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West and Central African Iron Ore: A Lesson in the Contestability of the Iron Ore Market

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Abstract

The paper briefly sets out factors behind Chinese demand for iron ore imports and the main features of China's medium term resource consumption growth path. It then outlines the potential of major iron ore export countries to meet China's medium term iron ore import demands.

The focus of the paper is on the potential of iron ore supplies from west and central Africa to enter the export market over the short and medium terms. To assess this, three export capacity scenarios (low, medium and high risk) are constructed for 17 iron ore mines (over 27 production expansion phases) in west and central African.

The results suggest the development of west and central African iron ore has the potential to create significant downward pressure on the price of iron ore exports over the short to medium term. The impact of the excess export capacity on iron ore price is estimated and it suggests that there would be significant knock-on effects for iron ore-centric economies such as Australia and Brazil.

JEL classifications: L72, O13, Q31, Q37

Introduction

The price of iron ore has reached historically high levels in the past five years as exporters have been unable to expand fast enough to keep pace with China's booming steel demand. This situation has drawn China's domestic iron ore producers into expanding production despite having operating costs of around three times those of the established international exporters.

Over the coming five years, China is expected to increase its demand for iron ore imports at a steady but slowing rate as it attempts to correct structural issues. At the same time, predictions of China's continuing growth have led to a recent scramble by major exporters, juniors and investors to explore, expand, and develop iron ore resources in established and emerging regions.

The rush to expand global export capacity and the willingness of Chinese investors and banks to provide funding to projects in high-risk areas, especially in west and central African countries, has created a scenario where export capacity could significantly outgrow demand at its current price in the next five years. This oversupply will have consequences for the profitability of the iron ore industry and for economies heavily invested in the current boom such as Australia and Brazil.

Understanding the potential for development of Africa's iron ore riches is of high importance to Australia. High prices and expanding iron ore production have been an important element in Australia's recent economic success, reflected in its historically high terms of trade. In 2011-12 iron ore exports are forecast to increase by 2 per cent to AU$59.7 billion, compared with 2010-11 (BREE 2012). There is, however, scant analysis of the potential of west and central African iron ore to supply Chinese import demand, and how this could impact the industry worldwide or in Australia specifically.

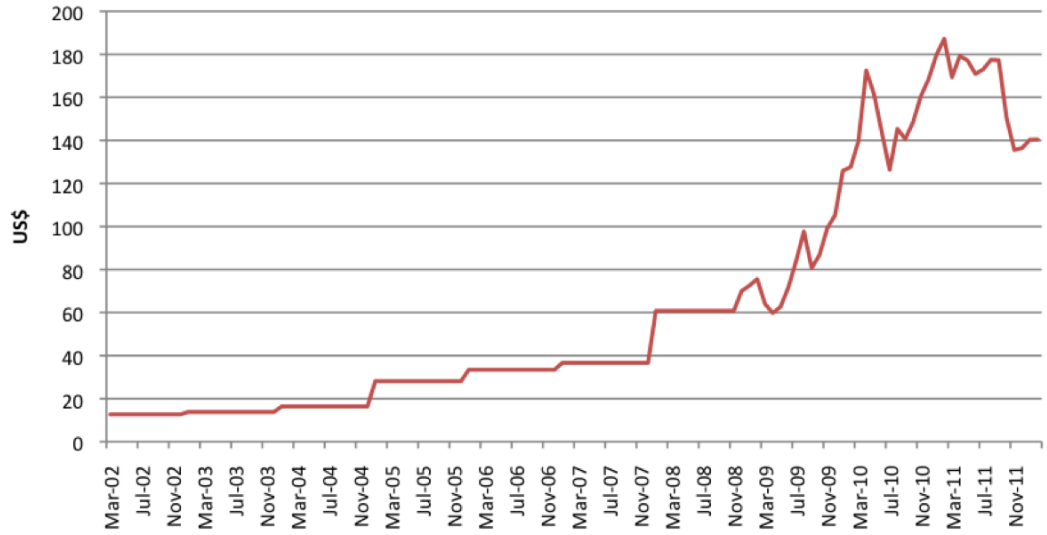
This paper attempts to assess the current state of the iron ore market and predictions for the medium term, with a focus on the potential of west and central African iron ore rich countries. The paper is set out as follows: first, the future of Chinese development is briefly discussed to provide context to understand China's future demand for iron ore imports. Second, the export outlook is outlined for established country producers: India, Australia and Brazil. Third, the paper attempts to assess the export potential of west and central African iron ore-rich countries and how this may affect the market in the future. Finally, the impact of Africa's expanding export potential on the iron ore price and profit margins are discussed. The paper concludes by outlining the key findings.

Demand

The most important use of iron ore (up to 98 per cent) is as a primary input to steel production. There is no current substitute for iron ore in blast furnace steel production and it takes approximately 1.6 tonnes of iron ore to produce one tonne of steel. Blast furnace production accounts for around 70 per cent of global steel production technology and 86 per cent of China's production (Song et al. forthcoming 2012).

China is in the middle of a period of unprecedented economic growth which has put significant strain on the iron ore industry to expand to keep pace with supply. When China joined the WTO in 2001 iron ore sold for around US$12.68/t. Since then, its rapid industrialisation, emerging middle class and urbanisation have contributed to unprecedented growth of demand of China's steel industry—this was the main driver for the export price reaching the historic high of US$187.18/t in February 2011 (see Figure 1 below).

FIGURE 1: Iron ore price, 2002-2011



SOURCE: http://www.indexmundi.com/commodities/?commodity=iron-ore&months=120, accessed 3 April 2012.

Since opening up in 1978, China's economic growth has averaged around 10 per cent per annum (see Table 1 below). This growth has been rapid but unbalanced and now Chinese authorities have identified a number of structural problems that require urgent attention: examples include a high investment ratio, large current account surplus, unequal income distribution, high resource intensity, serious environmental degradation and widespread corruption (Garnaut & Song, forthcoming 2012).

TABLE 1: China's economic growth by five-year plan, 1991-2015 (%)

Five Year Plan	8th ('91-95)	9th ('96-00)	10th ('01-05)	11th ('06-10)	12th ('11-15)
Target	6.0	8.0	7.0	7.5	7.0
Actual	12.3	8.6	9.8	11.2	8.4*

* Forecast.
SOURCE: Huang et al. (2011).

Despite China's internal restructuring requirements and global economic uncertainty, Barclays Capital (2011) estimates that Chinese economic growth was 9.1 per cent in 2011 and will be 8.4 per cent in 2012, they predict that even a steep decline in growth from 9 per cent to 5 per cent would not cause a meltdown.

At 8.1 per cent, the growth rate in the first quarter of 2012 did not meet these expectations but the reasons for optimism on China's economy are significant. The government has enough room to stretch policy and prevent a systemic economic meltdown with a strong balance sheet, backed by foreign exchange reserves estimated

at US$2.8-3.5 trillion, a current account surplus of around 5 per cent of GDP, and a strong currency (Huang forthcoming 2012).

The Australian government's Bureau of Resource and Energy Economics (BREE) estimates that to satisfy the needs of its growing economy and the accompanying demands of its emerging middle-class, continuing urbanisation and industrialisation, China's steel consumption will grow from 657mt in 2012 to 812mt in 2017 (see Table 2 below) (BREE 2012).

TABLE 2: Global crude steel consumption outlook, 2010-17 (mt)

	2010	2011	2012	2013	2014	2015	2016	2017
European Union	160	164	164	166	168	171	173	176
United States	90	94	96	98	101	104	107	110
Brazil	30	31	32	34	35	36	37	38
Russian Federation	42	44	45	47	48	50	52	53
China	600	624	657	695	729	761	787	812
Japan	68	69	74	77	78	80	81	83
Korea, Rep. of	55	56	57	59	61	64	66	68
Chinese Taipei	21	24	25	25	26	26	27	28
India	66	76	82	88	95	101	107	113
World steel consumption	**1389**	**1450**	**1508**	**1575**	**1639**	**1694**	**1745**	**1803**

SOURCE: BREE (2012).

To meet its domestic steel demand China relies heavily on imports despite having the largest reserves of iron ore globally. BREE's (2012) forecast indicates that iron ore exports to China will continue to grow at around 2.8 per cent per annum between 2012 and 2017 (a total increase of around 141mt over the period) (see Table 3 below).

TABLE 3: World iron ore imports, 2010-17 (mt)

	2010	2011	2012	2013	2014	2015	2016	2017
European Union	133	136	139	142	144	146	149	152
Japan	134	128	134	136	138	140	142	143
China	619	645	713	742	757	770	813	854
Korea, Rep. of	56	64	67	72	75	78	80	83
Chinese Taipei	19	22	23	23	24	25	25	26
World imports	**1051**	**1075**	**1149**	**1213**	**1279**	**1355**	**1439**	**1500**

SOURCE: BREE (2012).

Despite large reserves the average grade of China's iron ore is low (generally around 30 per cent ferric content) and reserves are predominantly located in the country's north and west, making transportation costly to steel mills, which are located mainly in industrialised coastal southern provinces. China's marginal producers face costs of around US$120/t — around US$80/t more than established producers of high grade (generally around 62 per cent) iron ore in Australia and Brazil — making imports a more reliable and cost effective solution for China's steel industry. But the rise of China has outpaced the expansion of exporters and China's marginal iron ore producers supplied an estimated 38.8 per cent of China's iron ore to its domestic steel mills in 2010 (Trench 2004; Tse 2010).

BREE's (2012) forecast appears conservative when compared to a recent 'stress test' presentation by Raw Materials Group (RMG). For the "almost worst case growth scenario" RMG assumed that China had become a 'normal' country, with 35 per cent

rather than the current 45 per cent of GDP going to investment by 2015; domestic GDP growth slowing to 6 per cent per annum between 2011 and 2015; and the steel intensity of output remained constant. Under these assumptions RMG concluded that Chinese iron ore demand would grow 3.8 per cent per annum (Ocean Equities 2011). This growth will continue to be fed by imports as China's domestic iron ore producers face rising domestic inflation, continued exchange rate appreciation and decreasing international freight rates (UNCTAD 2011).

China's industrialisation, emerging middle class and urbanisation

China's continuing industrialisation, emerging middle class and urbanisation will be the main drivers for its steel and accompanying iron ore import demand growth.

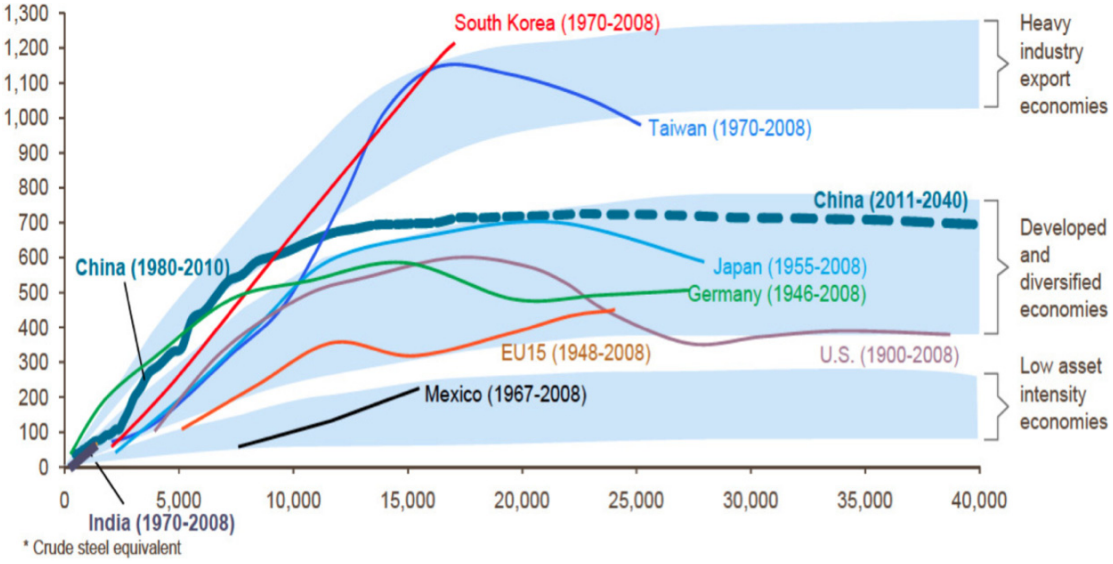
Historical patterns suggest that consumption of metals, such as steel, typically grow together with income as countries go through a period of industrialization and infrastructure building until the country moves into the high-income bracket (around $15,000-20,000 per capita, purchasing power parity adjusted dollars). At higher incomes, growth typically becomes more services-driven and the use of metals per capita declines (IMF 2006). As people move into the middle-income bracket their consumption of durable goods, such as cars, significantly increases with their disposable income, which drives the consumption growth of steel.

In 2010, China's middle-class was around 157 million people (Kharas 2010). Kharas (2011) forecasts China's middle-class will expand to 1.1 billion people by 2030. The emergence of a middle-class of this size suggests that China is far from reaching a saturation point for durable goods, which are a major consumer of steel. China's automobile penetration ratio, for example, was a mere 5 per cent of the US level in 2009 (McKay et al. 2010).

The IMF (2005) estimates that vehicle ownership starts to grow quickly when countries reach income of about US$2,500 per capita in purchasing-power-parity terms. Rapid growth continues until income per capita reaches about US$10,000. Saturation level occurs at around 850 vehicles per 1,000 people. China is projected to have nearly 20 times as many vehicles in 2030 compared to 2002 (269 vehicles per 1,000 people — a level comparable to vehicle ownership levels of Japan and Western Europe in the early 1970s). This forecast would see China with more vehicles than any other country (24 per cent more vehicles than the USA) and will represent a significant contribution to the country's steel demand (Dargay et al. 2007).

Measured by its per capita income ($8,394 in purchasing power parity terms), China is currently in the mid-phase of industrialization — a period characterised by a relatively high proportion of manufacturing in the total economy and a relatively high share of heavy industries in total industrial output. A key feature of this phase of industrialisation is the pattern of extensive growth in which factor inputs, especially physical capital, play a relatively more important role. As a result, China's steel consumption has been accelerating sharply, as shown in Figure 2 below (McKay et al. 2010).

FIGURE 2: Steel consumption (consumption, kg/capita vs. real GDP, $/capita)



SOURCE: Ridsdale (2011).

Although there is anecdotal evidence that China has already reached the turning point in its resource consumption, one benchmark that can be adopted is the projection by McKay et al. (2010). Assuming 7 per cent compound GDP growth and referring to work on the Kuznets curve for steel, McKay et al. (2010) conclude that China will not reach peak steel consumption per capita until 2024, and possibly after that if it follows a trajectory in the growth of steel demand similar to that of Japan (Findlay 2011).

The timing of China's predicted steel turning point by McKay et al. (201) is consistent with the forecasts of the current 12th Five Year Plan. Suggesting steel intensity will only start to decrease when the Chinese economy matures and the country's industrialisation and urbanisation level out – predicted to be around 2020-2025.

On the other hand, Garnaut (2011) argues that energy use will continue to increase despite climate change considerations, but that its rate of growth will diminish, as will the emissions intensity of energy production. This will have a negative influence on the intensity of China's demand for metals. Garnaut (2011, p.20) argues that "resource intensity of production will decline rather more rapidly than seems to be the common expectation, and more rapidly still as growth and the investment share of output fall from about 2015".

Growth in China involves not only industrialisation but also a rapid rate of urbanisation (Song 2010). Since the beginning of the reform period in 1978, China's urban population has increased rapidly from 19 per cent to 47.5 per cent in 2010, with a target of 51.5 per cent (around 717 million people) by 2015 set out in the 12th Five Year Plan.

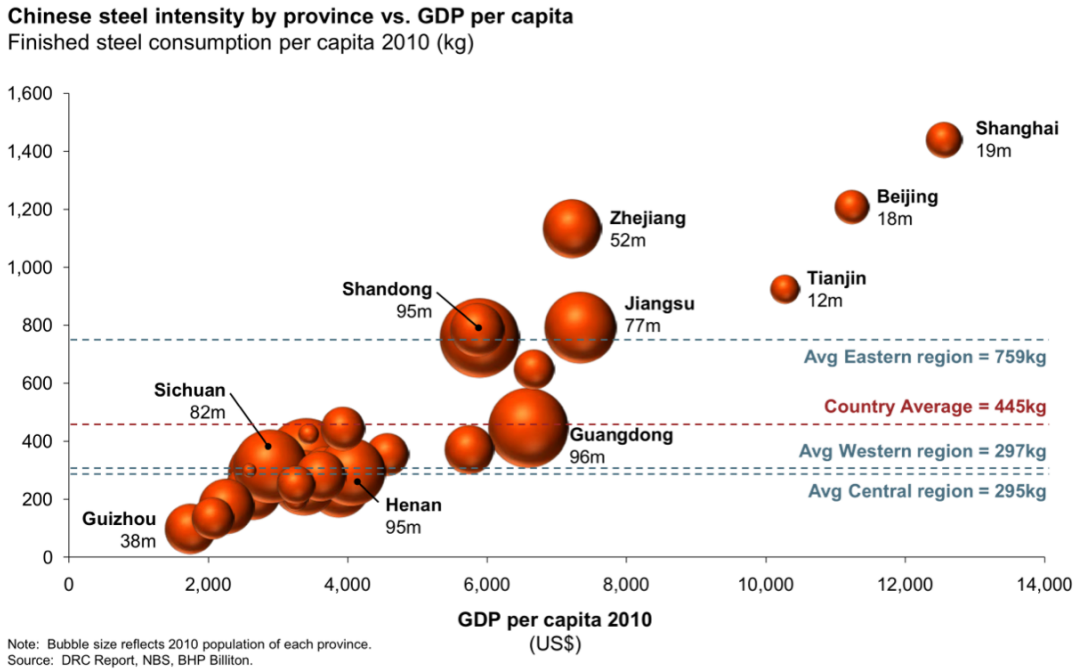
China's urban concentration ratio (the proportion of China's population living in megacities[1]) was 20.4 per cent in 2007 — 4 per cent lower than the world average, and 8 per cent lower than its predicted share at China's current level of economic development. It is predicted that 32 per cent of the Chinese population will live in

[1] A megacity is a metropolitan area with a population of more than 10 million.

megacities by 2020, reaching 37 per cent by 2030 (Wang 2011). These urban concentration ratios, although significantly higher than the present level in China, are still below present levels in the US and Japan (43 per cent and 48 per cent, respectively).

China's increasing urban concentration will develop mainly in current medium-sized cities, or even small cities. Over time new economic and population centres could emerge beyond the current Yangtze River Delta, Pearl River Delta and Beijing-Tianjin-Hebei regions; the Chongqing-Chengdu and Wuhan-Changsha areas, which are still in the early stages of the steel intensity curve, might become two such population centers in decades to come (see Figure 3 below).

FIGURE 3: China's steel intensity by province



Supply

BREE (2012) predicts that global demand for iron ore imports will increase by 425mt from 2011 to 2017 (around the size of Australia's total iron ore exports in 2011) — Chinese steel mills will account for around half of this demand increase (209mt).

TABLE 4: Iron ore exports, 2010-17 (mt)

	2010	2011	2012	2013	2014	2015	2016	2017
Australia	402	439	493	525	588	678	749	779
Brazil	311	313	333	372	411	443	467	489
India	96	63	43	46	46	46	44	40
Canada	33	34	36	37	37	38	38	38
South Africa	48	54	58	64	67	71	75	79
West Africa*	11	12	14	15	17	23	35	47
World exports	**1051**	**1075**	**1149**	**1213**	**1279**	**1355**	**1439**	**1500**

* West Africa includes Guinea and Mauritania.
SOURCE: BREE (2012).

Iron ore export expansion will be led by Australia and Brazil's big four exporters (Vale, Rio Tinto, BHP Billiton and Fortescue) as Indian exports recede in face of the recently imposed 30 per cent iron ore export tariff (see Table 4 above).

India: domestic supply focus

As Australian and Brazilian iron ore producers rush to meet rising demand from China, India is set to cut exports dramatically. In 2010, India was the world's third largest iron ore exporter, capturing around 9.1 per cent or 96mt of the global export market (BREE 2012).

In 2011, Indian authorities adopted policies to ensure their rapidly emerging middle class and urban infrastructure needs would be supported by Indian steel production, in turn served by India's own iron ore riches. On 2 January 2012, the Indian government announced a further increase of export tariffs to iron ore lumps and fines of 30 per cent.

Unless the Federation of Indian Mineral Industries is able to have the tariffs repealed, exports for the first quarter of 2012 could be 75 per cent lower than previously expected (BREE forecasts a drop in exports from 63mt in 2011 to 43mt in 2012) (Mukherjee & Dutta 2012).

The gap left by receding Indian exports will put upward pressure on international prices in the short term and further support the case for rapid expansion of the export industry in Australia and Brazil (de Krester 2012).

Australia: expansion plans and magnetite potential

Australian producers have developed significant expansion plans to capitalise on the rising demand from China and diminishing Indian exports. Currently around US$60.8 billion of investments are planned for new iron ore mines and to expand current capacity, with another US$22 billion earmarked for infrastructure projects to support new capacity — these investments are scheduled to occur by 2018. The expansion plans are led by the three big Australian iron ore producers (BHP Billiton, Rio Tinto and Fortescue) as they attempt to push the total seaborne iron ore trade from 439mt/a in 2011 to over 779mt/a by 2017 (BREE 2012).

High grade hematite, or direct shipping ore (DSO), has driven Australia's iron ore boom to date. But the recent historically high prices and accompanying profit margins for iron ore have brought Australia's vast magnetite deposits into consideration in expansion plans (Game-Lopata 2012).

Australia currently has around 60 magnetite mines in planning or operational phases with total magnetite resources estimated at around 24.1bt (see Table 5 below). A report published by Deloitte Access Economics in 2011 estimated that development of the magnetite industry could add AU$4.5 billion to national GDP per annum and create more than 4,000 jobs (Burrell 2011).

Magnetite contains less iron than hematite and is therefore of less value in its raw state. Before it can be used in steel production, magnetite needs to be processed ('beneficiated'), which requires capital-intensive processing infrastructure at or near

the mine site. Just as Japan's development and engagement was critical to unlocking Australia's Pilbara hematite reserves in the 1960s, China is now well-positioned to partner magnetite projects (Siddique 2011).

TABLE 5: Australian magnetite potential

State	Planned Mines	Total Magnetite Raw (mt)
WA	29	17,846.6
SA	25	6,048.8
Tas	3	61.2
Qld	2	137.4
NT	1	3.7
Total	**60**	**24,097.7**

SOURCE: Intierra database.

China's importance to the development of Australia's magnetite is on display with Sino Iron's CITIC Pacific Magnetite Project, the first major magnetite mining and processing project in Australia. It is a significant step for the budding industry and is set to become the largest magnetite operation in the world; at full capacity, CITIC Pacific will mine around 140mt per annum. But cost overruns and delays have resulted from a lack of understanding of Australia's policy environment more broadly — a key assumption underpinning the project was the cost savings CITIC hoped to gain from importing Chinese engineers and workers to build the mines. When standard Australian restrictions on imported labour were discovered by CITIC the budget blew out significantly. As of 2011 Chinese investors have suspended all investments in magnetite projects in Western Australia (Hurst & Wang 2012).

Without Chinese capital, major projects such as the troubled Oakajee port and rail project will be unlikely to get up. Comprising a 45mt per annum deep-water port near Geraldton and a 570km railway to handle 100mt per annum, the Oakajee project is seen as the key to opening Western Australia's mid-west magnetite-rich region — the Western Australian government has been pushing for Chinese companies to become equity partners for this project without luck (Game-Lopata 2012).

Brazil: expansion plans and cost reduction

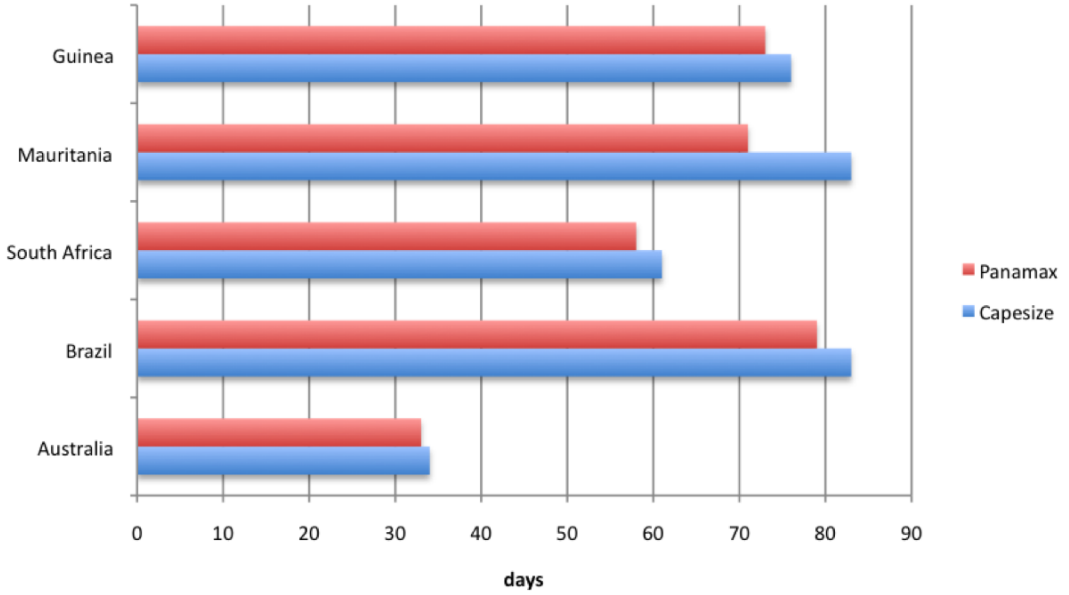
Brazil is the second largest global iron ore exporter. Led by Vale, Brazil's exporters are investing quickly to take advantage of the high price of iron ore. BREE (2012) forecasts that iron ore exports from Brazil will reach 489mt in 2017, up from 313mt in 2011 (see Table 4 above).

Vale will invest US$10.2 billion by 2014 to expand its iron ore mine Carajás Serra Sul. Carajás, in the northern state of Pará, is the site of the company's single largest iron ore mine. Vale will also invest US$2.5 billion by 2014 in the Apolo iron ore mine project in Minas Gerais.

Australian producers hold a cost advantage over their Brazilian counterparts due to their geographic proximity to China. In December 2011, Capesize shipping rates from Port Hedland/Dampier to Qingdao are around US$13.50 per tonne (3,458 nautical miles), whereas Brazilian exporters faced transport costs of US$30.50 per tonne from Tubarão to Qingdao (11,023 nautical miles). Capesize ships from Australia take around 22 days 12 hours[2] less time to reach Qingdao (see Figure 4 below).

[2] Based on 13 knot shipping speed.

FIGURE 4: Vessel roundtrip days to China, including congestion and bunkering



SOURCE: Ocean Equities (2011).

During the 10 months leading up to the financial crisis of 2008, the Baltic Dry Index[3] (BDI) was consistently above 11,000 and ships were leased at extremely high fees. Regardless of the inflated ore prices, shipping fees exacerbated the distance issue for Vale. In an attempt to diminish the cost advantage of Australian producers Vale has pursued an aggressive US$8 billion strategy to have 35 Valemax ships built. The Valemax's can carry 380,000—400,000 deadweight tonnes (dwt) of iron ore each — more than twice the capacity of the current Capesize vessels, representing around US$1.6-2 million saving per shipment. The project has met significant obstacles, such as a cracked ballast tank in one ship and being turned away from Chinese ports, but it is too soon to accurately assert its success or failure.

Western & central Africa: the new iron ore frontier

Africa's total iron ore reserves (measured plus inferred) contain an estimated 34.9bt of hematite[4] and 17.3bt of magnetite[5] (see Appendix 1). In comparative terms Africa has similar reserves to Australia, with 37.0bt of reported hematite reserves and 10.4bt of magnetite, although reserve levels provide a limited insight into production potential.

The sustained demand for iron ore from China and diminishing grades of hematite in Australia and Brazil, along with the uncertainty surrounding India's iron ore exports have encouraged miners to pursue assets in operationally risky locations, largely in west and central African countries (Johnston & Reddy 2012).

[3] The Baltic Dry Index provides an assessment of the price of moving the major raw materials by sea taking in 23 shipping routes measured on a time charter basis, the index covers Handysize, Supramax, Panamax, and Capesize dry bulk carriers carrying a range of commodities including coal, iron ore and grain.
[4] Estimate based on 66 reporting mines (Intierra database).
[5] Estimate based on 16 reporting mines (Intierra database).

Despite considerable investment risks, the African iron ore industry is going through a renaissance as low operating costs and vast, high grade discoveries of hematite have overshadowed countries' risk profiles (see Appendix 2 for development indicators).

The key driver for Africa's growth is not just China's booming resource import demand, but improved political and macroeconomic stability and microeconomic reforms. In the past decade the real GDP of iron ore-rich west and central African countries[6] has enjoyed a healthy growth rate of 4.0 per cent – the global average for the period was 3.9 per cent (McKinsey & Company 2010).

The improved business environment has benefitted from government debt relief for the most highly indebted countries. Increased pledges of overseas development assistance from donor countries and philanthropic institutions are also providing fresh opportunities to free up resources for investment in human and fixed capital (Donnelly & Ford 2009).

This growth and other political and macroeconomic indicators suggest that Africa may be at a turning point as a global resource supplier. Guinea's Bellzone and China International Fund joint venture operating company Forécariah Guinea Mining is an example of how high risk operations in Africa's are becoming realistic investment opportunities. The project is set to begin exporting iron ore to China in the first quarter of 2012, on schedule (Esterhuizen 2012).

The draw of Africa's iron ore is its relative purity. As ferrous content decreases in Australia and Brazil, unearthed African deposits consistently offer DSO quality resources. But for decades the main obstacle to investing in African mining has been insufficient — often non-existent — infrastructure. Deals that might have looked good on paper were often unviable once the infrastructure costs were factored into the internal rate of return. This situation means that the initial marginal cost for west and central African iron ore will be massive when compared to the marginal costs of expanding production in Australia and Brazil where infrastructure is developed.

To develop African resources Chinese operators have support from the US$5 billion China-Africa Development Fund (CADFund). The CADFund's stated aim is, "investing directly in Chinese enterprises which have set up operations in Africa or plan to invest in Africa, CADFund will push Chinese and African enterprises to reach their cooperation targets and facilitate infrastructure construction, as well as enhance the social and economic development of African countries." The Fund provides equity and quasi-equity investment, fund investment and investment management and consulting services for projects in agriculture, manufacturing, infrastructure, natural resources and industrial parks.

In addition to infrastructure development support, China's renewed investment push into global markets may hold the key for the development of west and central African iron ore. RBC Capital Markets (2011) reports that all-in capital costs to develop a sample of 32 iron ore mine sites across the African continent range between US$52 billion and US$54 billion. Current credit ratings for African iron ore countries (see Appendix 3), coupled with western banks' unwillingness to invest in such projects,

[6] Average GDP growth across Cameroon, Republic of Congo, Guinea, Liberia, Senegal, Sierra Leone, Gabon.

suggest that it is unrealistic to expect these resources will develop in the next 5 to 10 years. An Australian mining CEO explained:

> The difference is that the Chinese operators can get the funding from Chinese banks where the Western banks won't lend… So the Western company might make their assessment and go, 'Yeah, I want to buy', but can't get any funding for it and that's the difference.

Chinese ODI to Africa has increased 19-fold, from US$491.2 million in 2003 to US$9.3 billion in 2009 — Chinese ODI to Europe in 2009 totalled US$8.7 billion (Hurst 2011) (see Table 5 for Chinese ODI to iron ore rich African countries). Moran et al. (forthcoming 2012) stated that "Chinese investors will be more willing to take on new frontier — or even fringe — projects that the major established oil and mining companies might pass by." Moran (2010) noted that in 13 of 16 cases analysed, Chinese investors took an equity stake and/or wrote long-term procurement contracts with producers on the competitive fringe.

TABLE 5: Chinese ODI to Africa iron ore countries, 2003—2009 (US$m)

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Cameroon	5.73	6.98	7.87	16.46	18.51	20.34	25.05
Rep. of Congo	-	5.65	13.32	62.9	65.4	75.42	115.17
Guinea	14.34	25.77	44.22	54.63	69.97	96.37	129.32
Liberia	5.8	6.38	15.95	29.51	29.78	37.36	56.39
Mauritania	1.82	2.13	2.4	20.12	15.14	24.76	31.29
Nigeria	31.98	75.61	94.11	215.94	630.32	795.91	1025.95
Sierra Leone	5.74	18.45	14.89	32.28	43.7	47.47	51.23

SOURCE: MOFCOM (2010).

To date, Chinese investors in African iron ore projects have been from large companies and investment funds across the scope of ownership structures. Current African iron ore investors include Wuhan Steel (state owned), CADFund, China International Fund Ltd. (privately owned), Shandong Iron and Steel Group (state owned) and Chinalco (publicly owned).

Looking to the future, China has the necessary capital and an incentive to put downward pressure on the price by assisting the development of African iron ore export capacity in a way that will significantly alter the supply structure. China's Ministry of Commerce (MOFCOM) announced in early 2012 that over the next five years it will encourage ODI to increase global stocks to US$560 billion (an increase of US$390 billion over the period). This push aims to make better use of China's estimated US$2.8-3.5 trillion foreign exchange reserves at a time when exports markets are declining and FDI inflows slowing down as a result of the global economic crisis (Edwards 2012; Huang forthcoming 2012).

This future Chinese ODI is not all earmarked for African iron ore projects. But if 14 per cent of the $390 billion ODI is directed to African iron ore projects over the next five years, it would meet the $52-54 billion all-in capital costs reported by RBC Capital Markets to develop 32 mines across the continent.

It is essential for African governments to ensure a supportive business environment for these major capital-intensive projects. Chinese banks are able to take a longer-term view of projects in comparison to Western lenders but the Chinese authorities

are cracking down on risky investments in the wake of significant and embarrassing losses. China's State Assets Supervision and Administration Commission published new rules in 2012 that hold SOEs and their executives accountable for bad overseas investment decisions (Cai 2012).

Low levels of knowledge capital have also been a considerable obstacle for the development of technology intensive infrastructure and mine sites. Again, China is a promising partner on this front. Unlike Australia, most of Africa's resource-rich countries allow Chinese operators to import a wider range of labour and management. Although this has created cases of significant tension and difficulties it is a key ingredient for Africa's iron ore development which had been previously lacking.

China's aim to secure iron ore supplies in Africa is supported by long-established state relationships, fostered through its triennial Forum of China-Africa Cooperation (FOCAC) (see Table 6 below for FOCAC highlights).

TABLE 6: Highlights from FOCAC conferences

Year (Location)	Highlights
2000 (Beijing)	• Participants from 44 countries passed the *Programme for China-Africa Cooperation in Economic and Social Development*.
2003 (Addis Ababa)	• Under the Addis Ababa Action Plan China wrote off $1.3 billion debt for thirty-two African countries.
2006 (Beijing)	• Heads of state or government from 35 African countries. • China pledged $5 billion in concessionary loans.
2009 (Sharm el-Sheik)	• Heads of state from 49 African governments. A new $10 billion concessionary loan and a $1 billion loan for small and medium-scale African businesses. • China pledged construction of 100 new clean-energy projects and increased support for medical and education projects.
2012 (planned for Beijing)	• N/A

SOURCE: Sparks (2011).

TABLE 7: Chinese investor structure by industrial and commercial registration, 2008-2009 (%)

	Share in Number	Share in Stock
State-owned Enterprises	14.8	69.4
Limited Liability Company	54.0	21.1
Private Enterprises	8.4	1.0
Stock Limited Corporation	8.0	6.1
Cooperative Enterprises	5.7	1.1
Foreign Investment Enterprises	3.3	0.7
Collective-owned Enterprises	1.4	0.4
Hong Kong, Macao and Taiwan-Invested Firms	1.8	0.1
Others	2.7	0.3

SOURCE: Statistical Bulletin of China's Outward Foreign Direct Investment published by Ministry of Commerce, PR China in Huang and Wang (2011).

The advantage of the strong state ties also provides some assurance and political insurance for Chinese investment in iron ore (SOEs accounted for 69 per cent of China's ODI stocks globally in 2008-09) (see Table 7 above). China's non-interventionist approach to international engagement also permits relationships with regimes where Western governments would be unwilling (Hurst 2010).

Already there are hundreds of iron ore projects under study or being developed in Africa, including some large scale ones, and African governments are pushing to increase their iron ore export capacity while the price is high. For example, the government of Gabon recently reached a deal with BHP Billiton to award them the Belinga iron ore concession after it decided China Machinery Engineering Corporation was not developing the resources fast enough. This kind of 'strike while the iron's hot' mentality by the Guinean government has pushed Rio Tinto to truck iron ore 650km to meet its first ore shipment deadline of mid-2013 from its Simandou mine in Guinea.

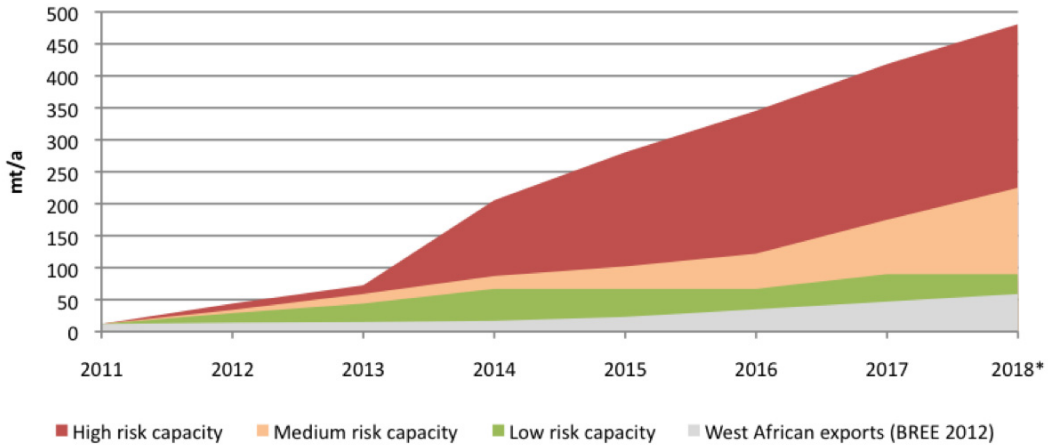
The author constructed a risk index for each of the 27 production expansion phases of 17 mines across west and central African. A production expansion phase refers to the expansion of a mine's capacity which is brought online in a staggered fashion. For example, the Forecariah Iron Ore Deposit will come online in two phases – phase one will have 4mt/a capacity by 2012, the second phase will expand production capacity to 10mt/a by 2013.

The risk index incorporated seven risk categories (host operational risk, host political risk, project infrastructure requirements, investor experience, investor-government relations, funding risks, and Chinese ownership and funding) to construct three risk based scenarios – high, medium and low-risk. Another way of looking at these risk scenarios is to think of low risk projects as having a high probability of coming on stream as designed and within the timeframe planned; medium and high risk expansion phases have a lower probability of meeting their outlined initial production dates, being more likely to be delayed. The likelihood of these higher risk projects coming online in the long-term is nonetheless real and they represent a significant longer term overhang in the market.

Based on the reporting of 17 mines (over 27 production expansion phases), west and central African iron ore production has the potential, in the high-risk scenario, to add 481mt/a to world iron ore export capacity by 2018 (see Figure 5 & Table 8 below). This figure is in-line with estimates by RBC Capital Markets (2011) that 475—575mt/a of iron ore export capacity will become available in Africa by 2016 (based on analysis of 32 mines), and by Ocean Equities (2011) that 300mt/a could be available by 2018 (based on 16 mines).

The low-risk scenario suggests that if all high and medium-risk projects are delayed beyond 2018, 31mt/a (in addition to the 425mt of already forecast global export supply expansion) will come online by 2018 — representing a global export supply overcapacity of 2 per cent. If all medium and low risk phases are achieved on time and high-risk phases delayed, 166mt/a export capacity could come online — representing 10.6 per cent export overcapacity by 2018. If all 27 analysed production expansion phases come online as outlined an extra 422mt/a could enter the global export market by 2018, representing export capacity that would be 27 per cent over currently forecast global demand, see Figure 6 & Table 9 below.

FIGURE 5: Potential west and central African iron ore export capacity scenarios, 2011-2018 (mt/a)



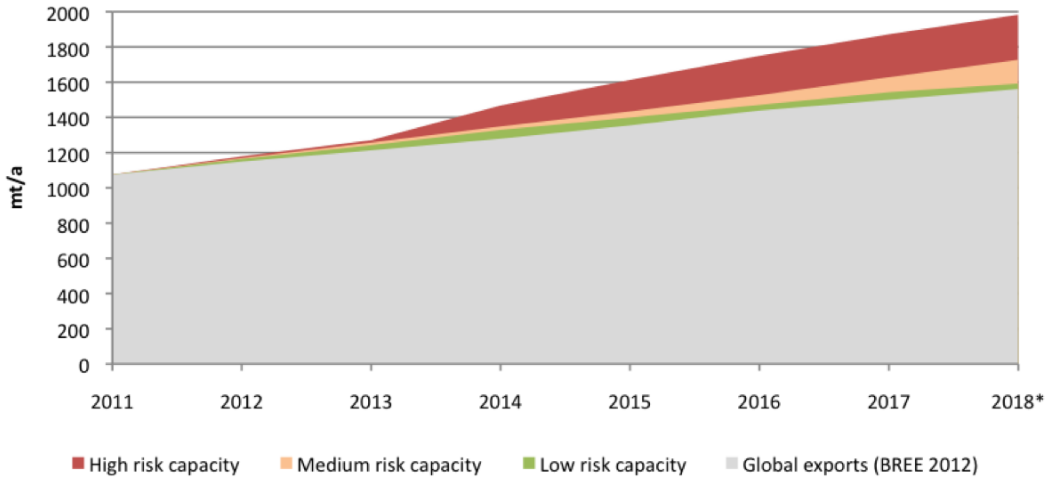
SOURCES: BREE (2012); Intierra database; RBC Capital Markets (2011); Ocean Equities (2011); company reports; author's calculations.

TABLE 8: Western and central African export capacity scenarios, 2011-2018 (mt/a)

	2011	2012	2013	2014	2015	2016	2017	2018*
BREE (2012) West African forecast	12	14	15	17	23	35	47	59
Low risk capacity	0	15	29	50	44	32	43	31
Cumulative additional capacity	12	29	44	67	67	67	90	90
Medium risk capacity	0	5	15	20	35	55	85	135
Cumulative additional capacity	12	34	59	87	92	122	175	225
High risk capacity	0	10	13.6	118.6	178.6	223.6	243.6	256
Cumulative additional capacity	0	44	72.6	205.6	270.6	345.6	418.6	481

* For 2018 import growth is assumed to be linear.
NOTE: Rio Tinto's Simandou mine capacity is assumed to come online as 5mt (2013), +5mt (2014), +10mt (2015), +15mt (2016), +30mt (2017), +30mt (2018) in the medium risk scenario.
SOURCES: BREE (2012); Intierra database; RBC Capital Markets (2011); Ocean Equities (2011); company reports; Hurst (forthcoming 2012).

FIGURE 6: Potential global export capacity scenarios, 2011-2018 (mt/a)



SOURCES: BREE (2012); Intierra database; RBC Capital Markets (2011); Ocean Equities (2011); company reports; author's calculations.

TABLE 9: Potential global export capacity scenarios, 2011-2018 (mt/a)

	2011	2012	2013	2014	2015	2016	2017	2018
High risk capacity	1075	1179	1270.6	1467.6	1612.6	1749.6	1871.6	1983
Export overcapacity	0.0%	2.6%	4.8%	14.8%	19.0%	21.6%	24.8%	27.0%
Medium risk capacity	1075	1169	1257	1349	1434	1526	1628	1727
Export overcapacity	0.0%	1.7%	3.6%	5.5%	5.8%	6.1%	8.5%	10.6%
Low risk capacity	1075	1164	1242	1329	1399	1471	1543	1592
Export overcapacity	0.0%	1.3%	2.4%	3.9%	3.3%	2.2%	2.9%	2.0%
Global exports (BREE 2012)	1075	1149	1213	1279	1355	1439	1500	1561*

* BREE forecast export growth for 2010-2017 has been extrapolated linearly for 2018.
SOURCES: BREE (2012); Intierra database; RBC Capital Markets (2011); Ocean Equities (2011); company reports; author's calculations.

Price impact

Most disclosed estimates of operating costs for west and central African iron ore projects tend to be relatively low due to low labour costs and the high grade ore, which requires little processing. African Free On Board[7] (FOB) cost estimates range from as low as US$20/t for the planned DSO material from Sundance's Mbalam project up to US$50/t for Sierra Leone's Marampa mine[8] (RBC Capital Markets 2011; Emery 2012). When shipping costs are included, west and central African iron ore will, on average, cost around A$50-80/t.

In a business as usual scenario, BREE (2012) estimated that the contract price of iron ore will average around A$140/t in 2012 and will drop to A$109/t by 2017.

In the low risk scenario the addition of BREE's forecast global expansion and African export capacity could decrease the price to A$80/t Cost, Insurance and Freight[9] (CIF) into China by 2018; the medium-risk scenario could see the price drop to around A$65/t; and the high-risk scenario to around A$60/t.

In the low-risk scenario, west and central African iron ore will push current marginal suppliers — mainly Chinese but also Indian and others — out of the market. If the high-risk scenario is realised some of the new higher cost African capacity will also be pushed out (see Figures 7 & 8 below).

The iron ore pricing mechanism is moving away from quarterly and monthly contracts toward a spot market, so the decreases in price caused by the export overcapacity will occur in real time.

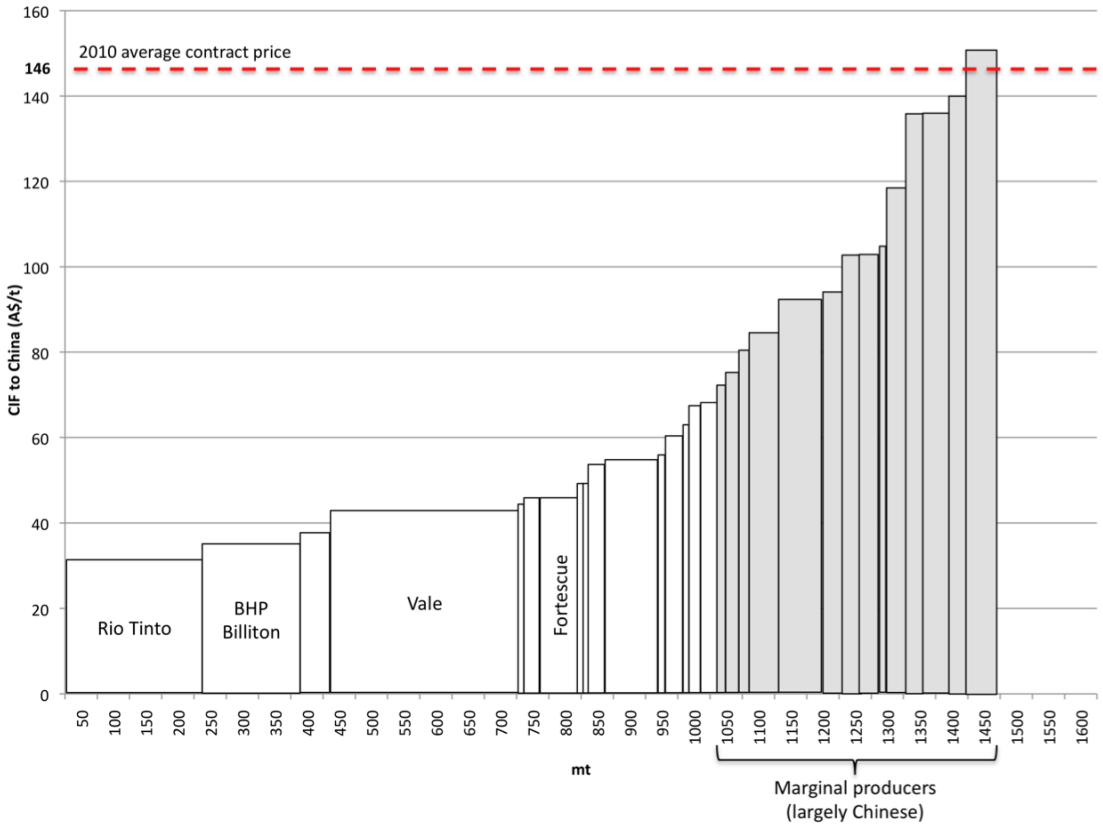
If the iron ore price dropped to A$80/t, low-cost exporters such as Rio Tinto, BHP Billiton and Vale would still have a A$35-45/t margin. If the high or medium-risk scenarios materialised, the low-cost producers' margins could drop to around A$25-30/t (see Figure 8 below).

[7] FOB requires the seller to deliver goods on board a vessel designated by the buyer. The seller fulfils its obligations to deliver when the goods have passed over the ship's rail.

[8] Note that many of the available estimates are still at the prefeasibility or feasibility stage, and so there exists some potential for cost increases once these operations are in production. Further, much of the pellet feed operating cost estimates for African projects do not include the cost of pelletizing.

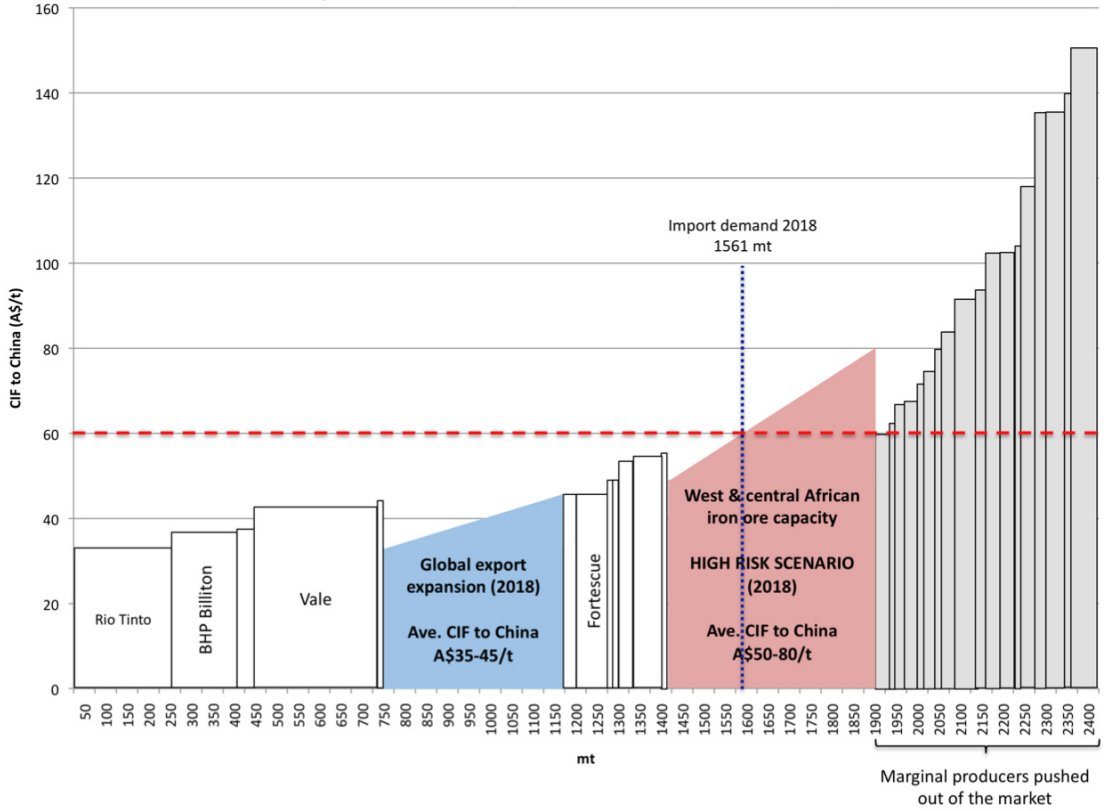
[9] CIF price includes insurance and all other charges up to the named destination port.

FIGURE 7: 2010 iron ore cost curve & average contract price (CIF to China A$/t)



SOURCE: Adapted from Mackenzie (2011).

FIGURE 8: 2010 iron ore cost curve with global export capacity expansion and high risk Africa scenario (2018, CIF to China A$/t)



SOURCES: Mackenzie (2011); BREE (2012); author's calculations.

The knock-on effects of these price scenarios would be significant for iron ore-centric economies such as Australia — iron ore is expected to provide A$59.7 billion to Australia's GDP in 2011-2012 (BREE 2012). A drop in iron ore prices in all the scenarios outlined above would negatively impact Australia's terms of trade, real exchange rate, and revenue collected from the Mineral Resource Rent Tax (MRRT). The falling price would also be another significant constraint for the development of Australia's budding magnetite industry development, which is forecast to add A$4.5 billion to national GDP per year and create more than 4,000 jobs over the coming decade.

Conclusion

Over the coming five years, China is expected to increase its demand for iron ore at a steady but slowing rate as it pursues readjustments to its economy in the face of significant structural issues.

The forecast growth of China's iron ore imports and India's focus on supplying its domestic steel industry, has led to a scramble to expand and capitalise on the high price. Miners and investors have aggressively pursued exploration, expansion and development of Australian and Brazilian resources but there has been a recent trend to look further afield to countries traditionally considered too risky, especially in west and central African countries.

Countries in west and central Africa have vast and high quality iron ore reserves but development of these resources requires massive capital infrastructure investment in operationally risky environments. Western banks are extremely hesitant to lend and the scarcity of capital has been a large impediment to development.

China, on the other hand, has an estimated US$2.8-3.5 trillion in foreign exchange reserves and authorities have stated they will support US$390 billion in overseas direct investments over the next five years.

China has also capitalised on its non-interference approach to international engagement and established state-ties with several of Africa's iron ore rich nations. This state-level engagement provides assurance to China's state-owned investors and banks when making large capital investments in operationally risky projects. But in light of recent overseas investment failures, Chinese authorities are requiring more rigour in due diligence and African governments will be required to ensure their investment environment is supportive of the major capital projects required.

The scramble to expand iron ore export capacity in Africa along with African governments' pressure to get iron ore to market while the price is high has created significant risk of export over-capacity in the short to medium-term.

If overcapacity occurs, it is likely that supply expansion in Australia and Brazil will be deferred as African governments in Guinea and Gabon have shown their willingness to take away mining concessions if resources are not developed in a timely manner.

If all the iron ore projects analysed came online as reported, by 2018 an additional 481mt/a will be available to the global export market — representing 27 per cent over-capacity in global exports. This could lead the price of iron ore to drop to around A$60/t CIF to China in the high-risk scenario — the price could fall to around A$65/t in the medium and A$80/t in the low risk scenarios.

A price decrease to A$80/t would still provide intra-marginal producers with considerable yet highly impacted margins of around A$40/t — instead of current margins of over A$80/t — but it would have serious consequences for the competitiveness of marginal producers and iron ore-centric economics such as Australia and Brazil. A price fall as outlined in the medium and high-risk cases would have catastrophic impacts to the industry and iron ore centric-economies such as Australia.

Iron ore is forecast to contribute A$59.7 billion to Australia's economy in 2011-12; a drop in the price, in all the above scenarios, would negatively impact the overall terms of trade, the value of the Australian dollar, and see a significant short-fall in the revenues collected from the MRRT. The falling price would also be another significant constraint for the development of Australia's budding magnetite industry development, which is forecast to add A$4.5 billion to national GDP per year and create more than 4,000 jobs over the coming decade.

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Appendix 1 — Potential hematite and magnetite reserves for African iron ore rich countries

Country	No. Mines Reporting	Unknown Mine Type	Total mines	Reported Iron Ore (mt)	% Total	Reporting Mines	Mines Operating	Other*	Reported Magnetite Raw (mt)	% Total	Reporting Mines	Mines Operating	Other
Algeria	4	1	5	132.00	0.38	2	2	-	2,320.00	13.41	2	-	2
Cameroon	11	2	13	6,960.80	19.92	9	-	9	3,510.60	20.29	2	-	2
Congo (Rep. of)	4	8	12	5,899.80	16.89	4	-	4	-	0.00	-	-	-
Guinea	4	10	14	2,732.00	7.82	3	-	3	6,160.00	35.60	1	-	1
Liberia	2	14	16	2,174.00	6.22	2	-	2	-	0.00	-	-	-
Mauritania	5	5	10	270.00	0.77	2	2	-	3,836.00	22.17	3	1	2
Nigeria	7	7	14	6,378.00	18.26	7	1	6	-	0.00	-	-	-
Senegal	4	0	4	107.00	0.31	1	-	1	1,067.00	6.17	3	-	3
Sierra Leone	7	10	17	2,611.00	7.47	6	1	5	37.00	0.21	1	1	-
South Africa	10	15	25	3,720.74	10.65	10	7	3	-	0.00	-	-	-
Other	24	58	82	3,951.68	11.31	20	-	20	371.30	2.15	4	-	-
TOTAL	**82**	**130**	**212**	**34,937.02**	**100**	**66**	**13**	**53**	**17,301.90**	**100**	**16**	**2**	**14**

SOURCE: Intierra database (accessed 18 January 2012).

* 'Other' refers to a mine with a status other than operational i.e. adv. exploration, construction, exploration, feasibility study, grass roots, pre-feas/scoping and unknown.

Appendix 2 - Development indicators for central and west African iron ore rich countries vs. other iron ore rich regions

Country	GDP (current US$, 2009)	GDP per capita (current US$)	Mortality rate, under 5 (per 1000)	Net ODA (% GNI)	FDI Net Inflows (BoP, US$)	Corruption Perception	Corruption rank	Business Freedom	Investment freedom	Property rights
Cameroon	22,393,529,278	1143	136	2.9	-551,207	2.5	134	47.1	35	30
Guinea	4,510,589,866	452	130	5.8	101,350,000	2.1	164	38.5	45	20
Liberia	986,201,594	247	103	69.9	452,870,864	3.2	91	55.9	20	30
Mauritania	3,636,296,936	1,051	111	9.3	13,630,000	2.4	143	51.3	40	25
Nigeria	193,668,738,107	1,222	143	1.0	6,048,560,295	2.4	143	55.6	40	30
Republic of Congo	11,897,620,542	2,943	93	4.1	2,815,957,839	2.2	154	40.6	20	10
Sierra Leone	1,905,015,045	325	174	24.3	86,590,239	2.5	134	51.8	45	10
Australia	924,843,128,521	42,131	5	0.0	30,576,304,123	8.8	8	91.9	80	90
Brazil	2,087,889,553,822	10,710	19	0.0	48,437,734,672	3.8	73	53.7	50	30
India	1,727,111,096,363	1,475	63	0.2	24,159,180,720	3.1	95	35.5	35	50
China	5,926,612,009,750	4428	18	0.0	185,080,774,436	3.6	75	68.8	25	20

SOURCES: World Bank Development Indicators, Heritage Foundation, Transparency International.

NOTES:

- Corruption Perception Index gives countries a score from 0 to 10, 10 is no corruption.
- Business freedom is a quantitative measure of the ability to start, operate, and close a business that represents the overall burden of regulation as well as the efficiency of government in the regulatory process. The business freedom score for each country is a number between 0 and 100, with 100 equaling the freest business environment.
- In an economically free country, there would be no constraints on the flow of investment capital. Individuals and firms would be allowed to move their resources into and out of specific activities, both internally and across the country's borders, without restriction. Such an ideal country would receive a score of 100 on the investment freedom component of the Index of Economic Freedom.
- The property rights component is an assessment of the ability of individuals to accumulate private property, secured by clear laws that are fully enforced by the state. It measures the degree to which a country's laws protect private property rights and the degree to which its government enforces those laws. It also assesses the likelihood that private property will be expropriated and analyses the independence of the judiciary, the existence of corruption within the judiciary, and the ability of individuals and businesses to enforce contracts.

Appendix 3 — African long-term foreign currency rating (as of 28 November, 2011)

Country	S&P	Fitch
Cameroon	B	B
Congo, Republic of the		
Guinea		
Liberia		
Mauritania		
Nigeria	B+	BB-
Sierra Leone		
South Africa	BBB+	BBB+

Appendix 4 — African iron ore prospects, 2011-2018

Property Name (Phase)	Risk Rating#
Tonkolili Iron Ore/Magnetite Operation (Phase 1)	Low
Faleme (Phase 1)	Low
Forecariah Iron Ore Deposit (Phase 2)	Low
Mayoko-Moussondji Iron Ore Project (Phase 1)	Low
Tonkolili Iron Ore/Magnetite Operation (Phase 2)	Low
Tonkolili Iron Ore/Magnetite Operation (Phase 3)	Low
Bong	Medium
Forecariah Iron Ore Deposit (Phase 1)	Medium
Kango	Medium
Simandou Iron Ore Project*	Medium
Kalia mine project (Phase 2)	Medium
Simandou Iron Ore Project*	Medium
Simandou Iron Ore Project*	Medium
Simandou Iron Ore Project*	Medium
Kalia mine project (Phase 3)	Medium
Simandou Iron Ore Project*	Medium
Simandou South (Zogota, Koni, Brikoidou) (Phase 1)	High
Marampa Magnetite Mine (Phase 1)	High
Kalia mine project (Phase 1)	High
Mbalam Iron Ore Project (Phase 1)	High
Simandou (Blocks 1&2) Iron Ore Project	High
Western Cluster (Mano River Iron Ore Deposits, Bomi Hills Iron Ore Deposits and the Bea Mountain Iron Ore Deposits (greenfield))	High
Avima Iron Ore Project	High
Simandou South (Zogota, Koni, Brikoidou) (Phase 2)	High
Zanaga	High
Putu	High
Marampa Magnetite Mine (Phase 2)	High

Risk was calculated by considering data from a number of sources on host operational risk, host political risk, project infrastructure requirements, investor experience, investor-government relations, funding risks, and Chinese ownership and funding.