox® is a low temperature, low pressure process for the oxidation of sulphide minerals that utilizes a combination of fine grinding followed by pressure oxidation under mild conditions.

advantage. In 2007, Norilsk Nickel finally won the bidding war with Xstrata and acquired LionOre for a reported \$6.3 billion.¹¹⁰ This gave Norilsk control of LionOre's Activox technology, which helps produce metal from low-grade ore, as well as mines in Australia, South Africa and Botswana.¹¹¹

However, by 2013 Norilsk began to realise that its comparative advantage lay in developing its Russian assets and not becoming a global mining company. It has begun a strategic retreat from the global stage after a decade as a multinational. At the time of writing it was selling its foreign assets in Africa and Australia and appointed Barclays to dispose of them. In future it will concentrate on its core competencies in Russia.¹¹²

THE TATI NICKEL ACTIVOX REFINERY PROJECT AND ITS CLOSURE

Prior to the acquisition of LionOre by Norilsk, Tati Nickel had launched the Botswana Metal Refinery project, which was a significant step towards the diversification of both the Botswana economy and the mineral sector. The project had three components, namely the Dense Media Separation Plant, an electric transmission line from Selebi-Phikwe, and the

Key features of the Activox® hydrometallurgical process:

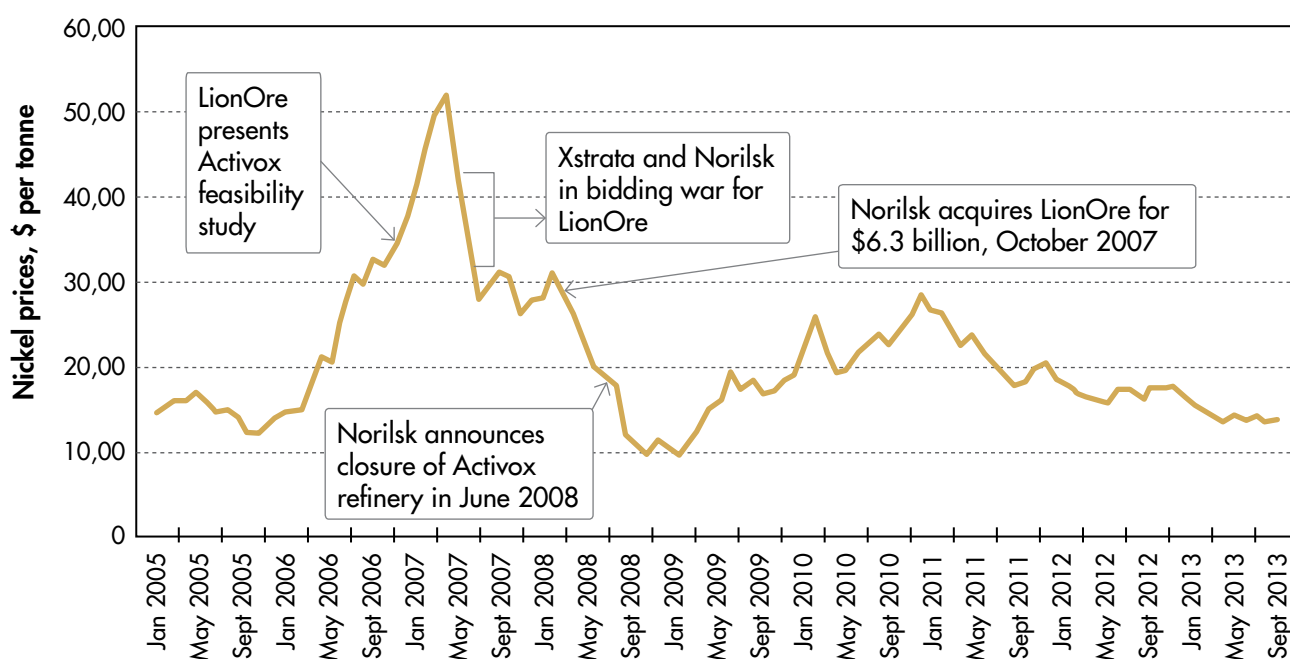
- Improves metal recoveries
- Lowers operating costs
- Unlocks marginal orebodies (eg, Selkirk)
- Treats impurities (e.g. impurities in Honeymoon Well)
- Alternative for treating 'problem' concentrates not suited to smelting
- Produces LME nickel & copper cathodes
- Combination of Activox® & pyrometallurgy can maximise smelter throughput efficiencies
- Flexible to produce either intermediate for refining or fully integrated SX/EW refining process.

See Norilsk Nickel, 'Norilsk process technology', http://95.163.124.250/en/our_products/norilsk_process_technology/, accessed 20 January 2014.

- 110 Campbell K, 'Russia's Norilsk Nickel now stretches from Arctic to SA, US to Australia', *Mining Weekly*, August 2008, <http://www.miningweekly.com/article/russias-norilsk-nickel-now-stretches-from-arctic-to-sa-us-to-australia-2008-08-15>, accessed 17 January 2014. There is some dispute over the figure, with some financial media suggesting that the price was CAD 6.8 billion.
- 111 Behrman E, 'Norilsk Nickel hires Citigroup to sell mines in Australia', *Bloomberg Business*, September 2013, <http://www.bloomberg.com/news/2013-09-06/norilsk-nickel-hires-citigroup-to-sell-mines-in-australia.html>, accessed 20 January 2014.
- 112 Tan G, 'Norilsk Nickel hires Barclays to sell international assets: South Africa and Botswana are on the block as miner focuses on Russian projects', *The Wall Street News*, October 2013, <http://online.wsj.com/news/articles/SB10001424052702304561004579134211374529096>, accessed 24 January 2014. See also Norilsk Nickel, 'Norilsk Nickel unveils new strategy focused on Tier 1 assets and higher returns', press release, 4 October 2014, <http://www.nornik.ru/investor/presentations/3946/>, accessed 24 January 2014.

Activox refinery.¹¹³ The Activox process was expected to increase Tati's mineral reserves by 97% and extend the life of the mine by at least five years. The new technology was also expected to reduce operating costs,¹¹⁴ allow the exploitation of marginal ore bodies, treat impurities and produce LME-quality nickel and copper cathodes. It was the first metal refinery technology of its kind in the world, abandoning the traditional, costly and environmentally degrading pyro-technical refining process for state-of-the-art technology.

FIGURE 22 WORLD PRICES OF NICKEL, 2005–2013



Source: Indexmundi, 'Nickel prices – monthly', <http://www.indexmundi.com/commodities/?commodity=nickel&months=60>, accessed 17 January 2014

113 Campbell K, 'Botswana to host new metals refining technology', *Mining Weekly*, June 2007, <http://www.miningweekly.com/login.php?url=/article/botswana-to-host-new-metals-refining-technology-2007-09-14>, accessed 17 January 2014.

114 Paphane BD *et al.*, 'Kinetic studies on the leaching reactions in the autoclave circuit of the Tati Hydrometallurgical Demonstration Plant', *J. S. Afr. Inst. in. Metall.*, 113, 6, 2013. The lower operating cost of Activox stems from the low temperature and pressure required in hydro-metallurgical processes. 'The Activox® leaching process combines fine milling, using a suitable power-efficient stirred mill, with low-temperature pressure oxidation. The mild operating conditions of temperature (about 105°C) and pressure (about 1 100 kPa) simplify the engineering requirements and reduce costs while maintaining the advantages of pressure oxidation compared to conventional pressure oxidative leaching (POX), which operates at temperatures over 200°C and pressures of over 2 200 kPa.'

In June 2006 the board of LionOre in Canada announced its intention to proceed with the development of an Activox refinery in Francistown at a cost of \$625 million,¹¹⁵ which included the cost of connecting the refinery to a reliable source of electricity at the BCL power facility.¹¹⁶ LionOre, unusually, published the results of the feasibility study in considerable detail – no doubt expecting it to have a significant positive effect on its market capitalisation. The results of the bankable feasibility study (BFS) indicated that:¹¹⁷

- Tati Nickel cash costs forecast to reduce significantly to \$1.69 per pound of nickel over the life of the Activox® Project
- Ability to lower cut-off grade to 0.10% doubles Phoenix mine reserves to 111.6 million tonnes containing 331000 tonnes of nickel
- Activox® Project nearly doubles annual nickel production from the Phoenix Mine to +/-22000 tonnes and increases total payable nickel production over life of mine five-fold to a total of 236000 tonnes
- Activox® Project capital cost per annual pound of nickel equivalents estimated at \$11–\$12 on an equivalent greenfield basis
- Project life of mine is 11 years, with the potential to increase to more than 20 years when the Selkirk resource is factored in.

The announcement of the operating and financial results of the BFS needs to be understood within the context of the soaring global nickel market. The price of nickel, at the time of the LionOre study, had risen to approximately \$30,000 per tonne and would continue to rise during the subsequent bidding for LionOre to a record high of over \$51,000 per tonne in May 2007.

Table 2 from the BFS indicates what the change in reserves for the Phoenix project and possible results from Selkirk would be, should it prove viable.

With the production costs of nickel at slightly over \$3,700 per tonne, the profits at the Francistown Activox refinery would, at least on paper, be considerable. But, more importantly, the new technology created the possibility of undercutting competitors' costs.¹¹⁸ Two of the main producers in the global nickel market at the time were Norilsk and Xstrata. As discussed, Xstrata had moved to acquire LionOre in early 2007, with the

115 MarketWired, 'LionOre approves Activox® Refinery and DMS plant at Tati Nickel for \$620 million', 9 August 2006, <http://www.marketwired.com/press-release/LionOre-Approves-ActivoxR-Refinery-and-DMS-Plant-at-Tati-Nickel-for-620-million-607226.htm>, accessed 20 January 2013.

116 It is important to note that LionOre intended to invest \$24 million connecting its plant to the BCL facility. At the time of its closure in 2008 Norilsk cited the electricity shortages in Southern Africa.

117 LionOre Mining International Ltd, 'LionOre approves Activox "R" Refinery and DMS Plant at Tati Nickel for \$620 million', Market Wired, 9 August 2006, <http://www.marketwired.com/press-release/LionOre-Approves-ActivoxR-Refinery-and-DMS-Plant-at-Tati-Nickel-for-620-million-607226.htm>, accessed 21 January 2014.

118 Creamer M, 'Xstrata to have lowest-cost chrome and nickel technologies', *Engineering News*, 27 March 2007, <http://www.engineeringnews.co.za/print-version/xstrata-to-have-lowestcost-chrome-and-nickel-technologies-2007-03-27>, accessed 20 January 2014.

TABLE 2 RESULTS OF LIONORE'S BANKABLE FEASIBILITY STUDY FOR ACTIVOX REFINERY (2006)

	Base case	BFS	Positive impact	Selkirk Upside potential
Activox projects capital expenditure	Nil	\$ 620 million	N/A	N/A
Life of mine	2011/2012	2016	+ 5 years	+2026
Nickel production per year	11 360 tonnes	22 458 tonnes	97% increase	23 350 tonnes
Total nickel production	54 702 tonnes	235 808 tonnes	331% increase	466 997 tonnes

Source: LionOre Mining International Ltd, 'LionOre approves Activox "R" Refinery and DMS Plant at Tati Nickel for \$620 million', MarketWired, 9 August 2006, <http://www.marketwired.com/press-release/LionOre-Approves-ActivoxR-Refinery-and-DMS-Plant-at-Tati-Nickel-for-620-million-607226.htm>, accessed 21 January 2014

two entering a bidding war over LionOre in May 2007. The possibility of Xstrata acquiring the Activox technology was potentially far more serious for Norilsk, as its main resource in the Russian Arctic, while still a large deposit, used old, energy-intensive and highly polluting technology. In the hands of Xstrata the technology could have posed a threat to Norilsk's long-term commercial position.

In June 2008, with nickel prices collapsing and the world entering a global economic crisis, Norilsk announced that it was suspending the Activox refinery at Tati Nickel. This was seven months after it had completed its acquisition of LionOre and slightly less than two years since LionOre had announced the results of the BFS to the Toronto Stock Exchange. There are several hypotheses as to why Norilsk terminated the Activox refinery project.

- Collapsing nickel prices undermined the project.
- Electricity shortages in Botswana and South Africa undermined the project.
- Rising capital expenditure (CAPEX) costs undermined the project.
- Norilsk wished to move the project to Russia and was not interested in development in other regions.

The publicly available evidence is limited and aspects of the termination of the project remain confidential. The analysis below examines the above hypotheses in light of the publicly available information.

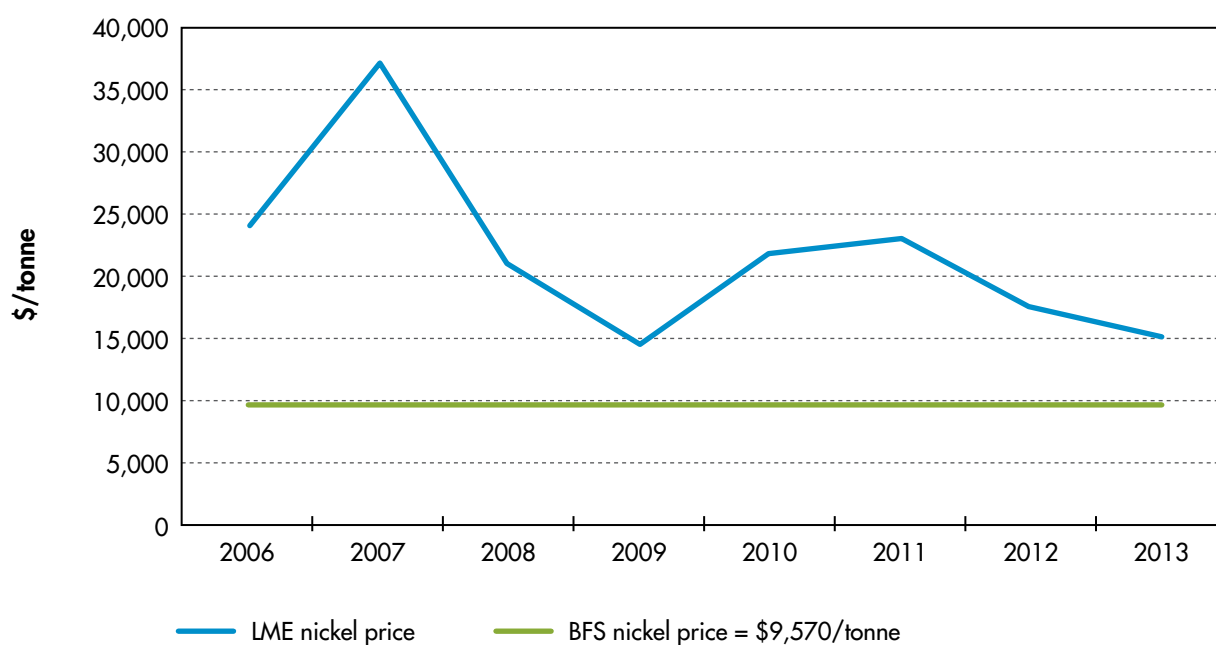
COLLAPSING NICKEL PRICES

The media suggested that the declining nickel price could explain the termination of the project.¹¹⁹ However, although commodity prices in general and that of nickel in particular

119 Bifm Economic Review, 2nd Quarter 2008, p. 5. 'Falling nickel prices – down to \$22,000 a tonne at the end of May 2008, from a peak of \$54,000 a year earlier – also contributed to the demise of the [Activox] project.'

were in sharp decline in 2008, even at the low point of the trade cycle in December 2008 (when monthly average LME nickel prices fell to \$9,800) they were still higher than the conservative price used in the BFS, as Figure 23 suggests. At all times throughout the crisis the annual average price remained about 220% above the conservative price that LionOre had used in the BFS. It would therefore appear that commodity prices, in and of themselves, could not explain the failure of the Activox refinery in Botswana. In fact, the incremental internal rate of return (IRR) of the project of 17% would have been significantly higher had the company used a more realistic nickel price for the purposes of the BFS. As we shall see below, the problems likely lay elsewhere.

FIGURE 23 ACTIVOX BFS NICKEL PRICES AND LME NICKEL PRICES COMPARED



Source: Indexmundi and LionOre Mining International Ltd; 'LionOre approves Activox "R" Refinery and DMS Plant at Tati Nickel for \$620 million', Market Wired, 9 August 2006, <http://www.marketwired.com/press-release/LionOre-Approves-ActivoxR-Refinery-and-DMS-Plant-at-Tati-Nickel-for-620-million-607226.htm>, accessed 21 January 2014

Electricity shortages derailed the project

Norilsk's argument that electricity was not available for the project is at odds with the agreement between the Botswana Power Corporation (BPC) and LionOre as found in the BFS. There were and are electricity shortages in South Africa and Botswana, but the contractual arrangement made by LionOre was with BPC to supply power from the generator at Selebi-Phikwe, which was supplying BCL. The BFS also included a significant

component of \$24 million to connect to the Phikwe area. While this would not increase national supply it would guarantee a more reliable connection. Moreover, this was at a concessional price of \$0.027/kWh with a guaranteed supply. These concessional prices are very similar to the price levels being charged in South Africa and Namibia to other aluminium and zinc refineries.

While the Activox refinery would have become the single largest consumer of power in Botswana, to argue that BPC would have closed either the BCL mine or the refinery when it had provided a 'guarantee of supply' flies in the face of the experience of mining projects in Botswana during this period. Despite load shedding in the light industrial, commercial and residential sector in Botswana, the burden of load shedding did not fall directly on mining or heavy industry. Given the financial implications, BPC would have complied with its legal obligation based on 'guarantee of supply'. It is the consumer, the retail and industrial sectors that would have suffered even worse load shedding during the 2008–2014 period.

Cost increases in the CAPEX undermined the project

In June 2008 the Activox refinery project was postponed and eventually terminated, just two years after LionOre announced its intention to build it. The main reason cited by Norilsk was that the construction costs had escalated. It was also the official position accepted by the government of Botswana.¹²⁰ In the official announcement of its decision to postpone the Activox refinery project, Norilsk stated that it had undertaken¹²¹

an extensive review of the Activox® Refinery project ... This included internal and independent third party reviews which highlighted a substantial project cost escalation from the September 2006 bankable feasibility study estimate of US\$498 Million. The major factors to the substantial cost escalation were an increase in construction, equipment and project management costs worldwide.

In addition, short term energy constraints, as a result of the tight energy balance currently in [the] Southern Africa Region, were assessed as a risk that would have adversely affected the commissioning, time to production and overall economics of the Activox® Refinery Project.

Further, Norilsk stated that applying the technology in a brownfield development would only result in incremental recovery gains, which did not economically justify the capital

120 In the 10th National Development Plan the official reason given for the closure of the plant was that costs had increased more than three-fold. See Botswana, 'National Development Plan 10, 2009–2016'. Gaborone: Government Printer, 2009, p. 173.

121 Norilsk Nickel, 'Norilsk Nickel announces projects in Botswana', June 2008, <http://nn.aplex.ru/en>, accessed 16 January 2014.

expenditure increase. The official capital cost increase was over 300%,¹²² but mining media suggested that the cost escalation was 150%.¹²³ Moreover, there is no way to verify that the CAPEX had risen as sharply as the government was informed. There is, however, little doubt that construction costs were rising rapidly in the Southern African mining sector at the time, and this certainly was the view of both LionOre and Norilsk.

The question arises as to whether these CAPEX increases would have been sufficient to halt the project. Table 3 presents the results of a simulation of the cash flow model developed by LionOre in 2006. The first row represents the publicly available results of the base case cash flow model presented to the Toronto Stock Exchange in August 2006. The details of the model were never publicly specified and as a result the second row represents an attempt at simulating the cash flow model based on publicly available data. Where the assumptions were not fully specified, such as the timing of CAPEX expenditure, estimates are made (see Annex 1). The results of the simulation are found in the second row; they are similar but by no means identical to the LionOre BFS model. The third row presents the net present value and internal rate of return in the event of a 50% increase in CAPEX, and shows that the project would be sub-economic based on the LionOre assumptions. The fourth row shows the results in the event that CAPEX increased by 50%, while using the actual prices of nickel and copper. In such an eventuality the rate of return was clearly positive. Thus, in retrospect and even with a substantial increase in CAPEX, it appears as though the Activox refinery would have been profitable if Norilsk had allowed it to continue. However, in the fifth row, where the simulation is carried out with a 300% increase in CAPEX, even with the high actual prices observed the project is sub-economic.

There are three possible explanations for why the CAPEX costs had escalated by an estimated 300% in a period of less than two years – between the time that the BFS closed tenders expired in September/November 2006 and the announcement of the termination of the project in August 2008.

- The original LionOre BFS CAPEX estimates were inaccurate or the project was ‘gold plated’.
- There was tender rigging by construction and engineering firms.
- Norilsk had no intention of going ahead with the Activox refinery in Botswana and wished to repatriate the technology to Russia.

However, in the absence of private data it is not possible to conclusively explain the apparent CAPEX blowout.

122 In a personal communication, the Government of Botswana’s representative on the board of Tati Nickel said:

[B]ut the reality is that the best tender priced by the EPCM contractor came at a shocking +\$2,100 million. Various attempts to bring this down still resulted in a figure over \$1,600 million. By the time project closed over \$310 million had been committed and ended up being paid. Very expensive way to end a project.

Jacob Thamagae, Director, Tati Nickel, personal communication, 3 June 2014.

123 Campbell K, 2008, *op. cit.*

TABLE 3 RESULTS OF ACTIVOX BANKABLE FEASIBILITY STUDY SIMULATION AND SENSITIVITY ANALYSIS

	Net present value*	IRR
LionOre base case	159,000,000	17%
Simulation of LionOre base case	173,556,726	14%
CAPEX 150% of base case in simulation	-96,025,926	6%
CAPEX 150% of base case; prices of copper and nickel based on average 2006–2014	27,804,329	9%
CAPEX 300% of base case; prices of copper and nickel based on average 2006–2014	-780,943,631	-4%

NB: Assumptions are specified in Annex.

Source: LionOre Mining International Ltd; 'LionOre approves Activox "R" Refinery and DMS Plant at Tati Nickel for \$620 million', Market Wired, 9 August 2006, <http://www.marketwired.com/press-release/LionOre-Approves-ActivoxR-Refinery-and-DMS-Plant-at-Tati-Nickel-for-620-million-607226.htm>, accessed 21 January 2014; and author's calculations

The original LionOre BFS CAPEX estimates were inaccurate or the project was 'gold plated'

One of the standard procedures in undertaking a BFS for such a large project is to determine the CAPEX by seeking tender bids on the market. When LionOre released the results of the BFS to the Toronto Stock Exchange in August 2006 it stated that:¹²⁴

In line with the current high capital costs being experienced within the resource sector the projects capital costs have exceeded the company's June 2005 estimates and reflect a similar trend being experienced by other major capital projects in the mining industry. The capital estimate was compiled with a base date of June 2006. *Most procurement items were priced based on a closed tender with validities of 90–120 days.* This will enable LionOre to procure key equipment and contracts to minimize the risk of further inflation and cost over-runs in the current tight market for equipment and service. [emphasis added]

It is common for capital cost estimates in mining and industrial BFS to be significantly at variance with the actual outcomes. This is why sensitivity analysis based on a 50% escalation is normally undertaken by most financial analysts. This is especially the case with greenfields projects and projects using relatively untested technology. However, the subsequent 300% increase in CAPEX, which occurred in such a short period of time between the original CAPEX estimates based on tenders, suggests that another explanation for the blowout of capital costs needs to be considered. One possible explanation is that it was clear that the Activox technology was the most important asset in LionOre's otherwise limited portfolio. In 2006 and 2007 the market valuation of the company at \$6.3 billion

124 LionOre Mining International Ltd; 'Results of Bankable Feasibility Study', p. 3, <http://www.marketwired.com/press-release/LionOre-Approves-ActivoxR-Refinery-and-DMS-Plant-at-Tati-Nickel-for-620-million-607226.htm>, accessed 21 January 2014.

could certainly not be explained by the income stream from the nickel mines it owned in Africa and Australia. One possibility is that the LionOre BFS underestimated the CAPEX and erred on the low side. Alternatively the engineering, procurement and construction management (EPCM) contractor may have, for perfectly valid technical reasons, ‘rolls royced’ or ‘gold plated’ the project. When such a new technology as Activox is used, it is understandable that the EPCM contractor would tend to err on the high side when estimating project costs. At the same time, however, the incentives involved in contracts where remuneration is by the hour means that gold plating can be quite profitable for the contractor.¹²⁵

There was tender rigging by construction and engineering firms

The escalation of construction costs in the Activox refinery project could in part be explained by illegal and anti-competitive practices in the construction industry in South Africa and the region in this period. Three companies involved in tendering for the Activox refinery project confessed to having colluded to rig the tender bids:¹²⁶

Stefanutti in a joint venture with Grinaker LTA (Stefanutti-Grinaker Joint Venture) reached agreement with Basil Read... and Murray & Roberts on or about June 2007, in that they agreed on a cover price in respect of this project. In terms of the agreement, Stefanutti-Grinaker Joint Venture gave a cover price to Basil Read and Murray & Roberts so that

125 One senior engineer who was interviewed and had worked on the Activox project for Tati Nickel, both under LionOre and Norilsk, and who, for professional reasons, did not wish to be quoted by name, said:

- 1 The BFS was fast-tracked by TWP-Matomo with all pricing being done on data sheets with no drawings.
- 2 TWP-MATOMO backed out of the EPC at the eleventh hour citing over-commitment. Maybe they knew it was an unattainable rush-job. Why not just appoint more people ... it's what Hatch did.
- 3 The site was placed on an area of black cotton soil, which had to be removed. A simple shift would have sufficed. Insufficient site investigation was done.
- 4 Hatch was appointed as the only other alternative. In my opinion, they had too many bums on seats and gold plated the design with huge offices which they only ever quarter-filled, on-site accommodation, and massive concrete. They took advantage of the poor BFS to create a blank chequebook for which they couldn't be held accountable. Most of the staff were hire-ins and not of a particularly high quality.
- 5 Hatch proposed the contractors. The head of Stefanutti Stocks had just moved from the competition. LTA joint ventured with them on their portion and WBHO did the infrastructure.
- 6 Structural steel was bought at a premium.
- 7 Hatch consistently overstaffed the project, eg, employing environmentalists when that wasn't in their scope, employing too many safety officers knowing no one would complain – if someone got hurt it would be the complainant's fault.

126 *Competition Commission v Stefanutti Stocks Holdings Ltd* (017038) [2013] ZACT 63 (22 July 2013), <http://www.saflii.org/za/cases/ZACT/2013/63.html>, accessed 20 January 2014.

Basil Read and Murray & Roberts could submit a non-competitive bid to ensure that the Stefanutti-Grinaker Joint Venture won the tender. The Stefanutti-Grinaker Joint Venture was awarded the tender in line with the collusive agreement. This conduct is collusive tendering in contravention of section 4(1) (b) (iii) of the Act. This project was for the civil works at Tati Activox® near Francistown in Botswana for Botswana Metal Refinery (Pty) Ltd. The project was completed on 31 September 2008.

Following an agreement with the South African Competition Commission, the three companies involved in the rigging of the Activox refinery civil engineering bids were fined ZAR¹²⁷ 700 million (\$83.3 million) for their tender rigging activities in South Africa. In total ZAR 1.45 billion (\$173 million) in fines were imposed on 15 major construction firms, covering virtually the entire sector in South Africa.¹²⁸ The Botswana Competition Commission suggested that it could not intervene as the tender rigging occurred prior to the promulgation of the country's Competition Act.¹²⁹ The only recourse that the Botswana government has is criminal proceedings through the Directorate of Corruption and Economic Crime, which deals with corrupt practices. This directorate cannot take action because the tender rigging was not in the public sector, and thus it has no remit. The other alternative for redress is civil action by the government as a partner in the Tati Nickel mine.

While tender rigging is relatively common in Southern Africa, as illustrated by the magnitude of fines and the number of large construction projects involved, it is difficult to explain such a significant change in CAPEX costs simply through rigging, although in the absence of the actual bids it cannot be entirely discarded as a full explanation for the CAPEX increases.

Norilsk wished to move the Activox refinery project to Russia

Another explanation for the apparent rise in CAPEX costs is that these were not actual increases: Norilsk simply wanted an excuse not to proceed with the project in Botswana. It was often argued in Botswana that the Activox refinery was terminated simply so Norilsk could move the technology to Russia, where the company has substantial sulphide ores. These ores only have a 20-year life without the improved technology offered by Activox. Norilsk announced that the Activox demonstration plant would continue to operate as a large-scale test site for concentrates from Norilsk Kola operations in Russia. This was seen in Botswana as a move by Norilsk to use the demonstration plant to test samples from its Kola operations in order to establish if the ore from its Russian plant could be refined successfully using the Activox technology. If the technology worked, then it was

127 Currency code for the South African rand.

128 *SA Commercial Property News*, 'Competition Commission fines R1.46 billion to SA construction firms', 24 June 2013, <http://www.sacommercialpropnews.co.za/business-specialties/property-construction-development/6097-competition-commission-fines-r1-46-billion-to-sa-construction-firms.html>, accessed 22 January 2014.

129 Botswana, Competition Act 2009 (Act 17 of 2009).

argued the demonstration plant would be moved to Russia.¹³⁰ Activox technology is much more environmentally friendly than traditional pyro-metallurgical nickel refining, so the adoption of the technology in Russia – if feasible – would be useful to the group.

Responding to these allegations, Tati Nickel mine divisional manager Peter Moswele told local newspapers that this would not happen. He emphasised that ore concentrates from Norilsk operations around the world would continue to be sent to the Tati demonstration plant for tests.¹³¹ Other mining sources indicated that moving the demonstration plant would be too expensive and time consuming, and would be a waste of the expertise developed by the management and workforce in Botswana.¹³²

However, while there may have been no intention to move the demonstration plant, the management were saying that the Activox refinery project could well be moved to Russia.¹³³

Botswana Metal Refinery ... general manager, Wayne Venter has not ruled out the possibility of the Russian-based Norilsk Nickel International relocating the Activox® Refinery technology to Russia ... 'It's all dependent on the test work going on now. If the test produces good results, then there is a likelihood of the company looking critically at the gains of the Activox ...'

One could have disregarded the conspiratorial hypothesis that suggests Norilsk had intentionally exaggerated the capital cost in Botswana of the Activox refinery, had it not been for the fact that within two years Bloomberg¹³⁴ was reporting that Norilsk would test whether the same Activox technology that had proven sub-economic in Africa would be suitable for Arctic ores in its polar division. This only served to heighten local suspicions that Norilsk had always intended to repatriate the Activox technology to Russia. The general director of Kola MMC, Evgeny Muravyov, is reported to have said:

The (polar) division must invest in new projects to counter dwindling output as the ore it mines yields less metal. The division must raise ore output by about 3 percent a year to keep nickel production flat ... We're considering switching from pyro-metallurgy to hydro-metallurgy based on Activox® technology. The cost of applying Activox® in Norilsk still needs to be evaluated. Installing the technology at all of Norilsk nickel's facilities, at a cost of as much as \$10 billion, would allow the company to remove all ecological problems and cut electricity and gas consumption.

130 Campbell K, 2008, *op. cit.*

131 *Ibid.*

132 *Ibid.*

133 Gabathuse R, 'Activox might pack up and go', *Mmegi Online*, 11 July 2008, <http://www.mmegi.bw/index.php?sid=1&aid=45&dir=2008/July/Friday11> <http://www.mmegi.bw/index.php?sid=1&aid=45&dir=2008/July/Friday11#sthash.oyzJEyWp.IBNN0kQT.dpuf>, accessed 22 January 2014.

134 Khrennikov I, 'Norilsk Nickel plans \$20 billion programme to boost Arctic output', *Bloomberg Business*, 18 October 2010, <http://www.bloomberg.com/news/2010-10-18/norilsk-nickel-plans-20-billion-program-to-boost-arctic-output.html>, accessed 21 January 2014.

From the above, it appears as though Norilsk had strategic plans to use the Activox technology in its polar division even after its 'failure' in Botswana. In 2013 Norilsk announced it was continuing to develop its hydro-metallurgical technology.¹³⁵ The Russian operations are Norilsk's core business, and produce some 22% of the world's nickel. While the acquisition of LionOre was essentially about transforming Norilsk into a transnational, the motivation of ensuring that a major competitor did not acquire a cutting-edge technology that could be crucial to the continuation of Russian nickel production as head grades drop must have entered the equation. Company outsiders can only speculate about the extent to which the increased capital costs that were subsequently announced were realistic. However, the conspiracy theory suggesting that Norilsk did not want to open the Activox plant in Botswana does not bear commercial scrutiny. If the Activox technology had proven profitable in Botswana, there is no commercial reason why Norilsk would not operate a facility in Botswana as well as Russia.

Lastly, it is worth noting that if there was a genuine CAPEX blowout at the Tati Activox refinery of the magnitude suggested by Norilsk, the application of this technology would only be commercially viable in an environment in which throughput was significantly larger and prices higher. It is only in Russia and at Norilsk's operations that such volumes of nickel exist that would render the Activox refinery project viable, assuming the CAPEX estimates are accurate. Thus the shift of the Activox technology to Russia may be a direct result of the commercial imperatives of the project. It may also be influenced by Norilsk's desire to maintain control over the technology and not use it in conjunction with other joint venture partners such as the Botswana government or Africa Rainbow (which owns the other 50% of the Nkomati nickel mine in South Africa).

CONCLUSIONS

While Norilsk has been disposing of virtually all of its offshore assets, including those in Botswana, South Africa and Australia, it seems unlikely that Norilsk would dispose of the only other substantial asset it had acquired in 2007 from the LionOre acquisition, ie, its Activox refinery technology. In fact, it has been developing the technology further. The Activox refinery technology was cutting edge at the time and is still praised by engineers, at least for its technical qualities, despite the apparent 'failure' of the Tati Nickel refinery.¹³⁶ Had the project been implemented it could have held substantial economic benefits for Botswana over and above the commercial benefits from cash flow. Based on the feasibility study, the loss of nickel exports from the Phoenix mine alone is the equivalent of \$2.5 billion at current prices.

135 Campbell K, 'Russia's Norilsk unveils new strategy, technology', *Mining Weekly*, 25 October 2013, <http://www.miningweekly.com/article/russias-norilsk-unveils-new-strategy-and-technology-2013-10-25>, 17 January 2014.

136 Nel GJ & DA van den Berg, 'Novel design aspects of the Tati Activox® Project ammonia recovery circuit', paper presented at Fifth Southern African Base Metals Conference, Kasana, Botswana, 27–31 July 2009.

Tati Nickel indicated that it would close its Phoenix mine in 2015,¹³⁷ hence the loss of the Activox refinery in effect means that 1 064 workers¹³⁸ will lose their jobs. In the LionOre feasibility study the Phoenix and Selkirk mines would have continued for up to 20 years (ie, 2026) and the volume of output would have doubled from the Phoenix mine alone. The amount of energy used to refine nickel would have declined dramatically along with the harmful emissions. Thus the apparent abandonment of the technology has left the country with considerable economic losses. Also lost is the opportunity to use the base metals deposits in eastern Botswana as a springboard for developing technologically more sophisticated exports. The ore bodies in eastern Botswana, which have been developed for 25 years, are now virtually exhausted, with little development benefit for the country. Botswana has developed no sustainable linkages between the base metal mining sector and other sectors of the economy. There have been neither backward nor forward linkages, only horizontal ones, ie, taxation and increased consumption, neither of which is sustainable. Given the imminent closure of Tati Nickel this is proof once again of the bankruptcy of mining development models that do not emphasise sustainable linkages and beneficiation.

The closure of the Activox refinery at Tati Nickel may have been a direct result of Norilsk's desire to control the Activox technology and assure that it stays in Russia. Those closely associated with Norilsk argue that the Activox technology was only one of a number of low-cost hydro-metallurgical processes and posed no real threat to Norilsk's operations. However, it was certainly the industry view that if Xstrata had held the Activox patent its production costs would have been the lowest in the industry. At the same time, the reasons offered by Norilsk, ie, cost overruns, may be to blame and the confessed collusion by the main engineering companies may have contributed, but how significantly cannot be known. In either case the loss of the Activox plant is likely to have been caused by factors other than of a competitive economic nature.

The illegal and anti-competitive tendering practices by the South African construction companies that have admitted to collusion over Activox can be addressed either through civil action by the government or through action by the Botswana Police. The analysis has indicated that even with a modest CAPEX escalation resulting from the collusion among the construction companies the project would have been profitable if more realistic nickel and copper price assumptions had been used. Clearly a 300% CAPEX increase would mean the project was sub-economic. The evidence conclusively shows that the collusion among the firms raised costs. Moreover, there have been suggestions that the alleged 'gold plating' of the Activox project was responsible for the substantial CAPEX blowout. This cannot be proven but requires further consideration.

137 Pickering R *et al.*, *Botswana Resource Sector Review 2013/2014*, 2013, p. 4, <http://www.capconferences.com/files/2013/06/BOTSWANA-RESOURCE-SECTOR-OVERVIEW-2013.pdf>, accessed 27 January 2014.

138 Mengwe MS, 'Towards a Social Impact Assessment of Copper-Nickel Mining in Botswana', PhD dissertation, Faculty of Science, Nelson Mandela Metropolitan University, 2010, p. 137. This figure does not include a very large number of contract workers. These are 2009 employment levels.

There are important economic lessons for Botswana from the Activox refinery experience. First, the failure of the Activox refinery shows that it is essential to manage relations with multinationals and increase vigilance in the tendering of construction contracts. Second, it is necessary to rethink policy on the beneficiation and use of base metals, as new and substantial deposits of base metals are being discovered in Ngamiland. Without such a policy revision, Botswana can only expect a repetition of the outcomes of Tati Nickel and BCL, where the country remains a resource supplier to other nations with little prospect of sustainable economic development from linkages deriving from mining. The Botswana government has frequently mooted the possibility of establishing a state mining corporation that would partner with the private sector in such innovative developments. If successful, this would be an important development, but it runs the perpetual risk of mismanagement that has beset other state investment arms such as the Botswana Development Corporation. This proposal can only be advanced once these issues are addressed.

Before changing policy in the base metal sector, Botswana and other resource-rich countries need to consider Zambia's experiences.

ZAMBIA'S EXPERIENCE WITH COPPER PROCESSING AND BENEFICIATION

While base metals are relatively peripheral in Botswana and even Namibia, they have been central to Zambia's economic development since its independence from the UK. Copper production and exports – the country's largest export at 60% of total exports – are central to the country's prosperity. One thing is particularly interesting in terms of industrial policy in Zambia. In no other case in the SADC region has the international community worked so consciously against the development of forward linkages than with Zambia's copper, which has been one of the world's top 10 copper producers since independence. While other countries in the SADC region were marginal base metal producers, Zambia was consistently ranked as one of the world's most important copper producers and, in 2012, as the world's seventh largest copper producer.

Institutions ranging from the World Bank and UKAid to EU think tanks have provided the intellectual input to help retard beneficiation, on the grounds that it would not be commercially viable for Zambia to attempt.¹³⁹ While the arguments against beneficiation are strong, few of the analyses explain why the global economic context militates against any form of beneficiation. It is also important to note that, despite the consistent opposition of the international community, the Zambian government's industrial policy has always favoured the development of copper beneficiation, although to limited effect.

139 Rielander J, Shimeles A & HR Solignac-Lecomte, 'Bridging Africa's Transformation Gap: Could Natural Resources Do Good After All?', ECDPM, Great Insights, 2013; World Bank, 'What is the Potential for More Copper Fabrication in Zambia?', 2011, <https://openknowledge.worldbank.org/handle/10986/2812>, accessed 27 January 2014; World Bank Zambia, 'How Can Zambia Increase the Fabrication of Copper Products? Dispelling the Myth that Domestic Production of Copper is an Advantage', draft report, 2012.

While the arguments against copper beneficiation may be grounded in economic theory, there has been no quantitative analysis of why Zambia should not move up the copper value chain through increased beneficiation. Four questions regarding downstream processing in the copper industry in Zambia are addressed below.

- Zambia exports largely refined copper, although the export of concentrate appears to have been increasing over the last decade. Is the share of concentrate in fact growing?
- Why has Zambia been able to export semi-fabricates and what retards further development?
- What policies would assure that a profitable and sustainable beneficiation programme would develop down the value chain?
- What role is there for partners such as China, which are a large part of the problem but potentially an important part of the solution?

ZAMBIA – FROM FLAWED PRIVATISATION TO AN UNSTABLE TAX REGIME

Zambia has had a long, ambiguous and at times troubled relationship with its rich copper deposits, those who mine them and the international financial institutions that provide policy advice. Copper mining in Zambia dates back to 1928 under two mining companies, Rhodesia Selection Trust¹⁴⁰ and AAC, both of which were initially involved with the development of the BCL mine at Selebi-Phikwe. Immediately following independence in 1969, the-then Zambian president Kenneth Kaunda nationalised the copper mines. Zambian mining assets were consolidated into Zambia Consolidated Copper Mines (ZCCM), which was majority-owned by the government (60.3%), with a minority share owned by AAC (27.3%).

Nationalisation proved to be a significant drain on the mining industry and on the economy as a whole. The industry was affected by decreasing world prices and the government's reluctance to devote scarce resources to re-capitalisation, cost-cutting measures and exploration. Annual copper exports declined from a peak of approximately 720 000 tonnes in 1969 to approximately 257 000 tonnes in 2000.¹⁴¹ The government failed to reform the sector, inject capital or deal with escalating operating costs. Privatisation was necessitated by the fact that ZCCM was earning an estimated -47% rate of return prior to privatisation – the equivalent of 9% of GDP.¹⁴² The privatisation of the

140 The Rhodesia Selection Trust was formed in 1928 and subsequently renamed the Roan Selection Trust.

141 See US Geological Survey, 'USGS Minerals Yearbook 2005: The mineral industry of Zambia', www.minerals.er.usgs.gov/minerals/pubs/country/1996/9245096.pdf, accessed 15 August 2015.

142 Manley D, 'Caught in a Trap: Zambia's Mineral Tax reform', ICTD (International Centre for Tax and Development) Working Paper, 5, 2012, p. 21.

copper mines at the bottom of the copper price cycle was, however, costly in terms of subsequent lost revenues.¹⁴³

Finally, Zambia, which was virtually bankrupt at the time, agreed in principle to a structural adjustment programme (SAP) in 1983. However, it was not until the Chiluba government was elected in 1991 that the core of the SAP, which was the privatisation of mines, began in earnest. This was done between 1992 and 1997, when the government privatised ZCCM under the auspices of the World Bank with technical assistance from the Commonwealth Secretariat.¹⁴⁴ At the time of the eventual privatisation of ZCCM's assets in 1997–98 it was estimated that Zambia was subsidising the mining industry by approximately \$360 million a year. By 2001, all the mines but Konkola had been privatised. Transactions over the latter were concluded in 2004. However, the prices paid for Zambia's mining assets, being sold almost at the bottom of a 20-year cycle in copper prices, were very low.¹⁴⁵

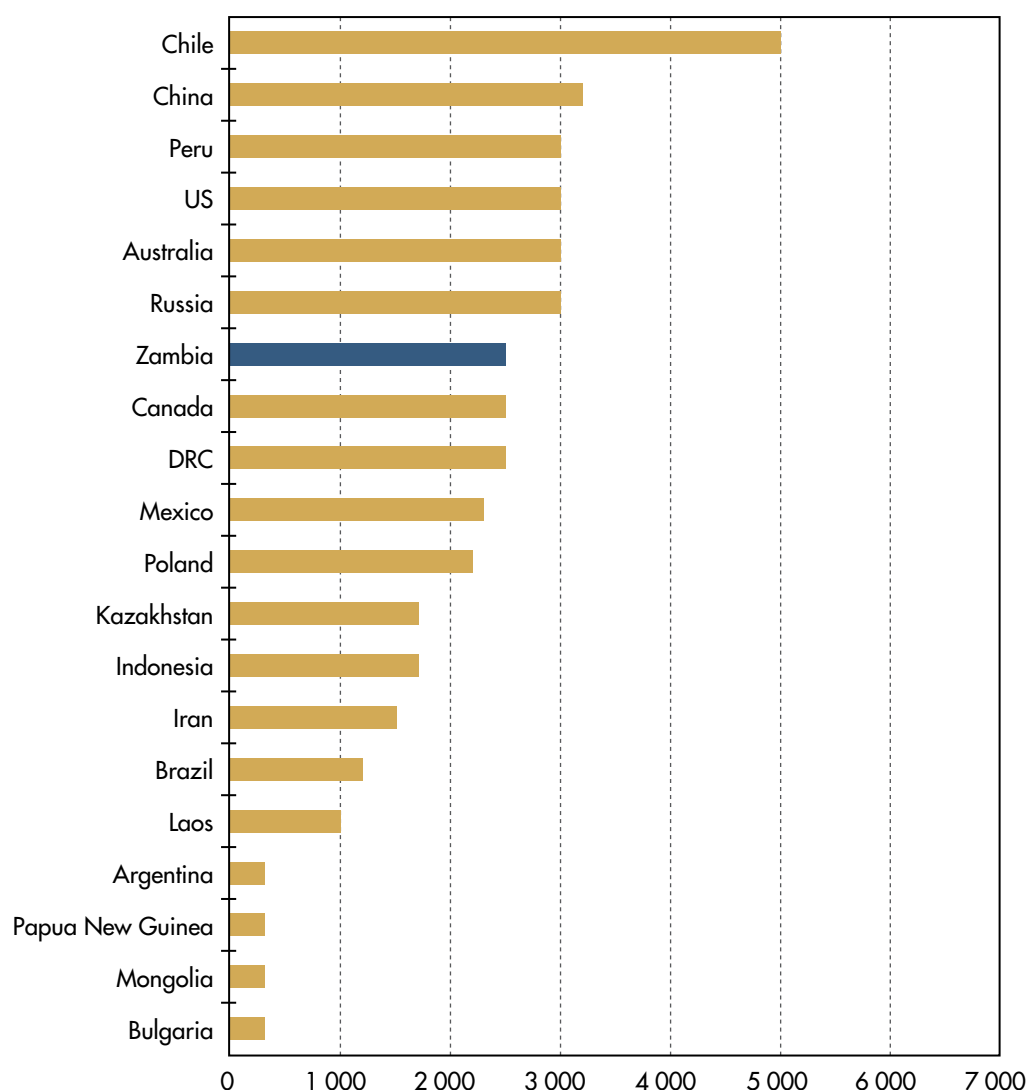
The privatisation process was conducted under the provisions of the Mines and Minerals Act of 1995. Table 4 presents the tax regime that followed privatisation and the bilateral development agreements. The World Bank, which oversaw the privatisation,

143 It should be pointed out that Codelco, the world's largest copper miner in Chile, remained state owned throughout even the Pinochet era, but was generally managed in a proper commercial manner with due regard for the financial exigencies of running a business. Codelco, the largest of the Chilean producers, was always relatively well managed and provided virtually all of the Chilean government revenue in the same period as Zambia was privatising, ie, approximately 6% of revenue in the 1995–2003 period. See Korinek J, 'Mineral Resource Trade in Chile', OECD (Organization for Economic Cooperation and Development) Trade Policy Paper, 145, 2013. Lundstøl O, Raballand G & F Nyirongo, 'Low Government Revenue from the Mining Sector in Zambia and Tanzania: Fiscal Design, Technical Capacity or Political Will?', ICTD Working Paper 9, April 2013, pp. 36–37 notes:

It is also striking that the two foremost success stories among mining countries globally over the last two decades, Chile and Botswana, have both relied heavily on government ownership interest to rise above the average performance of other countries. For Chile, ownership interest explained as much as 76 per cent of total government take 1998–2011. This was despite comparable levels of investment by the state company CODELCO and private mines over the period and previously, and despite significantly higher production and export levels from the private mines.

144 See Kaunda F, *Selling The Family Silver: The Zambian Copper Mines Story*. KwaZulu-Natal: Interpak Books, 2002.

145 Zambia Consolidated Copper Mines (ZCCM) prior to its privatisation operated 10 mines, three smelters, two refineries and a tailings leach plant. ZCCM was owned by Zambia Industrial and Mining Corporation (60.3%), Anglo American subsidiary ZCI Holdings (27.2%), RST International (7.0%) and the public (5.5%). ZCCM was sold in 1998 for only \$627 million, split into seven units, including Konkola copper mine (\$25 million), Kansanshi mine (\$28 million), Luanshya mine (\$35 million), Chibuluma mine (\$17.5 million) and Chambishi mine (\$20 million). The mines were privatised after the copper price had dropped from \$2,300/tonne in 1997 to about \$1,500/tonne in 1998 – and remained at this level until the price boom in 2003. It is understood that ZCCM maintains minority interests in the mines of up to a maximum of 21%.

FIGURE 24 GLOBAL COPPER PRODUCTION, 2012

Source: ICSG (International Copper Study Group), 'World Copper Fact Book', 2013, <http://www.icsg.org/index.php/press-releases/finish/170-publications-press-releases/1188-2013-world-copper-factbook>, accessed 27 January 2014

subsequently¹⁴⁶ recognised that the terms of the development agreements (DAs) were overly generous to the private sector and resulted in a substantial loss of revenue during the peak of the copper boom. This was certainly the consensus of most authors¹⁴⁷ at the

146 See World Bank, 2011, *op. cit.*

147 Lungu J, 'Copper mining agreements in Zambia: Renegotiation or law reform?', *Review of African Political Economy*, 35, 117, 2008.

time. The loss of revenue only became evident with the start of the commodity super-cycle post-2004, when mining companies' profits rose sharply but government revenues failed to respond.

TABLE 4 THE EVOLUTION OF THE MINING TAXATION REGIME IN ZAMBIA

	Mines and Minerals Act 1995 + amendments	Mines and Minerals Development Act 2008 + announcement on 1 April 2008	Amendments in early 2009
Royalty on gross value	0.6%	3% ↑ increased	3%
Corporate income tax	25%	30% ↑ increased	30%
Depreciation of capital equipment for tax purposes	100%	25% ↓ decreased	100% ↑ increased
Withholding taxes	0%	15% on payment of dividends, interest royalties, management fees and payments of affiliates ↑ increased	15% on payments of dividends, interest, royalties, management fees and payments to affiliates
	Customs duty exemptions for capital-equipment imports Limits on duties payable for consumables	Variable profit tax for profits > 8% (new) Windfall tax on the production value when world copper prices > \$5,516/tonne (new) Hedging income not allowed to be part of mining income for tax purposes (new)	Variable profit tax for profit > 8% Hedging income allowed to be part of mining income for tax purposes (new)

Source: WTO (World Trade Organization), 'Trade Policy Review: Report by the Secretariat, Zambia', WT/TPR/S/219, 22 June 2009, http://www.wto.org/english/tratop_e/tp_r_e/tp319_e.htm, accessed 28 July 2015

In 2008, at the peak of the commodity boom prior to the global economic crisis with copper trading at \$8,500 per tonne (five times the price when the nation's mining assets were privatised), the mining sector contributed almost nothing to state revenues under the taxation rules negotiated with the assistance of the International Monetary Fund, the World Bank and Commonwealth Secretariat. Mining tax revenues accounted for a mere 8% of total government revenue.¹⁴⁸ By 2011 the share accruing to the government had increased dramatically following the tax reforms, and mining taxes had risen to some 30% of government revenues.¹⁴⁹ The government has been forced to backtrack on some of the 2008 changes: it returned the capital equipment allowance to 100% and scrapped the

148 World Bank Zambia, 2012, *op. cit.*

149 See ICMM (International Council on Mining & Metals), 'ICMM assesses mining's contribution to Zambia's national and local economy: The macro-economic contributions of mining', press information sheet, <http://www.icmm.com/document/6290>, accessed 5 March 2014.

windfall tax following the collapse in mineral prices in the wake of the global economic crisis.

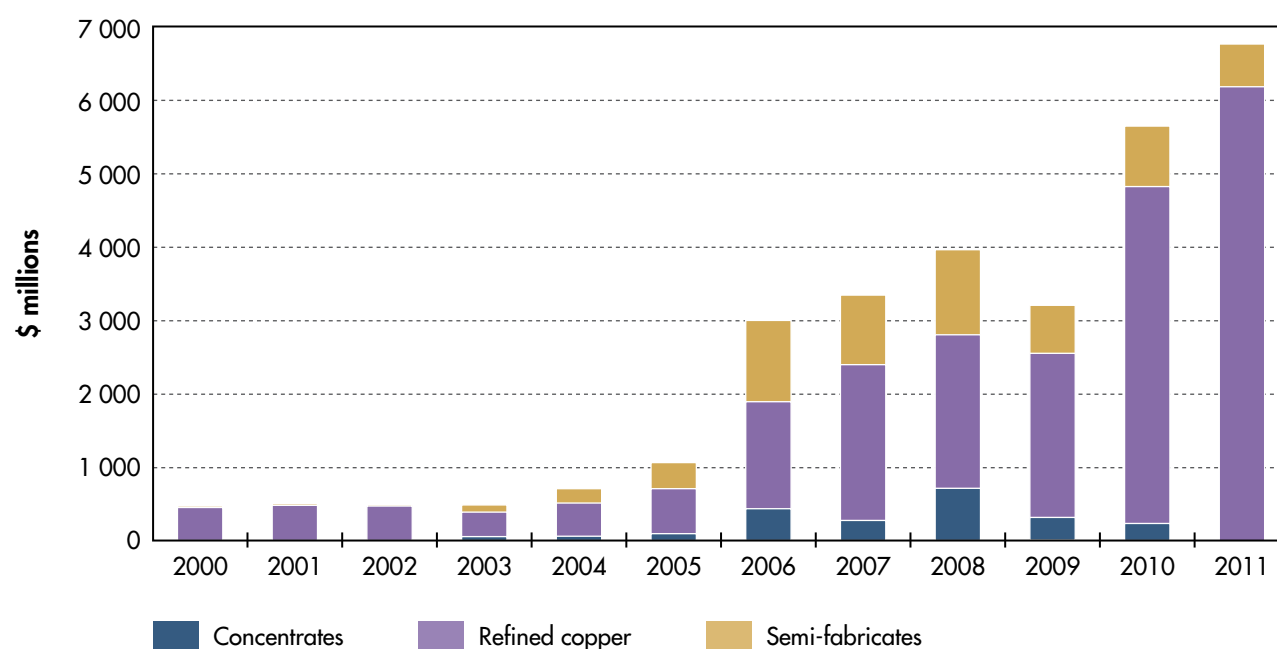
Perhaps the most important development has not been the emergence of a new taxation regime for mines, but what seems to be a replication of Namibia's experiences in moving down the value chain. Zambia, after Chile, is one of the few major copper producers that have developed a significant refining capacity as well as limited capacity to produce copper semi-fabricates. However, over the last decade the Zambian industry has progressively moved away from producing refined and semi-fabricated products to exporting more concentrate. As can be seen from Figure 25, Zambia's copper concentrate exports increased from 0.2% of total copper exports in 2000 to roughly 19% in 2008. This period coincided with the compression of processing/refining margins and the rapid rise in concentrate prices in China and other markets. The reason for allowing companies to temporarily export concentrate was that there is insufficient capacity in Zambia's smelters, where production and exports have risen dramatically. Zambia has traditionally been able to export refined copper and semi-fabricates because it can make use of the margins that arise from the fact that refined copper does not have to be exported with waste, which would have to be transported to distant smelters and refineries in Asia. When smelting and refining margins are high, no concentrate can reasonably be exported. However, with the decline in those margins caused by Chinese over-capacity, the 'deindustrialisation' of copper processing in Zambia continued until the government put an end to it through the imposition of export taxes on concentrates in 2012.

This replicates Namibia's experience with zinc production in the roughly the same period, with lower value-added products becoming progressively more important. While the rising Chinese demand for copper concentrates does not directly affect African copper production, it is part of a global process whereby concentrate exports become progressively more valuable over time.

Since 2008 concentrate exports have dropped. In its 2008 budget, the government introduced a 15% export tax on concentrate to attempt to reverse the trend away from refined copper and semi-fabricates.¹⁵⁰ This export tax was lifted in October 2013 for one year when mining companies argued that refining capacities were inadequate in Zambia and they needed to export. It was expected that large quantities of concentrate would be exported in 2013 and 2014 as a result of the temporary lifting of the export tax.¹⁵¹ Export figures for concentrate were negligible in 2011 and 2012. Concentrate exports began to rise the last decade as a direct result of the high demand for concentrate from China for its domestic smelting and refining industries.

150 World Bank, 'Zambia trade brief', http://info.worldbank.org/etools/wti/docs/Zambia_brief.pdf, accessed 20 June 2014.

151 IMF (International Monetary Fund), 'Analysis of change in Zambia's Mining fiscal regime', 2015, <http://www.imf.org/external/pubs/ft/scr/2015/cr15153.pdf>, accessed 28 January 2015

FIGURE 25 COMPOSITION OF ZAMBIA'S COPPER EXPORTS, 2000–2011 (\$ MILLIONS)

Source: Author's calculation based on Comtrade, copper exports, <http://comtrade.un.org/db/dqBasicQuery.aspx>, accessed 17 January 2014

CONSTRAINTS TO BENEFICIATION OF COPPER IN ZAMBIA

The Zambian government, like most governments in the SADC region, has long wanted to capture additional economic returns through the fabrication of copper products. The government has partially succeeded with the beneficiation of copper to the stage of semi-fabricates by Metal Fabricators of Zambia (ZAMEFA).¹⁵² Zambia believes that this development, if achieved, will be an important source of economic growth, jobs and diversification.¹⁵³ The World Bank report emphasises that prospects for further beneficiation are not favourable, at least in the short and medium term. Rielander *et al.* and the World Bank report¹⁵⁴ point out a number of supply- and demand-side factors constraining the processing and beneficiation of copper into semi-manufactures on a significant scale in Zambia. The following considers the World Bank's arguments against any further attempt at beneficiation.

152 ZAMEFA is a Zambian public enterprise, created in 1969, to manufacture wire, bars and rods from copper bil-lets.

153 See World Bank, 2011, *op. cit.*

154 See Rielander J *et al.*, *op. cit.*; World Bank, 2011, *op. cit.*

Supply-side factors

- While copper is a major input into the copper fabrication industry, there is little competitive advantage to sourcing copper inputs locally. Fabricated or refined copper would still incur the same costs going to market.
- Copper fabrication requires other raw materials, many of which are not available in Zambia. As a general rule, the industry prefers to use scrap, provided that there is a supply of acceptable quality, and 37% of copper used is derived from scrap metal. However, Zambia lacks sufficient quantities of scrap to sustain a major copper fabrication industry. In addition, many copper products are copper alloys and Zambia produces only a few of the other metals required (eg, nickel). Having to import other metals (particularly zinc, to make brass) to a land-locked country such as Zambia would be a source of comparative disadvantage.
- Copper fabrication requires a relatively high capital investment despite the fact that its margins are lower than in copper mining/refining. The margins are compared with the total value of the metal throughput and as a proportion of production cost. The World Bank reports that the availability of capital in Zambia is poor as interest rates are high, at a reported 25–30%.
- Sophisticated plants demand careful attention and a consistent supply of labour with appropriate skills. Zambia has enough willing workers, but the main problem is reportedly productivity.
- Margins on beneficiation and fabrication are low. This is as a result of China's subsidised expansion.

Demand-side factors

- Local and regional demand will not support a substantial copper fabrication industry in Zambia in the short or medium term. The major source of demand for copper products is the manufacturing and construction industries (eg, copper products are used in the manufacture of electronic goods) and there is insufficient demand in the SADC region.
- Zambia cannot competitively access long-distance markets for fabricated products. Zambia's competitiveness in copper semi-manufactures or copper products (eg, low-voltage cables) on the international market outside Africa (such as India and East Asia, where there is strong local production capacity) is likely to be hampered by logistical difficulties (particularly border delays and long lead times).

While many of the constraints suggested in the World Bank's analysis are not without merit, the lessons from countries such as Japan and China are clear: without conscious industrial policy measures, such as the provision of concessionary loans, labour policy, taxation incentives and other financial benefits, no investment in processing copper is likely to materialise. In Zambia, the beneficiation of copper beyond cathode can only be part of a wholesale policy change that addresses the recognised constraints to investment in beneficiation activities. General trade and investment measures that encourage investment in any sector, eg, improved logistics, will also assist in the development of beneficiation activities.

- Zambia can create a commercial advantage for a copper beneficiation sector through the appropriate use of export taxes on unprocessed copper, as is increasingly being done in other countries such as Indonesia.¹⁵⁵ This tax would have to be graduated to assure that it is set at appropriate levels, depending upon the desired degree of domestic value addition. However, it is necessary to consider the implications for Zambia's copper industry if it should impose an export tax when large producers such as Chile and Peru do not have similar taxes.
- If Zambia wishes to beneficiate further down the value chain it must increase its exports of semi-fabricates to beyond Africa. In order to do this successfully Zambia needs a strategic partner to undertake these investments (with government support). The country's physical distance from large semi-fabricate markets can only be overcome by developing commercial proximity through a strategic partnership with a reliable and known commercial entity – this must be the first step addressed in the beneficiation policy in this sector. Phelps Dodge, a major transnational in the global copper market, has worked with the Zambian government as a strategic partner in the production of semi-fabricates at ZAMEFA, which have been exported for many years. It provided both a known marketing brand and established marketing infrastructure. Without such a partner, either in Europe, India or China, with a comparable commercial gravitas to that of Phelps Dodge, it probably would not be possible for a Zambian producer to penetrate key copper semi-fabricate markets. However, attempts at developing partnerships without the appropriate incentives are unlikely to achieve results. Chinese firms, with their rapidly expanding production and markets, remain the best option for Zambia. However, this will not be achieved without costs to the government and investment from reputable firms in the industry.
- Zinc deposits do exist in Zambia¹⁵⁶ and in nearby Mozambique,¹⁵⁷ despite what the World Bank report says. There are also zinc refineries in Namibia and South Africa. Thus this issue is less important than seemed the case to the World Bank in 2011. Zambia does have a shortage of scrap copper, which is an important part of the refining process, but it has still managed to export refined copper commercially for a number of

155 The EU prohibits the use of such export taxes under the economic partnership agreement with SADC and COMESA members, although there is no WTO provision prohibiting the use of export taxes.

156 There are two deposits in Zambia (see Mine Listings, 'Zinc mines for sale – Zambia, SA', <http://minelistings.com/mines-for-sale/chowa-south-zinc-mines>, accessed 12 March 2014): Chowa South (SML [Security Market Line] 346& 347) zinc mines which are located in Chowa area of the Kabwe District in the Central Province of the Republic of Zambia have been assessed for their zinc mineral resource value in accordance with the JORC [Joint Ore Reserves Committee] Code. Their value, based on the estimated zinc mineral reserves and prevailing zinc world market prices has been estimated to be about US\$2,860,000,000.00. The two mines are owned by Stargem Investment Ltd under Mining Licences SML 346 & SML 347, valid till the year 2017.

157 Kean A, 'Metals of Africa unfurls 3.2% lead, 18.6% zinc in Mozambique drilling', Proactive Investors Australia, 30 January 2013, <http://www.proactiveinvestors.com.au/companies/news/38887/metals-of-africa-unfurls-32-lead-186-zinc-in-mozambique-drilling--38887.html>, accessed 12 March 2014.

years despite this limitation. It remains possible for Zambia to trade in refined copper on the basis of the transport margin of waste materials in its concentrate.

- The key lesson in base metal beneficiation in Japan and China is that it is undertaken for a specific commercial reason, to assist the development of other sectors of the economy. It cannot be undertaken in isolation and without further commercial objectives either nationally or commercially down the value chain. In the absence of end-using sectors, the only possible policy if Zambia wishes to pursue beneficiation is to link into the value chain of an end user such as China.
- Logistic issues in international trade create serious barriers that will have to be addressed by the Zambian government as part of any industrial policy, whether that policy is aimed at beneficiation or any other commercial activity. These constraints exist for all potential exports and they cannot be underestimated as a barrier to trade. However, they are being addressed through international programmes on trade and logistic facilitation measures following the agreement at the WTO's Bali Ministerial.
- Similarly, the development of an appropriate labour market and manpower policy is vital to the success of beneficiation or any other attempt at product diversification, whether in the industrial or agricultural sectors.
- Perhaps the strongest argument against beneficiation is that, given the level of investment, the benefits are limited in terms of employment creation and spin-offs, although no evidence is provided by the opponents of beneficiation – merely a rejection of the notion. However, the alternatives to beneficiation suggested by the international community are by no means obvious. UKAid and the World Bank¹⁵⁸ have suggested that Zambia should in the long term develop its manufacturing sector, which would also make use of copper. However, the commercial constraints to manufacturing – the lack of markets, strategic competition with larger established producers, and labour and logistics constraints – are often the same if not even more onerous than with copper beneficiation.
- The international institutions have systematically failed to advise the Zambian government on the costs and benefits of the various options open to it. Zambia has simply been told that beneficiation is not viable and that it should trust the expertise provided by the IFIs and aid donors. These are the same IFIs that advised Zambia to enter into the discredited DAs in the 1990s and to sell its mining assets.
- China's industrial policy in the middle of the copper value chain, ie, regarding cathode and semi-fabricates, has compressed margins, as the analysis has shown. This is a direct result of China's policy of capacity expansion in the face of substantial and rising excess capacity in the sector. These low margins in the middle of the value chain act as a significant constraint to any African attempts to beneficiate copper. This compression of margins can only be addressed in co-operation with Chinese enterprises and integration into the value chain.

158 World Bank, 2011, *op. cit.*, p. 7.

CHAPTER 5

CONCLUSIONS

The first section of this report addressed the theory and practice of successful base metal beneficiation in Asia, using copper as a case study. Beneficiation as a tool of industrial policy has been criticised by the World Bank, with academic economists such as Hausmann providing a scholarly foundation for the critique. Yet the evidence suggests that 60 years ago Japan and then China implemented very successful policies of base metal beneficiation to assure either a commercial advantage for producers down the value chain or national self-sufficiency in strategic minerals. Initially these efforts were based on what were, at least in part, domestic mineral supplies, but as industrialisation progressed the beneficiation of base metals was increasingly based on imported concentrate and raw materials. In Asia, beneficiation of base metals was both a purposeful and successful industrial policy that made use of traditional industrial and trade policy instruments. Once these policies proved successful and its commercial advantage was assured Japan discontinued many of the policies, as they were no longer necessary to assure its commercial advantage. Thus the paramount lesson from Japan and China is that beneficiation of copper can and has worked in the past, but only as part of a wider industrial policy that assures economic benefits along the value chain. This value chain was initially national in the case of Japan and China but has become increasingly global.

Opponents to beneficiation claim that Africa has a fundamental resource intensity and technical capacity that is completely different from that of Japan in the 1950s and China in the 1990s. This argument is in itself not incorrect, but it does not take into account that the trajectory of base metal beneficiation in Asia was determined not by factor cost, technical capacity and availability of resources but rather by industrial policies aimed at developing a national commercial advantage further down the value chain. These policies included a range of measures that would be illegal under current WTO rules. The copper smelters in Japan owned by Mitsui, Mitsubishi and Sumitomo were and remain inextricably linked to the end users of that copper, which were often within the same conglomerate. They were frequently funded by banks within an existing conglomerate. If Africa continues to develop based on its static factor intensities it will export raw materials until none are left. If Asia's economic success over the last half-century teaches Africa anything, it is that the success of East Asian countries stems from a refusal by countries such as Japan and China to accept fallacious arguments of static comparative advantage. Given the ideological predilection and self-interest of developed country donors and their IFIs, developing African countries cannot reasonably expect any assistance for this type of transformative process.

What is true of Asia is also true of Africa. A policy of base metal beneficiation can only be successful in Africa if local producers are connected to international value chains. African markets for copper products at the moment remain too small. Export and connections along the value chain are therefore essential.

However, China's industrial policy in the copper sector in the last decade threatens any prospects of African beneficiation, as it has compressed smelting and refining margins and hence scuttled the construction of more capacity in Africa with its growing excess capacity. China's policy has been based on substantial subsidies to SOEs, which in 2012 were responsible for 75% of copper production. Zambia has managed to export refined copper only because the transport costs have been such that, even with low margins in China, the cost of exporting the waste in copper concentrate to China means it is generally not a commercially viable proposition. Yet even Zambia in 2008–2010, as global smelting and refining margins compressed and concentrate prices rose, increased its exports of concentrate until the government imposed, at least temporarily, an export tax on concentrate.

The use of appropriate export taxes on copper concentrate can be an important strategic instrument to counteract the distortive industrial and trade policies of the Chinese government in the middle of the copper value chain. Paradoxically, it is the EU, through its dictates against the use of export taxes in its economic partnership agreements with African countries, that is inadvertently defending China's commercial interests. China's stated policy in the 12th Non-Ferrous Metal Plan has been to decrease its excess capacity, but its actions in terms of its SOEs have been the exact opposite. Evidence from the copper sector has shown that excess capacity along the copper value chain has only increased and depressed margins in all copper-exporting countries. The rapid de-industrialisation of copper exports in copper-mining countries is a direct result of the Chinese policy of creating excess capacity in the smelting and refining sectors.

Yet one of the most important conclusions of this report is that China's industrial expansion and industrial policies also provide a real opportunity for Africa. Its emerging transnationals and SOEs are still relatively young and flexible corporate entities and as such are more likely to move to locations where there is both government direction and commercial advantage. It is imperative that African countries that have determined that base metal beneficiation is in their commercial interest provide these firms with the necessary commercial advantages and appropriate incentives, in the form of tax relief and electricity prices. At the same time, African countries that wish to pursue beneficiation must work with the Chinese government and their SOEs. The Chinese government could provide incentives for Chinese firms to move energy-intensive activities to those African countries willing to host them.

The second part of the report addressed the experience of four SADC countries in the processing and beneficiation of base metals. Of these, only Zambia has succeeded in moving beyond base metal production to refined products. All the countries examined recorded mixed outcomes.

- The experience of Mozambique with the beneficiation of bauxite at the Mozal project using its low-cost electricity has been that it has generally not resulted in any significant integration with international donors attempting to drive backward but not forward linkages. The project remains largely an enclave, which has transformed

the export base of Mozambique. It has also provided an important signal to the international market that Mozambique is 'open for businesses, and has been a beacon for other resource-based megaprojects in the country. The evidence suggests that while the transformation of the export base was real and provided stimulus to other major investments, the tax incentives provided by the state were excessive.

- Namibia has pursued a policy of zinc refining on the back of the same electricity pricing policy used in Mozambique. On the basis of its export figures, it has also seen the 'de-industrialisation' of its zinc exports, with zinc concentrates rising over precisely the same period (2007–2011) as was the case with Zambia's copper concentrate exports. At the Tsumeb copper smelter Namibia performs a unique function in Africa. Copper concentrate is imported into Namibia from the EU and processed into blister. It is exported once again for refining in the EU. Tsumeb thus absorbs the health risks of processing high-arsenic copper concentrates, which are banned in the EU.
- The experience of Botswana with base metal beneficiation has not been positive. In the case of BCL, beneficiation was blocked from the outset by one of the partners – AMAX – in the Selebi-Phikwe project in the 1970s. The company wanted the concentrate and matte for its own refinery in Louisiana. It is only recently that the company has introduced the Polaris II project, where it expects to diversify away from copper to processing iron ore from the Palapye region. Tati Nickel near Francistown, currently owned by Norilsk, never developed any sustainable beneficiation activities either. Its Activox demonstration refinery was closed in 2008 and it never went to full refining of copper. Several hypotheses are advanced as to the reasons why the refinery failed. Unless Botswana revises its policy on allowing companies to export unprocessed concentrate, the experience of BCL and Tati, where the companies exported blister over a period of 35 years, will be repeated with the new copper mines in Ngamiland.
- Zambia has progressed furthest with base metal beneficiation in SADC. Yet by any Asian standard its results have been extremely modest because of the absence of local downstream users. Most of its copper is now exported as refined product and while ZAMEFA exports some semi-fabricates to the region, there has been no significant export of semi-fabricates beyond Africa. Zambia briefly imposed and then removed an export tax on concentrate in 2011 to counter the de-industrialisation of copper exports. It faces numerous constraints to further beneficiation, as outlined by several World Bank studies. If Zambia wishes to beneficiate its copper further for export beyond Africa it will have to provide incentives to do so and, more importantly, form a strategic commercial relationship with semi-fabricate producing companies that will buy its semi-fabricates and incorporate them into their value chain. Given the compression of the value chain, it will be difficult to justify further processing capacity. Beneficiation only makes commercial sense in Zambia in the context of a broader industrial policy that also addresses the multiple constraints to further industrial development. The obvious strategic partners, given Zambia's close political association, are in China.

However, beneficiation policy in Japan and China shows that it works well when it is part of a coherent and well-managed industrial strategy that is associated with lowering costs at one or more points along the value chain. This translates into commercial advantages

for the firms at that point or further down. In Africa the question arises as to whether industrial policy interventions will be developmental in nature rather than simply rent seeking. Thus, in the final analysis, the success of beneficiation rests as much as on the quality of the administration that implements it and its will to bear the costs as on the technical and economic characteristics of the particular country.

ANNEXES

ANNEX 1 CASH FLOW SIMULATION AND SENSITIVITY ANALYSIS OF ACTIVOX REFINERY							
Activox model assumptions – modified LionOre model (all values in \$)							
Cost of production (nickel)	3,718						
Project life (2006–2016)	11 years						
Price of nickel	9,570						
Price of copper	2,750						
CAPEX	620,000,000						
Year 1	45%						
Year 2	35%						
Year 3	10%						
Year 4	10%						
Cost of nickel	3,718						
Discount rate	8%						
Annual production of nickel (tonnes)	22,458						
Production of copper (tonnes)	14000						
	2006	2007	2008	2009	2010	...	2016
Revenue				126711530	253423060	...	253423060
Costs	279,000,000	217,000,000	62,000,000	103,749,422	83,498,844	...	83,498,844
Net revenue	-279,000,000	-217,000,000	-62,000,000	22,962,108	169,924,216	...	169,924,216
NPV	IRR						
173,556,727	14%						

ANNEX 1 SENSITIVITY ANALYSIS (ALL VALUES IN \$)

CAPEX x 1.5							
Activox assumptions							
Cost of production (nickel)	3,718						
Project life (2006–2016)	11 years						
Price of nickel	9,570						
Price of copper	2,750						
CAPEX	930,000,000						
Year 1	45%						
Year 2	35%						
Year 3	10%						
Year 4	10%						
Cost of nickel	3,718						
Discount rate	8%						
Annual production of nickel (tonnes)	22,458						
Production of copper (tonnes)	14,000						
	2006	2007	2008	2009	2010	...	2016
Revenue				126,711,530	253,423,060	...	253,423,060
Costs	418,500,000	325,500,000	93,000,000	134,749,422	83,498,844	...	83,498,844
Net Revenue	-418,500,000	-325,500,000	-93,000,000	-8,037,892	169,924,216	...	169,924,216
NPV	IRR						
-96,025,927	6%						

ANNEX 1 SENSITIVITY ANALYSIS (ALL VALUES IN \$)							
CAPEX x1.5 + actual average prices							
Nickel and copper prices (\$)							
2006	2007	2008	2009	2010	2011	2012	2013
24,126	37,136	21,141	14,672	21,810	22,909	17,542	15,030
6,731	7,132	6,963	5,165	7,538	8,823	7,959	7,331
Activox assumptions (Values in \$)							
Cost of production (nickel)		3,718					
Project life (2006–2016)		11 years					
Price of nickel		21,795.75					
Price of copper		7,205.25					
CAPEX		930,000,000					
Year 1		45%					
Year 2		35%					
Year 3		10%					
Year 4		10%					
Cost of nickel		3,718					
Discount rate		8%					
Annual production of nickel (tonnes)		22,458					
Production of copper (tonnes)		14,000					
	2006	2007	2008	2009	2010	...	2016
Revenue				295,181,226.8	253,423,060	...	253,423,060
Costs	418,500,000	325,500,000	93,000,000	134,749,422	83,498,844	...	83,498,844
Net revenue	-418,500,000	-325,500,000	-93,000,000	160,431,804.8	169,924,216	...	169,924,216
NPV	IRR						
27,804,329	9%						

ANNEX 1 SENSITIVITY ANALYSIS (ALL VALUES IN \$)							
CAPEX x 3 (values in \$)							
Activox assumptions							
Cost of production (nickel)	3,718						
Project life (2006–2016)	11 years						
Price of nickel	21,795.75						
Price of copper	7,205.25						
CAPEX	1,860,000,000						
Year 1	45%						
Year 2	35%						
Year 3	10%						
Year 4	10%						
Cost of nickel	3,718						
Discount rate	8%						
Annual production of nickel (tonnes)	22,458						
Production of copper (tonnes)	14,000						
	2006	2007	2008	2009	2010	...	2016
Revenue				295,181,226.8	253,423,060	...	253,423,060
Costs	837,000,000	651,000,000	186,000,000	227,749,422	83,498,844	...	83,498,844
Net revenue	-837,000,000	-651,000,000	-186,000,000	67,431,804.75	169,924,216	...	169,924,216
NPV	IRR						
-780,943,631	-4%						

ANNEX 2 A CRITIQUE OF HAUSMANN

Hausmann's analysis is based on a product mapping, which is a modern variant of the traditional theory of comparative advantage. In Hausmann's analysis trade is based on factor endowments and not the specific conditions prevailing in a particular market for a given product. It is this that permits Hausmann to undertake work on a global basis using international data without the need for a sector-by-sector, microeconomic approach, which is normally associated industrial and trade policy. This, as we shall see, is the source of its elegance and simultaneously one of its main flaws. What is new about Hausmann's work is the mapping below and how it is applied to countries such as Botswana. This annex briefly looks at the greatest weakness of Hausmann's work, namely its complete failure to consider the institutional and historical details of each sector to understand the emergence of particular trade patterns. The first section considers the specific recommendations Hausmann made in his work on Botswana. The second considers his explanation of why global trade patterns emerge for particular products and why beneficiation has not occurred. Each suffers from the same drawback – a lack of institutional detail, which in turn stems from the very nature of the analysis, based on simple technical characteristics rather than a detailed understanding of a commodity or a sector.

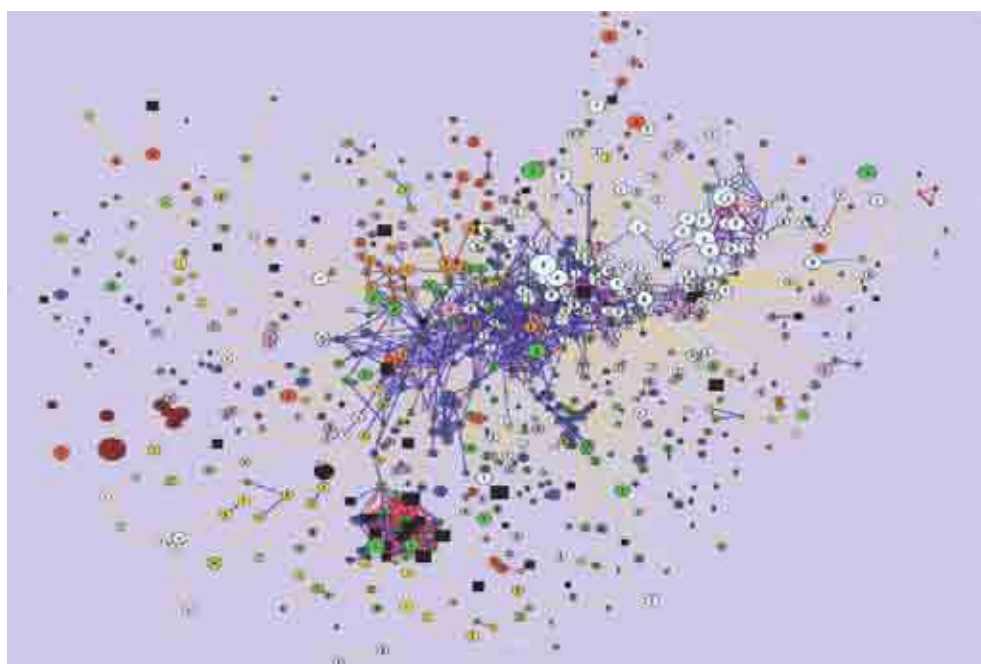
HAUSMANN ON BOTSWANA

Each point or node in Figure 26 is a product, and its size is determined by the share of world trade. Those countries that produce products that are technically close find it easy to jump from one product to another. But countries such as Botswana and most other SADC countries produce isolated products that are not close to other nodes. In the representation Botswana's exports are depicted by black squares, which are generally far from the range of products, apart from the lower cluster, which is garments and has now ceased to exist because of the loss of trade preference. All the nodes in the case of Botswana are now relatively isolated. Countries that produce products in the dense part of the cluster find it easy to diversify. Countries such as India, China and Indonesia are found in this area.

Countries such as Botswana have a range of export products, such as diamonds, copper and nickel, that are not technically close to the central clusters. They require highly specialised inputs that are not readily usable in other sectors. Based on this Hausmann makes recommendations on what he sees as the most propitious sectors for Botswana. While recognising that the data is based on 2008 statistics and that the garment industry was collapsing due to the loss of preferences and subsidies, he based his analysis on this data and apparently no other sector-specific analysis. Hausmann provides suggestions for what he considers to be 'close sectors'. The analysis predates the complete collapse of Botswana's garment exports in 2009, but its contents reflect the risks of industrial policy analysis with highly aggregated international data and almost no eye to sectoral or microeconomic detail. Almost all of the sectors (especially coffee and sugar) that Hausmann suggests are close to the technological and resource mix of existing exports and are considered 'low-hanging fruit' would not pass even the most superficial sectoral scrutiny of their commercial viability as export sectors for Botswana. This analysis and

its questionable results are not untypical of results derived from global databases with no knowledge of the sector specificities.

FIGURE 26 BOTSWANA'S 'REVEALED COMPARATIVE ADVANTAGE', 2008



Source: Hausmann R & B Klinger, 'Achieving Export Diversification in Botswana', Centre for International Development, 2010, p. 11

TABLE 5 'LOW-HANGING FRUIT' FOR BOTSWANA À LA HAUSMANN

Exports (\$ million)	Prod PPP	World trade (\$)	Density	Products	Learner category
0	6136	2	0.074	Plants, plant parts for perfumery, pharmacy, etc.	Animal products
0	3762	0	0.073	Accordions and similar instruments, mouth organs	Labour intensive
0	2076	1	0.072	Goat or kid skin leather, without hair	Capital intensive
0	9170	4	0.072	Dates, figs, pineapple, avocado, guava, fresh or dried	Tropical agriculture
0	2293	2	0.072	Coconuts, Brazil nuts and cashew nuts, fresh or dried	Tropical agriculture
1.5	14685	6	0.072	Men's & boys' shirts, knit or crochet	Labour intensive
0.1	5795	17	0.071	Solid cane or beet sugar and chemically pure sucrose	Tropical agriculture
2.5	8024	3	0.071	Sacks and bags of a kind used for packing goods	Capital intensive
0	2222	10	0.071	Tobacco unmanufactured, tobacco refuse	Cereals, etc.
0	2149	0	0.07	Vegetable products, nes	Animal products
0.1	8974	1	0.07	Men's, boys' underwear, nightwear, etc., knit, crochet	Labour intensive
2.5	19729	17	0.07	Women's & girls' suits, dresses, skirts, etc., knit or crochet	Labour intensive
0	1887	0	0.07	Floor coverings with a base of paper or paperboard	Capital intensive
0	5519	3	0.069	Organic compounds, nes	Chemical
0	6394	2	0.069	Pepper (piper) crushed or ground capsicum, pimento	Tropical agriculture
0.1	8102	5	0.069	Wheat or meslin flour	Cereals, etc.
0	2211	3	0.068	Oil seeds and oleaginous dried, shelled	Cereals, etc.
0.5	19555	9	0.068	Women's & girls' underwear, nightwear, etc., knit, crochet	Labour intensive
0.2	4026	6	0.068	Vegetables, leguminous dried, shelled	Tropical agriculture
0	4564	0	0.067	Woven fabric of jute or other bast fibres of 53.03	Capital intensive
0	2719	18	0.067	Coffee, coffee husks and skins and coffee substitutes	Tropical agriculture
0	795	0	0.067	Sisal, agave, raw, processed, not spun, tow and waste	Cereals, etc.
0	6009	0	0.067	Fulminates, cyanates and thiocyanates	Chemical
0.4	7492	6	0.067	Soaps	Chemical
0.2	18149	4	0.067	Men's & boys' underwear, nightwear, etc., knit, crochet	Labour intensive
0	3411	0	0.067	Glass inners for vacuum flasks, other vacuum vessels	Labour intensive
0.3	10190	2	0.066	Women's & girls' underwear, nightwear, not knit, crochet	Labour intensive
0	5326	1	0.066	Molasses from the extraction or refining of sugar	Tropical agriculture
0	4467	0	0.066	Dolls representing only human beings	Labour intensive

Note: Columns are exports in \$ millions, production at Purchasing Power Parity (PPP) and total world trade in \$ billions

Source: Hausmann R & B Klinger, 'Achieving Export Diversification in Botswana', Centre for International Development, 2010, p. 20

HAUSMANN'S¹⁵⁹ SECTORAL ANALYSIS AND ECONOMIC RENTS

The difficulty with Hausmann's analysis is that, as is so often the case with such large-scale global statistical studies undertaken in the capitals of Europe and America, there is almost no space and certainly no time to devote to a detailed understanding of each of the sector-specific trade and microeconomic issues, which are often as important in determining what is traded as the factor endowment or technological sophistication of the country in question. Very often what is traded from particular countries is based on country-specific trading arrangements and has nothing to do with factor intensities. Resource rents are derived from trade in various products and without a detailed understanding of these rents the transformation that occurs especially in small developing countries is not readily understandable. It is worth considering the sectors that Hausmann himself uses to explain his model and his opposition to beneficiation, ie, cotton, sugar and logs.

COTTON AND TEXTILES

The transformation of cotton into textiles is frequently seen by proponents of downstream processing as an activity to be supported. Hausmann observes from his results that,¹⁶⁰

[i]n the case of cotton we see that only 24% of raw material exporters also exported processed cotton. Furthermore of the countries that exported raw cotton in 1995 but did not export processed cotton, only 9% were able to gain comparative advantage in processed cotton over the next five years. At the same time 50% of raw cotton exporters also export fruit, and 42% also export coffee.

The first obvious criticism of Hausmann's statistical analysis is that it is not reasonable to expect to observe economic transition in five years, which is a relatively short period, and his data sample is too short to come to the sort of conclusions he is making. Second, many of the countries that grow cotton and process it do so because of the requirements in preferential trading agreements that made two–three stage processing essential (through the rules of origin) in order for garments to be exported on a duty-free basis. In some trading arrangements this was unnecessary and countries were permitted to export clothing based on a cut, make trim basis, which required no connection between the materials used and final processing. Trade preference agreements such as the African Growth and Opportunity Act (AGOA) specified that less developed countries did not need to go beyond one stage transformation. This is particularly relevant in the period of Hausmann's investigation, ie, 1995–2000. Third, the fact that 9% of countries developed a comparative advantage in five years should be seen as a result of rules of origin rather than anything to do with technical capacities. Fourth, the production of cotton, fruit and coffee that commonly occurs together, as Hausmann observes, requiring similar factor intensities and technologies, tend to occur in the same countries because these products need similar but by no means identical, climatic and rainfall conditions. These conditions are commonly found in the same tropical developing countries.

159 Hausmann R, Klinger B & R Lawrence, 2008, *op. cit.*

160 Hausmann R, Klinger B & R Lawrence, 2008, *op. cit.*

SUGAR AND CONFECTIONARY

The sugar sector is also one where many developing countries have sought to promote downstream processing to confectionary. Hausmann notes:¹⁶¹

Only one third of raw sugar exporters also export that natural resource's downstream industry: confectionary products. Only 3% of raw sugar exporters who did not export confectionary products in 1995 were able to discover that sector by 2000, whereas the percentage of transition of sugar to garments was 30%.

The first problem with the analysis is that most developing country sugar exporters have market access under preferential trading agreements with the EU and the US. This is true of even very large exporting countries such as India, *let alone* the many smaller countries of the Africa, Caribbean and Pacific (ACP) group of states and the beneficiaries of the US access agreements. The marketing agreements pursuant to the Sugar Protocol of the Lomé Convention (the relevant legal instrument at the time) specify the type of sugar (88 polarity) that needs to be exported to the EU and the US. The highly refined sugar often needed for the production of many processed confectionary and sugar products is not produced in most of the developing countries that were signatories to that agreement. Second, the value chain for confectionary, especially at the time under investigation (1995–2000), for most countries cascaded heavily, with much higher tariffs the further one went up the value chain. While sugar-producing developing countries have long advocated the need for downstream processing for export, most are well aware of the many constraints to this ever happening, much as the producers of cocoa are aware that nominally desirable chocolate production is highly unlikely given tariff structures and non-tariff barriers to trade. It is hardly surprising that Hausmann found that only 3% of the significant number of sugar exporters were able to move to confectionary exports in five years, given the decades of protectionism in developed and developing country markets.

The fact that 30% of sugar-producing countries also moved to garments is a direct result of shifts occurring in the global trade regime at the time, ie, AGOA and the WTO's Multifiber Agreement, which facilitated the movement of rent-seeking garment manufacturing firms to small developing countries. Many sugar countries in the ACP group benefited directly from the liberalised access to the garment markets available in this period, for example Fiji, Mauritius, Jamaica and Swaziland. These countries all experienced a substantial expansion in their garment exports because of changing preference arrangements – which have all now evaporated, along with Hausmann's shift of sugar producers to the garment industry. Hausmann is right to argue that producing garments does not require a complex technology such as producing sugar, but this is not the casual factor in the observed sectoral change – it is a change in trade preferences that created increased incentives to movement into the garment industry by small developing countries.

161 Hausmann R, Klinger B & R Lawrence, 2008, *op. cit.*

Logs

Perhaps one of the most misunderstood sectors in Hausmann's work is the logging industry. Hausmann¹⁶² argues:

We see more than half of the world's log exporters also export sawmill output and it is common to see countries that exported logs but not mill output in 1995 transition to export mill output by 2000...Given the numerous policies to promote wood processing, we will observe more raw log exporters exporting processed wood than in a distortion free equilibrium, without these policies. Nevertheless even with this policy bias, we see that more log exporters exported fruit than plywood.

Hausmann argues that policy bias distorts the trade data but misses the most significant distortions to trade data, which stems from private sector malpractices. The tropical hardwood logging industry is arguably among the most corrupt resource industries globally. The economic reason for this is relatively simple. Tropical logging remains a cash flow industry, and like the capture fisheries, access to the resource gives rise to almost immediate rents given the absence of substantial overhead costs in extraction. The presence of substantial rents in the price of tropical hardwood logs, the absence of substantial investments and the resulting fixed costs mean that the corruption of public officials who can guarantee access to the resource is common in many countries. Furthermore, species misidentification, under-measurement of logs and transfer price manipulation have been pervasive in the logging sector globally for many decades and therefore the data on log exports is flawed. This is compounded by the incentives created to under-measure and under-price by stumpage and export taxes, which means that international trade data in this sector cannot be relied upon for the sort of analysis that Hausmann makes in the sector. It is this context of flawed price and volume data, compounded by rent-seeking behaviour by officials, and not Hausmann's 'distortion free equilibrium' that is relevant to understanding the trade in unprocessed tropical logs.

The attempts by governments in many developing countries to promote downstream processing at least to flitches, sawn timber and plywood have little to do with the desire of public officials to see processing as an attempt to deal with corruption and malfeasance in the industry. Raw logs are exported from numerous and often-remote locations, and forestry and export documentation is usually completed by poorly paid officials who are highly susceptible to the embellishments that are readily available from the rents earned in the sector. When logs are processed into sawn timber and plywood the potential for such malfeasance in the sector decreases substantially, as the processing occurs in a limited number of locations. What Hausmann fails to address is the question of why, given the numerous incentives for downstream processing in most developing countries, do log exports continue at all? The economic reason is straightforward – the actual rents available from unprocessed log exports are far greater than the value of the 'declared' incentives to process the logs, even with considerable government interventions. It is usually only

162 Hausmann R, Klinger B & R Lawrence, 2008, *op. cit.*

the most draconian of measures such as complete export bans that ultimately succeed in stamping out the pernicious trade in tropical unprocessed logs.

Hausmann's analysis fails because of the level of aggregation and its failure to appreciate the tedious minutia of international trade that create economic rents and quasi-rents, which have been the basis of economic activity in many of the world's small developing countries. Without such an analysis it is not possible to understand transformation along value chains, or why some countries move down these chains while others keep on producing a particular range of products.

ANNEX 3 REQUEST FROM THE US TO CHINA PURSUANT TO ARTICLE 25.10 OF THE WTO AGREEMENT: GUANGDONG PROVINCE

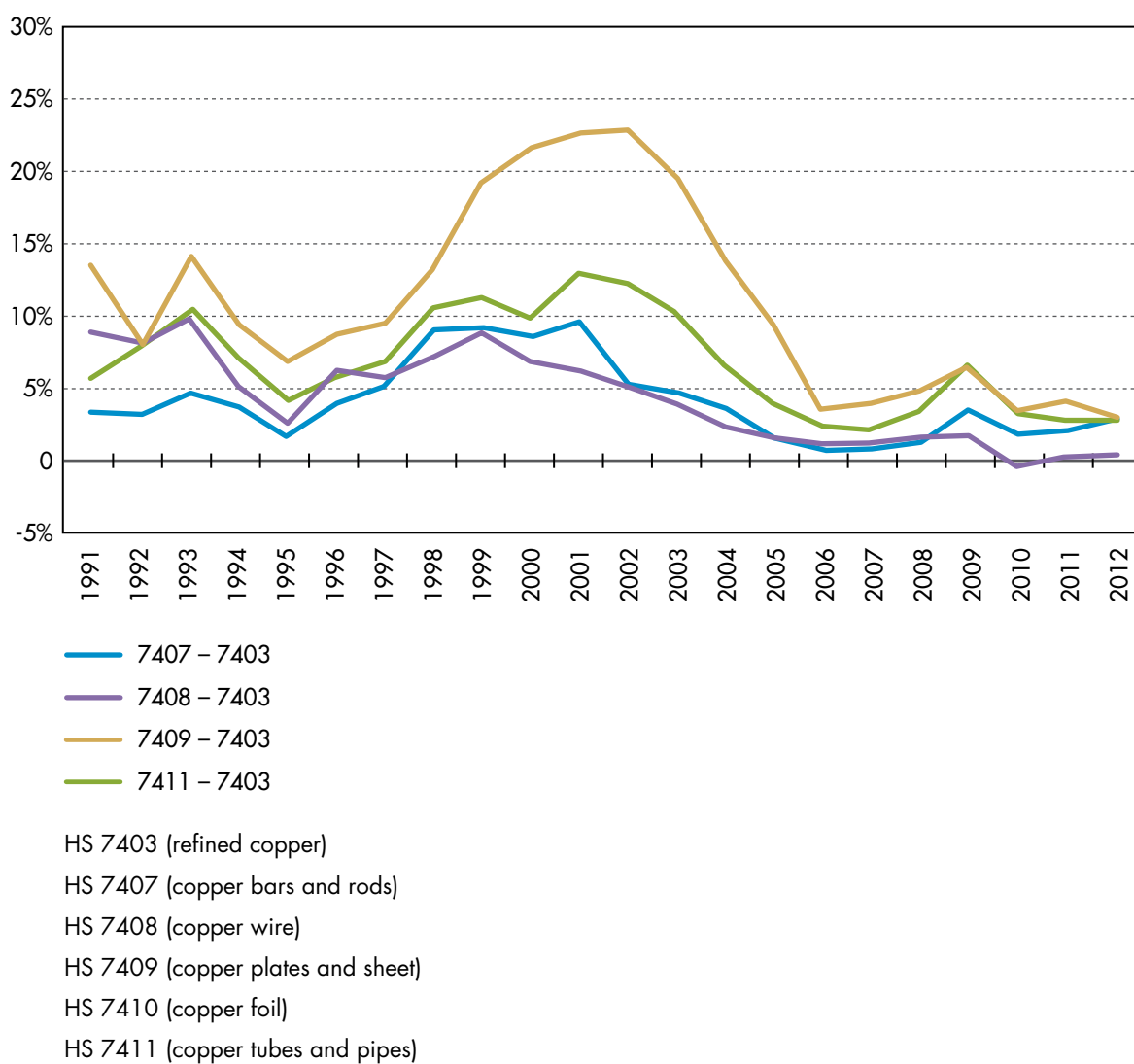
1	Circular on Printing and Distributing the Opinions on Recognizing 'Famous Export Brands' for the Foreign Trade and Economic Cooperation Department of Guangdong Province
2	Suggestions on the 'Export Brands Particularly Cultivated and Developed by the Department of Foreign Trade and Economic Cooperation Department of Guangdong Province' (Revised Edition)
3	Notices Concerning Alternative Name List Supplementary to the Export Brands Particularly Cultivated and Developed by the Department of Foreign Trade and Economic Cooperation of Guangdong Province
4	Measures for the Administration of Famous-brand (Industrial) Products of Guangdong Province
5	Measures for the Administration of Famous-Brand (Agricultural) Products of Guangdong Province
6	<i>Income Tax Programs for FIEs in Guangdong Province 'Preferential Policies for Foreign Investment':</i> Investment Guide to Guangdong
7	<i>Funds for Outward Expansion of Industries in Guangdong Province:</i> Implementing Measures of Guangdong Province on Supporting the Development of Outward-Oriented Private Enterprises
8	<i>Direct grants in Guangdong Province:</i> Implementing Measures of Guangdong Province on Supporting the Development of Export-Oriented Enterprises (29 September 2003)
9	<i>Preferential loans and interest rate subsidies in Guangdong Province:</i> Implementing Measures of Guangdong Province on Supporting the Development of Export-Oriented Private Enterprises (29 September 2003)
10	<i>Income Tax Programs for Export-Oriented FIEs in Dongguan City in Guangdong Province:</i> 'DongGuan: Preferential Policies'
11	Exemption from City Construction Tax and Education Tax for FIEs in Guangdong Province
12	Circular Concerning Temporary Exemption from Urban Maintenance and Construction Tax and Additional Education Fees For Foreign-Funded and Foreign Enterprises, Guo Shui Fa No. 038 [1994] (25 February 1994); See also Interim Provision on Additional Education Fee Levy, issued by the State Council (28 April 1986), amended by Order No. 60 (7 June 1990)
13	<i>Income Tax Reduction under the 'Torch' Program:</i> Decision on Promoting the Optimization and Updating of Industrial Structure through Scientific and Technological Progress by Guangdong Provincial Party Committee and the Municipal Government of Guangdong Province Yue Fa No. 16 [1998] (23 September 1998); Designation Criteria and Management Rules of Key High and New Technology Enterprises under National Torch Program (Provincial) (28 February 2001)
14	<i>Import Tariff Refunds and Exemptions for FIEs in Guangdong:</i> Regulations on Special Economic Zones in Guangdong Province Approved by the 15 th Session of the Standing Committee of the Fifth National People's Congress (26 August 1980); DongGuan Tax Administration, DongGuan Website
15	<i>Exemption from Real Estate Tax and Dyke Maintaining Fee for FIEs in Guangdong Province:</i> Invest in Shunde, Shunde Investment Promotion Bureau
16	<i>Land-related subsidies to companies located in specific regions of Guangdong Province:</i> Implementing Provisions for Encouraging Foreign Investment in Guangdong Province, People's Government of Guangdong Province (26 April 1987)
17	<i>Income Tax Programs for FIEs in Dongguan City in Guangdong Province:</i> 'DongGuan: Preferential Policies', available at http://english.dg.gov.cn/Preferential%20Policies.htm

18	<i>Income Tax Programs for FIEs in Dongguan City in Guangdong Province: 'DongGuan: Preferential Policies'</i> , available at http://english.dg.gov.cn/Preferential%20Policies.htm
19	<i>Support for Registered High-Tech Projects: 'Government of Huadu District Guangzhou: Investment Preferential Policies'</i> (March 2005), available at http://www.hdisc.gov.cn

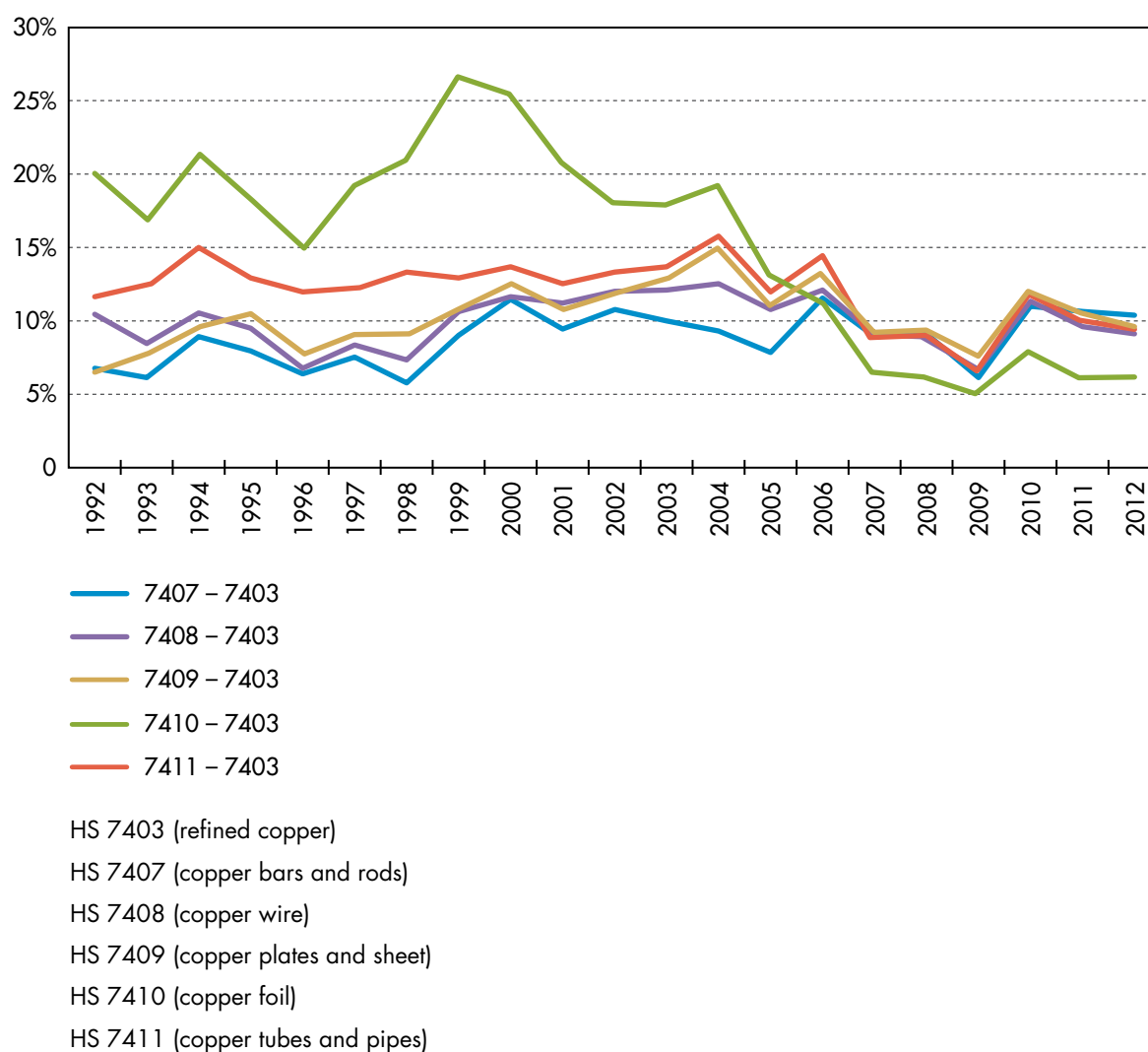
Source: WTO (World Trade Organization), 'Request from the United States to China Pursuant to Article 25.10 of the Agreement', 11 October 2011, <http://enforcement.trade.gov/esel/files/china-counter-notification.pdf>, accessed 17 February 2014

ANNEX 4 SEMI-FABRICATE EXPORT MARGINS

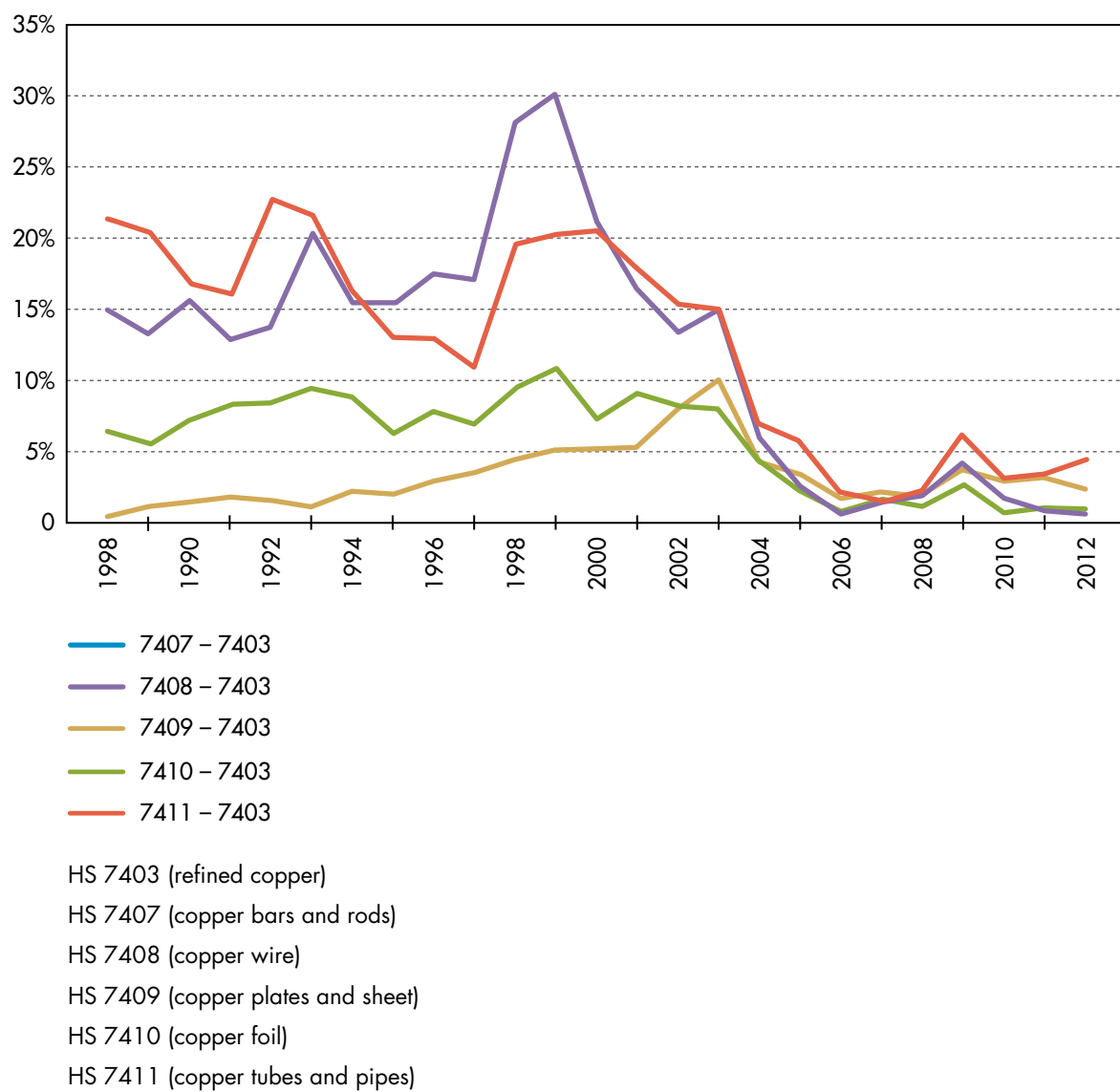
FIGURE 27 US, SEMI-FABRICATE EXPORT MARGINS



Source: Authors' calculations based on Comtrade, <http://comtrade.un.org/db/dqBasicQuery.aspx>, accessed 18 January 2014

FIGURE 28 CHILE, SEMI-FABRICATE EXPORT MARGINS

Source: Authors' calculations based on Comtrade, <http://comtrade.un.org/db/dqBasicQuery.aspx>, accessed 18 January 2014

FIGURE 29 JAPAN, SEMI-FABRICATE MARGINS

Source: Authors' calculations based on Comtrade, <http://comtrade.un.org/db/dqBasicQuery.aspx>, accessed 18 January 2014

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