

The Chinese nickel outlook and the role of nickel pig iron

Jim Lennon

Presentation to International Nickel Study Group

May 11, 2007

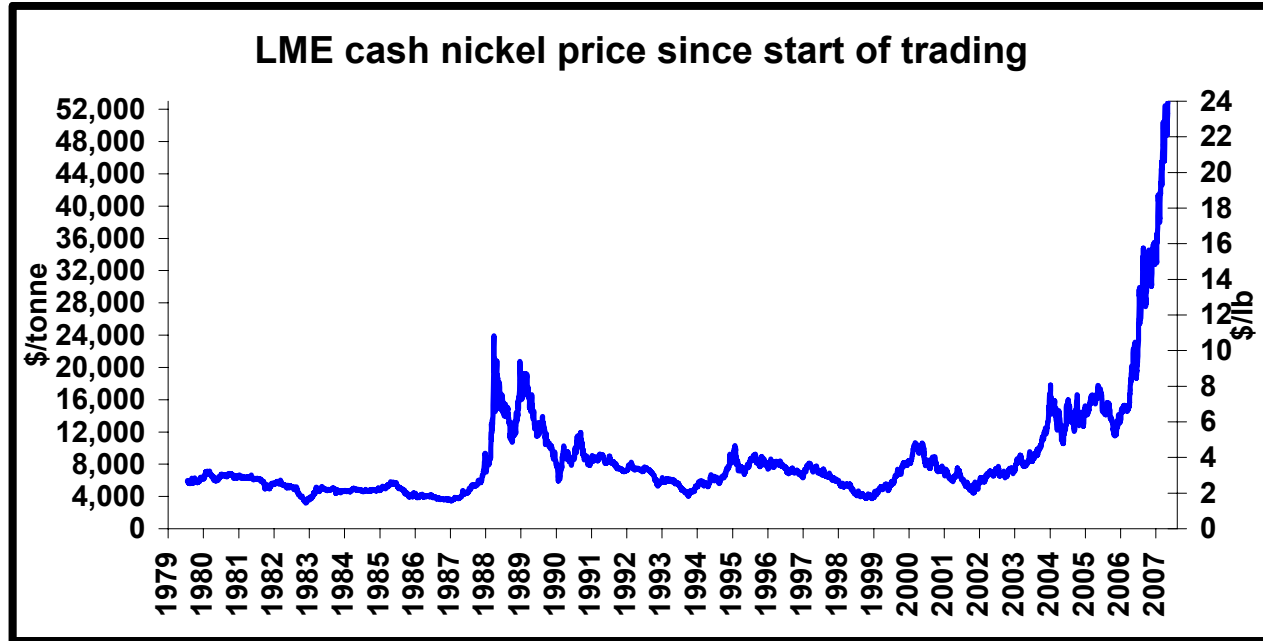


Overview – A new source of nickel for the stainless steel industry

- ➔ Massive rise in Chinese nickel demand in recent years
- ➔ China has limited domestic resources and is heavily reliant in imports of nickel raw materials
- ➔ Booming stainless steel production has created shortage of nickel
- ➔ In response, China has developed a different technology for processing low grade nickel ores to produce nickel pig iron
- ➔ Nickel pig iron is potentially a long term supply source for the Chinese and world nickel industry
- ➔ However, the high production costs of this product mean that it is not a sustainable source of long term supply and it acts as a floor on the nickel price near \$10/lb



Nickel – desperately seeking balance



Source: LME, May 2007

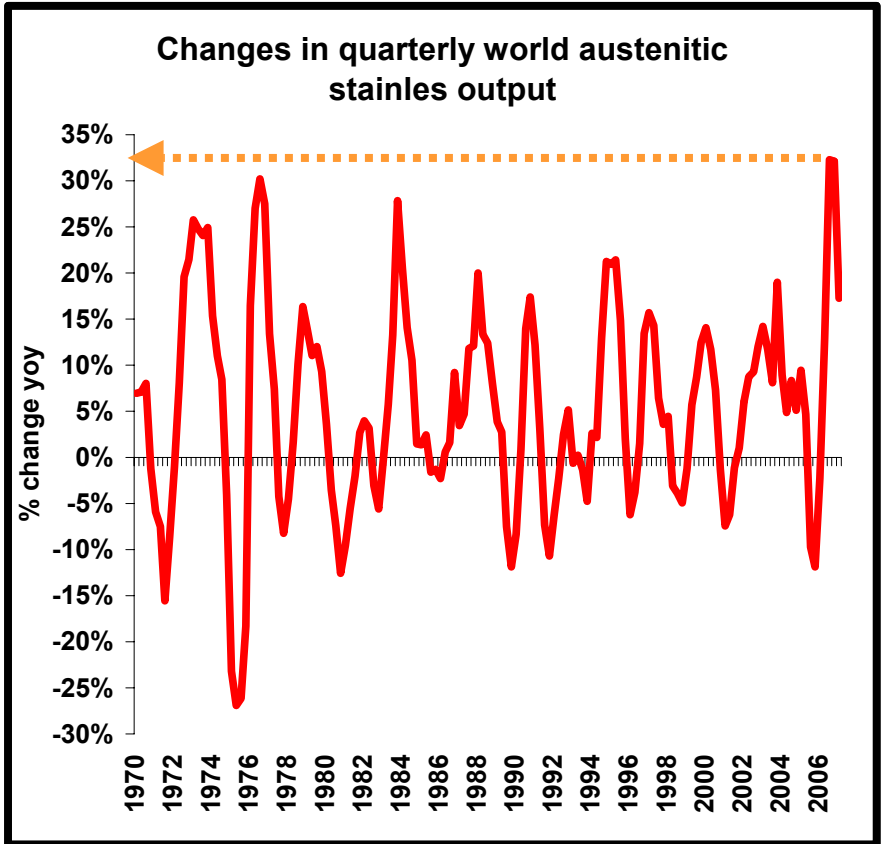
- ➔ Massive surge in nickel prices reflected major rise in world stainless steel production over the past 12 months, driven mainly by China
- ➔ Nickel supply was not adequate to meet this demand
- ➔ Prices are rising to a “market clearing” level. The market is being cleared by:
 - ➔ Substitution away from nickel
 - ➔ More scrap
 - ➔ **Chinese nickel pig iron**



3Q/4Q 06 – biggest quarterly growth in world stainless steel production

World austenitic stainless output

'000t	China	ROW	Total
Q105	677	4427	5104
Q205	654	4242	4896
Q305	671	3398	4069
Q405	582	3775	4357
Q106	754	4235	4989
Q206	1001	4529	5530
Q306	1081	4302	5384
Q406	1279	4477	5756
Q107	1404	4464	5868
Year 2005	2584	15843	18427
Year 2006	4115	17543	21658
% change yoy			
Q105	72.6%	3.6%	9.4%
Q205	55.4%	-0.3%	4.7%
Q305	29.7%	-14.8%	-9.7%
Q405	-0.3%	-13.4%	-11.9%
Q106	11.2%	-4.3%	-2.3%
Q206	53.0%	6.8%	12.9%
Q306	61.1%	26.6%	32.3%
Q406	119.8%	18.6%	32.1%
Q107	86.3%	5.4%	17.6%
Year 2005	35.0%	-6.2%	-2.0%
Year 2006	59.2%	10.7%	17.5%



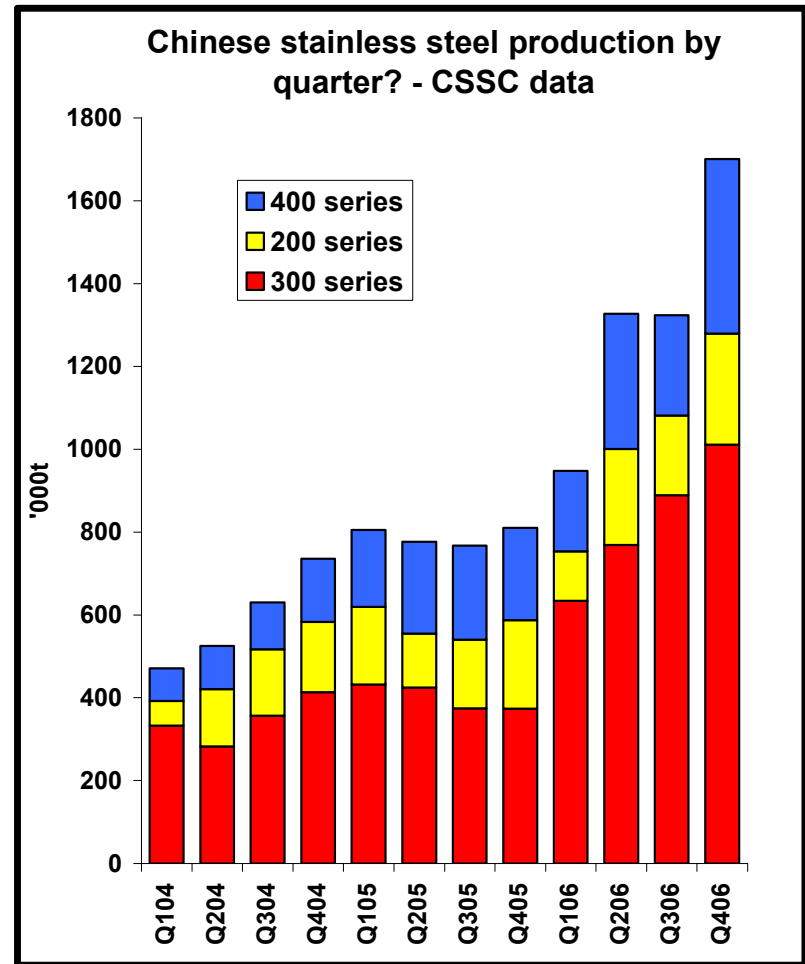
Massive growth in Chinese production

Source: INSG, CRU, CSSC, Macquarie Research, May 2007



Unprecedented surge in Chinese stainless steel production!

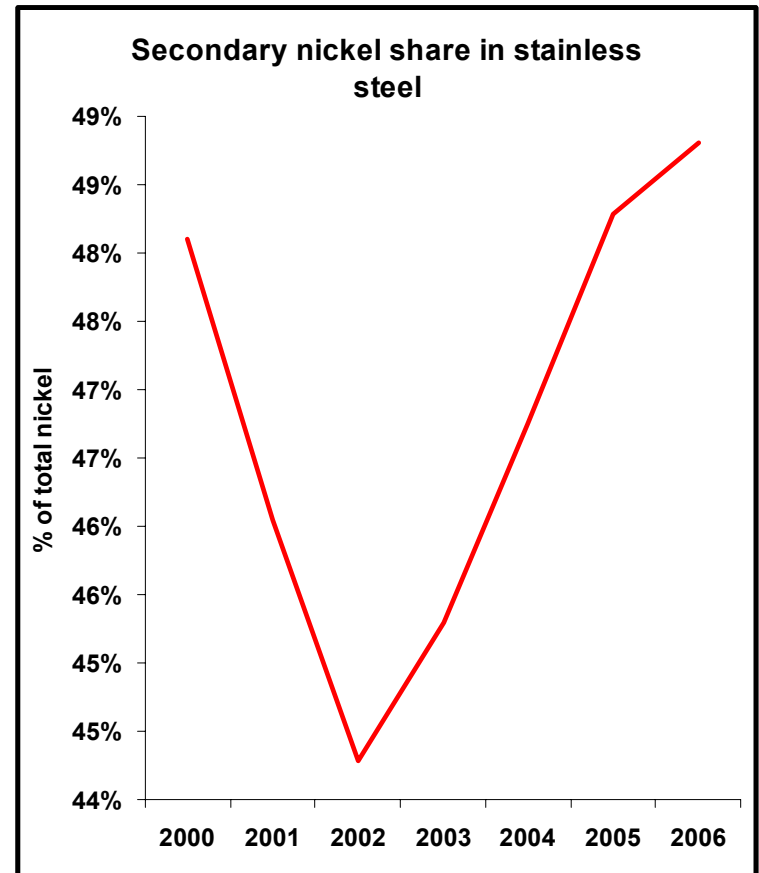
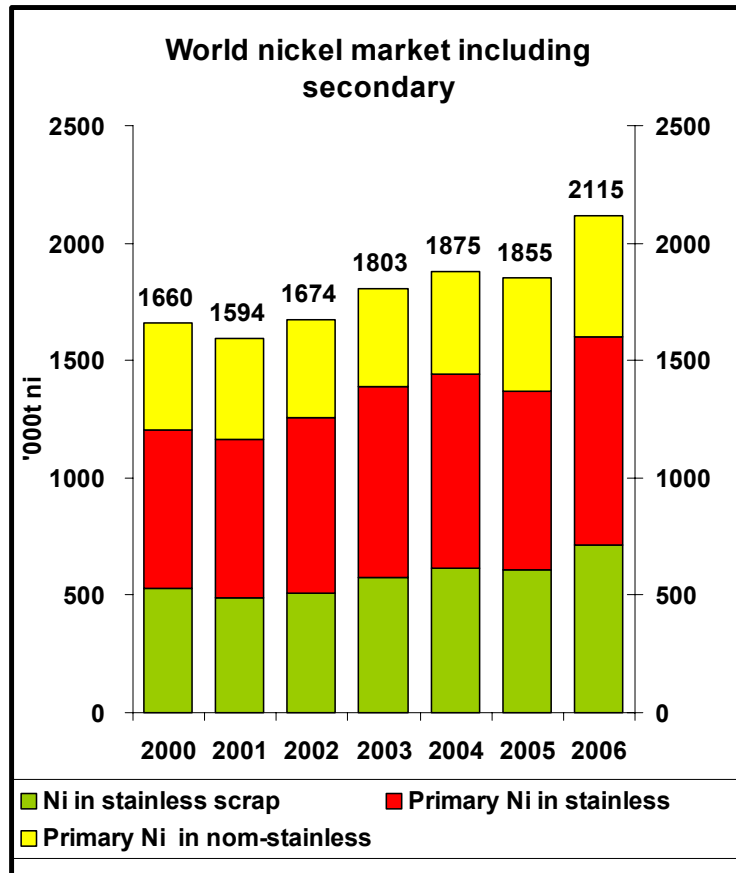
- Estimates of Chinese melt production in 2006 range from 4.75mt to 6.1mt; estimates of 2005 production range from 3.2mt to 4.3mt. The year-on-year rise in production was variously estimated at 35–70% yoy according to which figures are believed!
- According to the official Chinese body, the Chinese Stainless Steel Council (CSSC), production totalled 5.3mt in 2006, up 68% yoy from 3.16mt in 2005 – 4Q06 said to be up 110% yoy!



Source: CSSC, Macquarie Research, May 2007



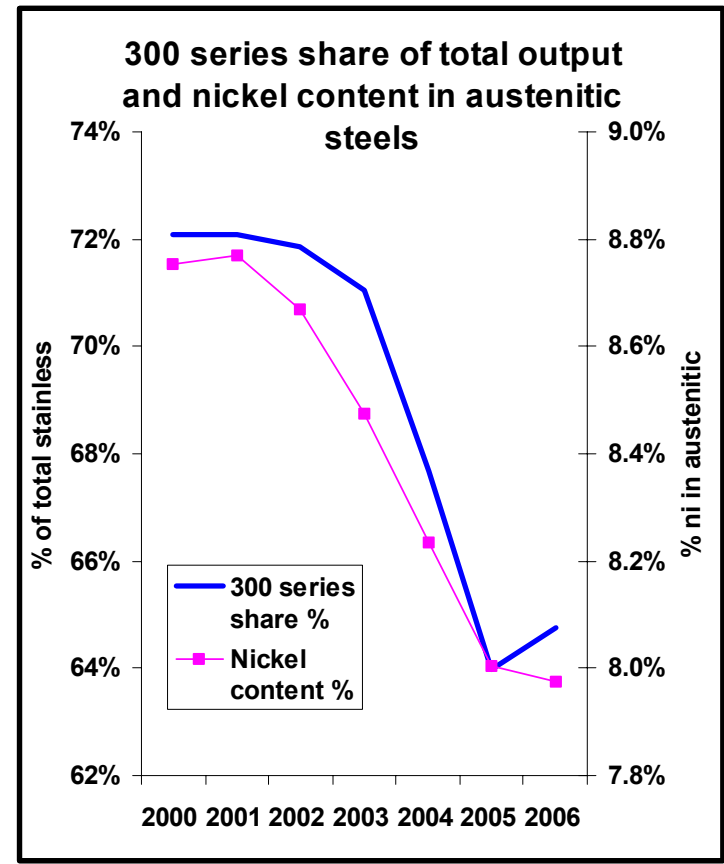
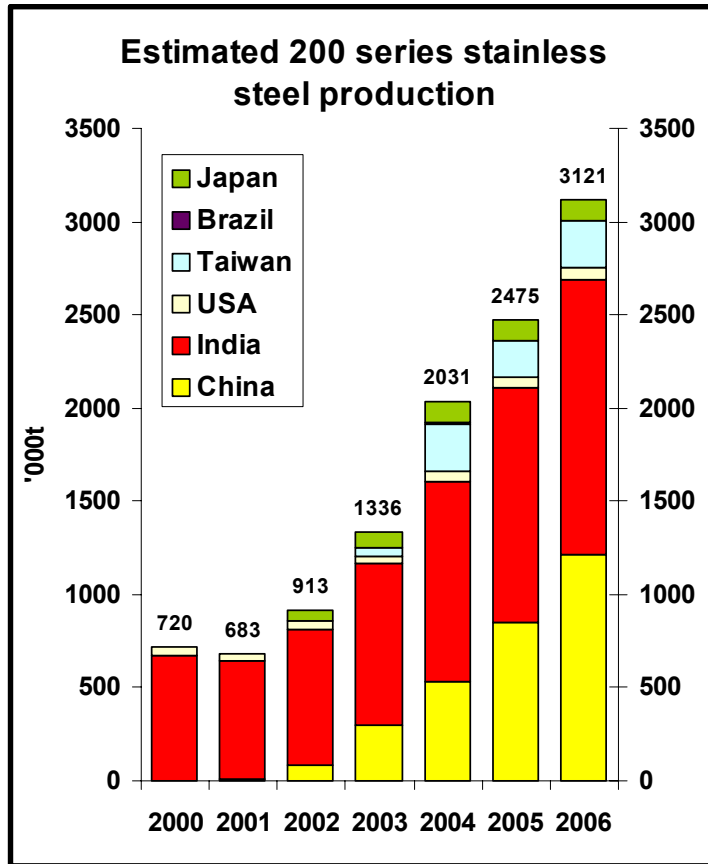
Impact of nickel prices – greater use of secondary nickel



Source: Macquarie Research, May 2007

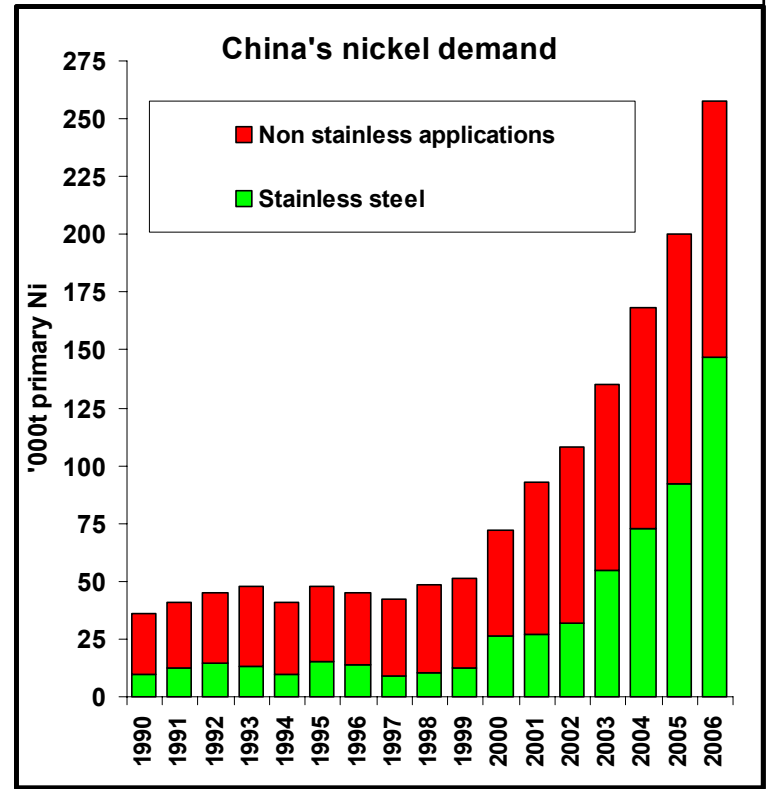
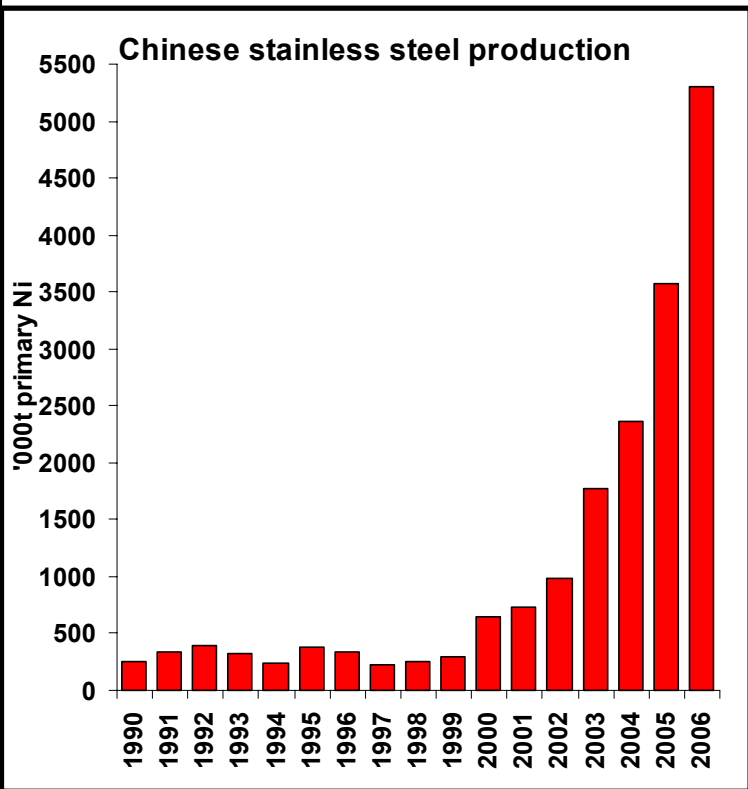


Impact of high nickel prices – lower use of nickel per tonne of stainless



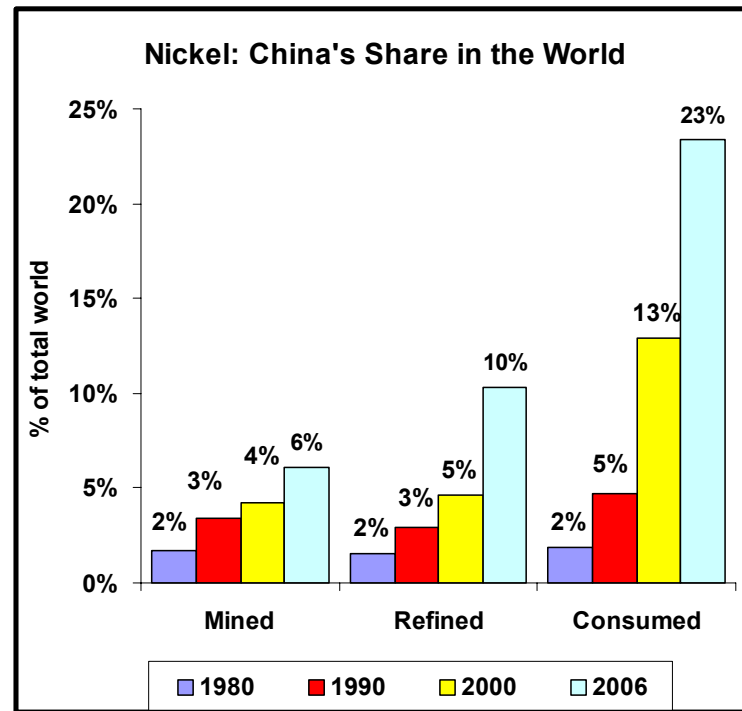
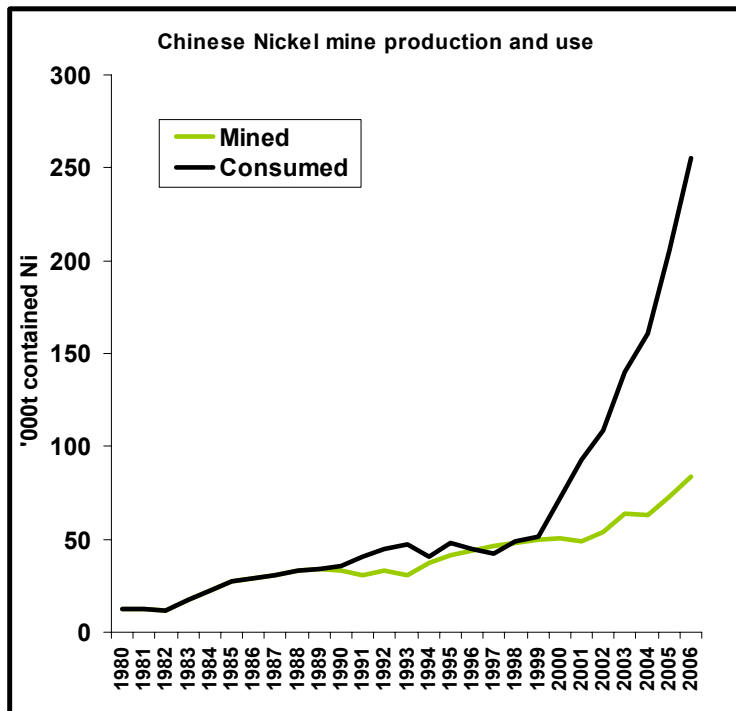
Source: ISSF, CRU, Macquarie Research, May 2007

Chinese stainless steel production and nickel demand explodes



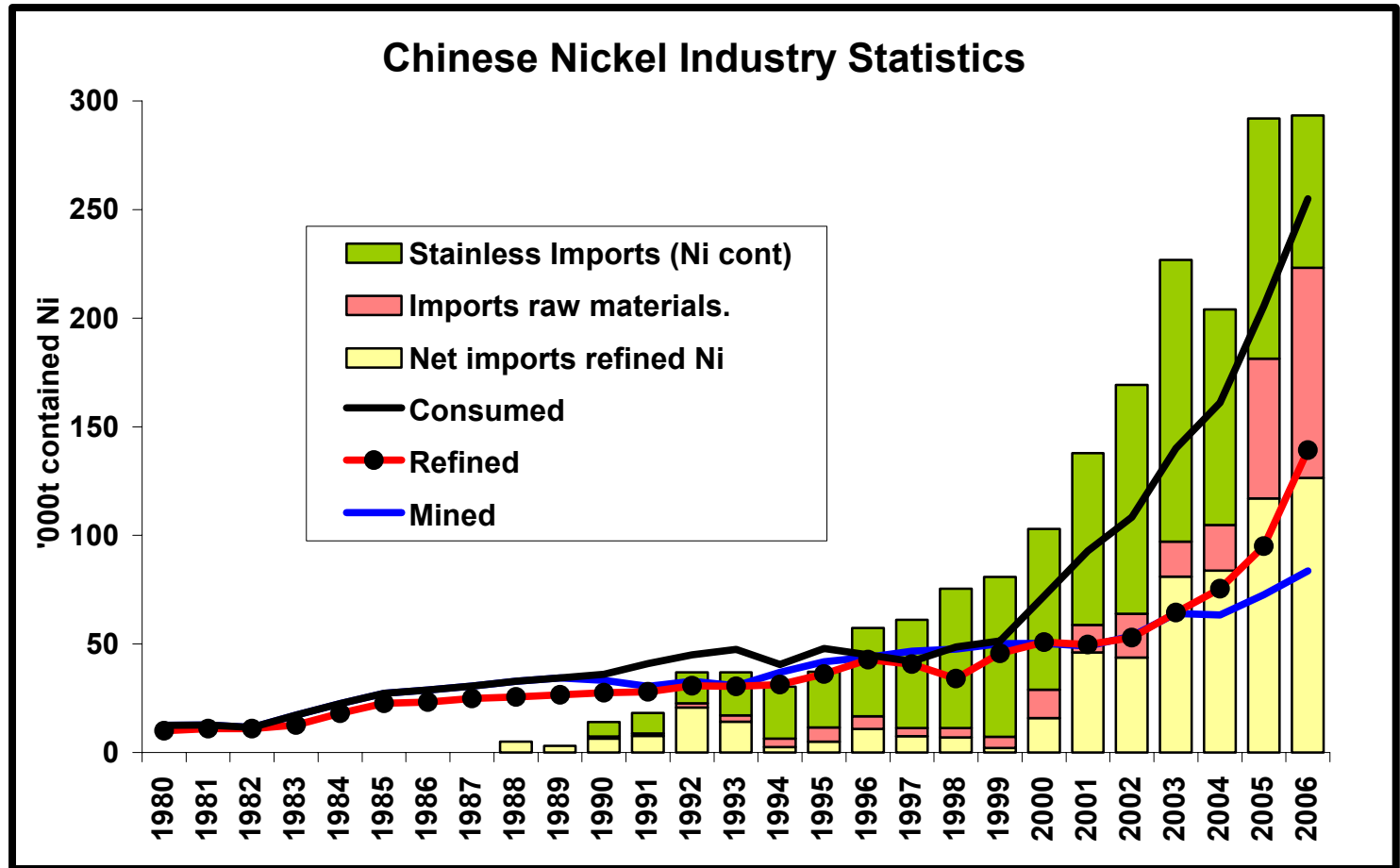
Source: INSG, CRU, CSSC, Macquarie Research, May 2007

China can't meet its nickel needs from domestic mining...



Source: China Metals, Macquarie Research, May 2007

Chinese imports of metal and raw materials rising as China struggles to meet demand growth



Source: China Metals, Macquarie Research, May 2007



MACQUARIE

Chinese nickel production by province

<u>Refined (ex salts)</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>2003</u>	<u>2004</u>	<u>2005</u>	<u>2006e</u>
Jiangsu		117					
Henan		116					
Sichuan	4,817	1,314	1,088	260			
Gansu-Jinchuan	42,902	43,819	48,001	60,788	71,203	90,112	101,000
Xianjiang (Keketuohai)	1,676	1,730	1,981	2,050	2,719	3,256	3,316
Yunnan					161	72	0
Chongqing	1,523	2,627	1,374	1,613	1,745	1,688	1,800
Others (inc Ni pig iron)						2,000	26,000
TOTAL	50,918	49,723	52,444	64,711	75,828	97,128	132,116

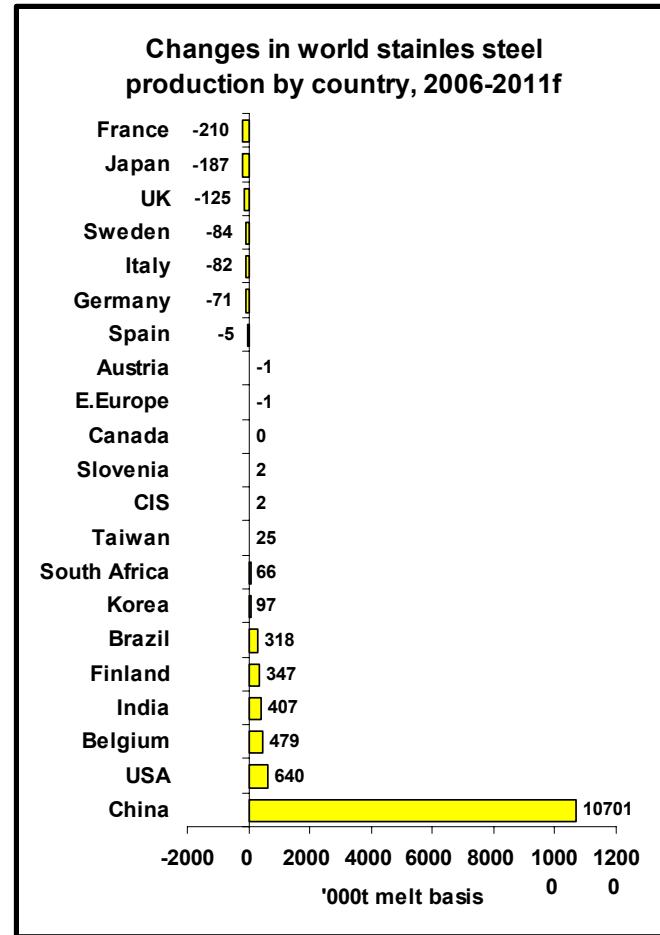
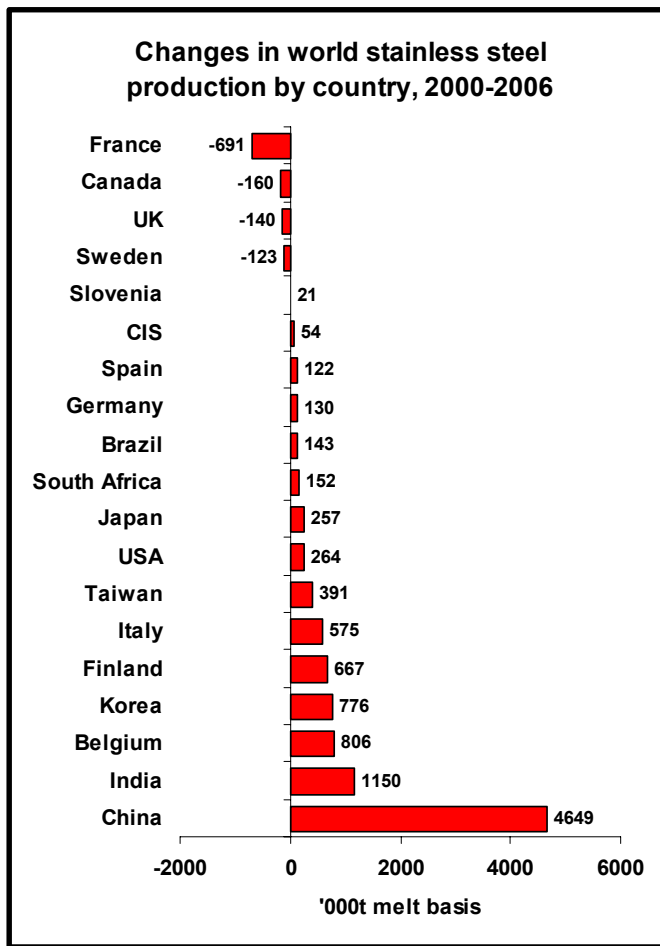
<u>Mined</u>	<u>2000</u>	<u>2001</u>	<u>2002</u>	<u>2003</u>	<u>2004</u>	<u>2005</u>	<u>2006e</u>
Jilin (Jilin Nickel/Tongua)	4,462	6,228	5,995	5,173	5,083	4,750	5,000
Inner Mongolia (Neimeng)					858		
Sichuan	344				1,496	1,300	1,500
Gansu-Jinchuan	42,319	44,117	47,710	54,448	56,997	62,648	70,500
Xianjiang (Keketuohai)	2,038	490	30	1,480	8,912	1,966	2,000
Yunnan	1,184	624			1,587	540	500
Qinghai					136		
Others					552	500	500
TOTAL	50,347	51,459	53,735	61,101	75,621	71,704	80,000

Mined as % of refined **98.9%** **103.5%** **102.5%** **94.4%** **99.7%** **73.8%** **60.6%**

Source: CNI-A, China Metals, Brook Hunt, Macquarie Research,
May 2007

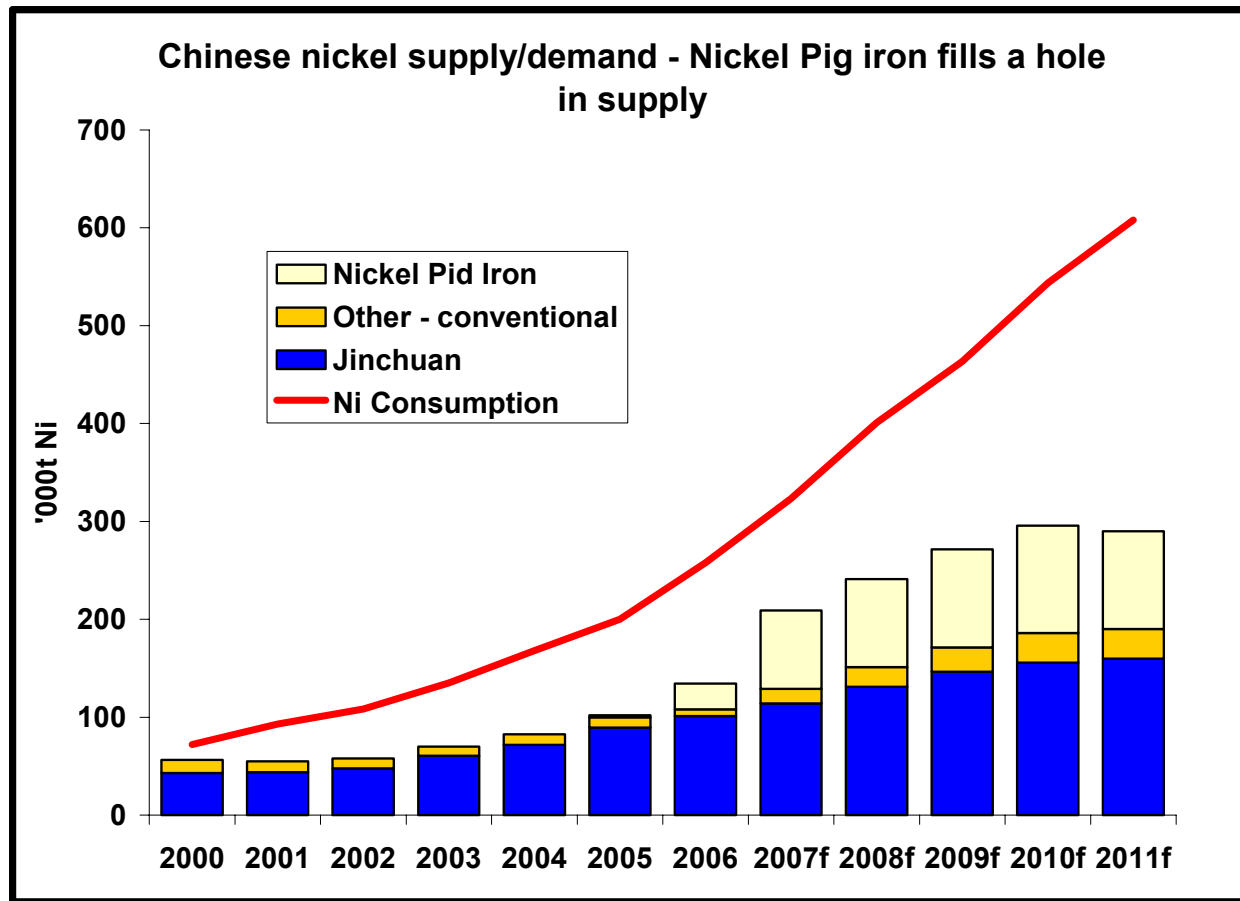
Raw material import needs grow

Guess where future nickel demand growth is?



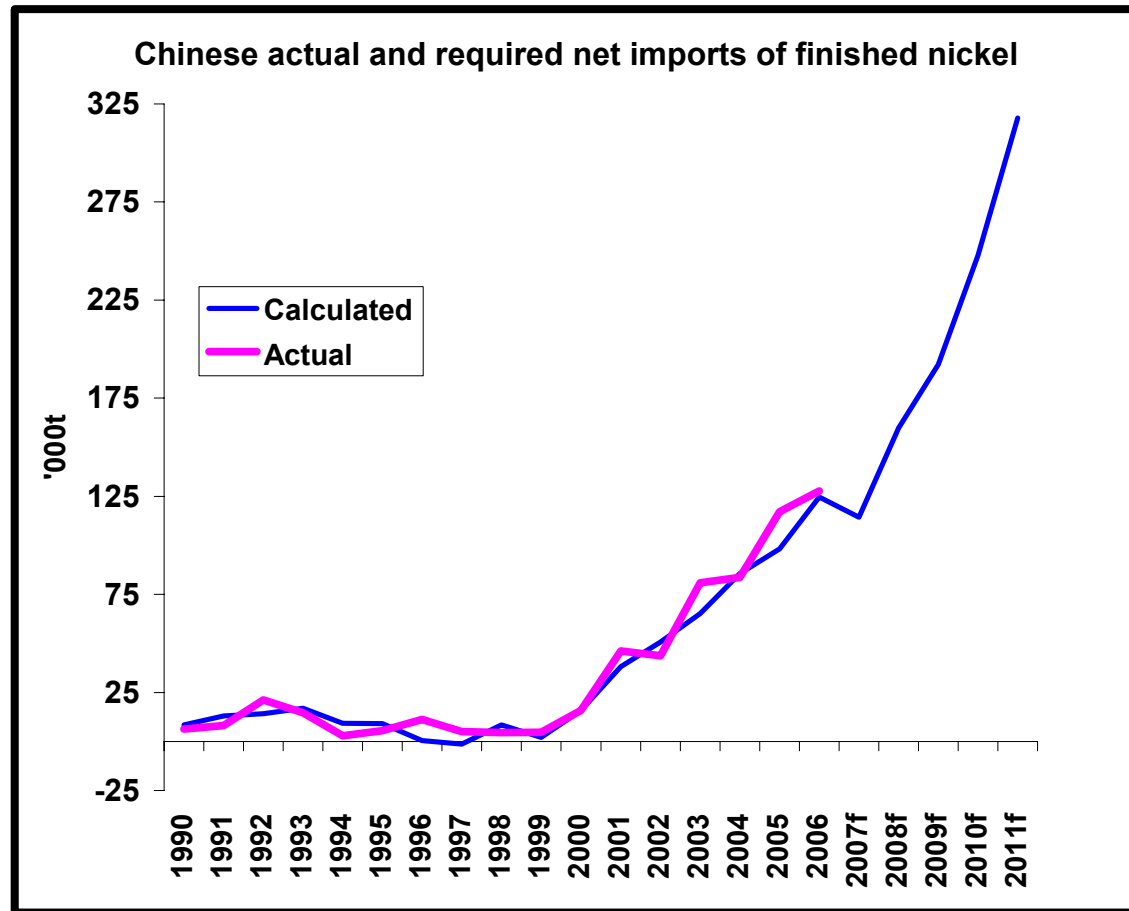
Source: Macquarie Research, May 2007

Nickel pig iron growth still leaves substantial import requirement





China will need to continue to import finished nickel, despite strong domestic nickel production growth



Source: Chinese Customs, Macquarie Research, May 2007



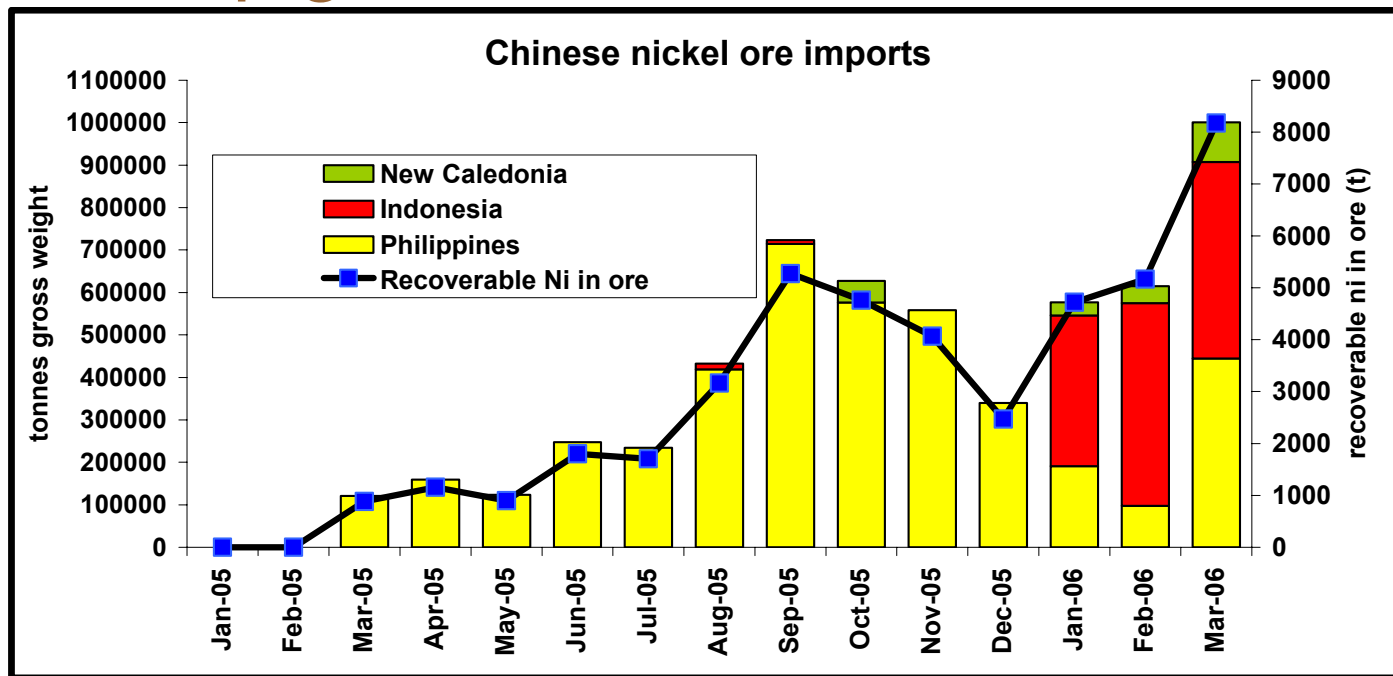
Nickel pig iron – plugging the gap between supply and demand

- ➔ Nickel pig iron is a low purity ferronickel with 1.5 to 8% Ni grade being produced from blast furnaces and 10–25% Ni grade from electric furnaces (much lower than conventional ferronickel, which averages 25–40% nickel content) with iron accounting for most of the balance. Other impurities include silica, phosphorus, sulphur, chromium and carbon etc.
- ➔ Where are the nickel pig iron producers? widely distributed across China with most of them located in Shandong, Shanxi, Fujian, Henan, Hainan Hebei, Jiangsu and Zhejiang provinces, where have much easier access to coke plant and transportation facilities.
- ➔ Some estimates out the number of production facilities in excess of 100 and growing
- ➔ This is not “new” technology – Eramet was producing this product 50 years plus ago. It was superseded by more efficient lower-cost technology, but the inability of existing technology to rise to the demand challenge has created an opportunity.

What is driving the growth?

- Government has mandated that blast furnaces with capacity of less than 200 cubic metres producing pig iron must close permanently but ferroalloy furnaces only less than 100 cubic metres must close
- 100-200 cubic metre blast furnaces are switching to nickel pig iron (a “ferroalloy”) to survive
- Reports from China are more than 100 blast furnaces are currently producing this product!
- Capital cost of these plants – essentially zero
- At current nickel prices this is hugely profitable!

Big growth in nickel ores imports...for nickel pig iron



Source: Chinese Customs, Macquarie Research May 2007

➔ In 2006, China imported 3.6mt of low-grade oxide nickel ores = 27kt Ni; Jan-March 2007 already 2.2mt (18kt Ni). Reports of April circa 1.5mt...another 12kt Ni!

➔ In 2007, Chinese imports predicted to rise to 11-12mt (85Kt Ni+) with majority of the material supplied by Philippines, Indonesia and New Caledonia.



One scenario, based on known plans

Chinese Ni ore imports

	<u>2005</u>	<u>2006</u>	<u>2007f</u>	<u>2008f</u>
mt wet ore				
Philippines	0.3	3.64	6.0	7.0
Indonesia	0.0	0.0	5.0	7.0
New Caledonia	<u>0.0</u>	<u>0.1</u>	<u>0.5</u>	<u>1.0</u>
Total	0.3	3.7	11.5	15.0

'000t recoverable nickel

Philippines	1.9	26.5	43.7	51.0
Indonesia	0.0	0.2	36.4	51.0
New Caledonia	<u>0.0</u>	<u>0.6</u>	<u>5.6</u>	<u>11.2</u>
Total	1.9	27.2	85.7	113.1

Source: Chinese Customs, Macquarie Research May 2007

→ Philippines: Nickel Asia looking to export 5-7mt in 2007 double 2006's level; Berong Nickel plans to export 1.5mt in 2006 and 2mt in 2008 from zero in 2006

→ Indonesia: PT Antam plans to export 2.05mt of low-grade saprolite in 2007 (1.5% Ni, 25% Fe) from virtually zero in 2007; China Special Steel (0.7% Ni) has plans to start mining and exports of 3mtpa of ore with 1mtpa in first year; Zheijianh Huaguang plans to start mining and exports in 2007 from a mine with 120mt of reserves with a grade of 1.8% Ni.

→ New Caledonia: SMSP has government approval to export 1mt to China in 2007 at an average grade of 2.05% Ni

Expansion plans

- Production has been limited due to constraints in raw material supplies but is now ramping up as more ore becomes available
- End-2006 capacity was around 1mtpa of pig iron

Expansion of Nickel Pig Iron Projects in China

Company Name	Location	Capacity ('000tpa)	Grade %	Metal Contained ('000 tonnes)	Timing
Fujian Wuhang	Fujian	1,000	4.0%	40	2H 2008
Zhejiang Huaguang	Shandong	350	4.0%	14	Early 2008
Zhejiang Huaguang	Shanxi	500	4.0%	20	4Q 2007
Shanghai Xiashang	Jiande Xianjiang	500	4.0%	20	2Q 2007
China Special Steel	Henan	200	3.0%	6.0	Mid 2008
Total		2,550		100	

Source: Macquarie Research, May 2007



What are applications of nickel pig iron?

- 200 series stainless – can replace all nickel – mainly using 1.6-1.7% Ni pig iron
- 300 series – small scale of commercial production at major Chinese stainless steel plant including Baosteel, Tisco and Posco. Estimated demand in 2007 at about 600,000t (4-5% nickel content nickel pig iron containing 24,000t-30,000t of nickel).
- More stainless steel plants in China will use nickel pig iron in austenitic (300 series) stainless steel production over the next year.
- Advantage: according to Baosteel, its cash cost of production could be cut by estimated RMB3-4,000t (\$385-513/t) when producing 300 series when using nickel pig iron compared with primary nickel

Trends in nickel pig iron

Phase 1 (2005-2006)

- Low-grade nickel pig iron (1.6-1.7%) product displaced nickel in scrap in 200-series production (around 20-25,000 tpa); This scrap was diverted to 300 series and displaces primary nickel

Phase 2 (2007-2008)

- Moves to higher-grade nickel pig iron (4% grade and 7-8% grade and (with EAF) 15-20% grades). Focus is now on lowering impurities and improving product consistency. Displaces primary nickel in 300 series and in some cases secondary
- Purpose built blast furnaces greater than 200 cubic metres being built to improve product quality and ensure long run survival

Phase 3 (2008 -)?

- Blast and electric furnaces to be built outside China to reduce ore costs, reduce risk of losing ore supply due to export bans and to avoid Chinese export taxes and other restrictions

What are the problems with nickel pig iron?

- Product quality and impurities: Phosphorous content is the key (below 0.035% for 300 series)
- Production costs: High operating costs compared with primary nickel especially through EAF process
- Raw material supplies: heavily dependent on imported raw materials from Philippines, Indonesia and New Caledonia (uncertainty over long term sustainable limonite ore supplies)
- Environmentally unfriendly: Small scale mills could be phased out in the future given central government growing concern in environment protection

Nickel pig iron product

- Average Chinese nickel pig iron producers' recovery rate is about 80-85% (some reporting 90% and above)
- Processing: similar process as to produce pig iron (going into sintering process first and smelting in the blast furnace)
- Phosphorous is reduced to standard set for 300 series within the blast furnace rather than going into a separate process-patent technology
- Finished product with 1.6-1.7% Ni selling for 80-85% of LE price; 4% selling for 90-100% and 7-8% grade can be sold at 100% of LME nickel price
- Free iron and chromium makes it highly competitive



Drivers of costs - ore

- One tonne of 1.6-1.7% nickel-containing pig iron requires three tonnes of wet laterite ore (at an ore grade of 1.0% nickel); coke rate 1.2-1.3t/t pig iron
- One tonne of 4% nickel-contained pig iron requires five tonnes of wet laterite ore (at an ore grade of 1.5% nickel); coke rate 1.8t/t pig iron
- One tonne of 7% nickel-contained pig iron requires seven tonnes of wet laterite ore (at an ore grade of 1.9% nickel). Coke rate 2t/t pig iron

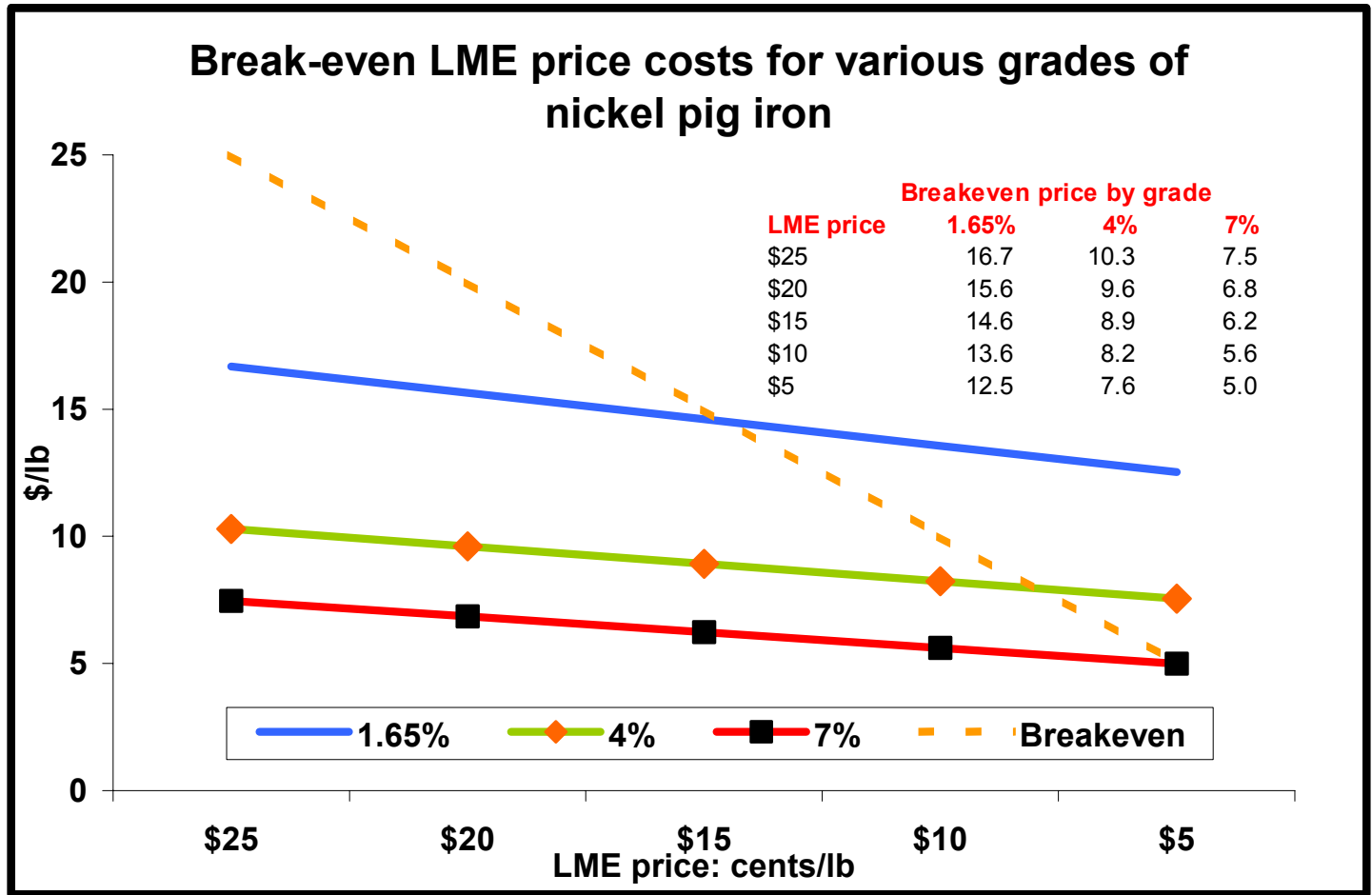
Ore prices now rising sharply as suppliers realise its value – started out a year ago at around \$20-25/t fob Philippines – currently \$80-85/t and going forward will increasingly price is linked to LME nickel price (1.5% nickel sold at 15% of LME nickel price)

Observations on costs

- Highly secretive due to ore price sensitivity
- Very sensitive to Ni pig iron grade produced
- Also sensitive to LME price as ore increasingly is priced as % of LME
- Our calculations indicates costs of \$8-11/lb nickel in 2006 (for 1.65% and 4% grades) with upward pressure towards \$10-16/lb range from these grades in 2006 being driven by rising nickel price (and linkage or ore to LME price) and rising coke prices
- 7% grade appears to be more attractive but will there be enough higher grade ore (costs at \$7.00-7.50/lb in 2007)
- As nickel prices fall, costs will also fall.
- Average nickel prices over 20 years to 2003 were just above \$3/lb – clearly prices cannot return to this level if this material becomes the base-load supply to the market
- Free iron and Cr may not be maintained



A rough guide to costs....

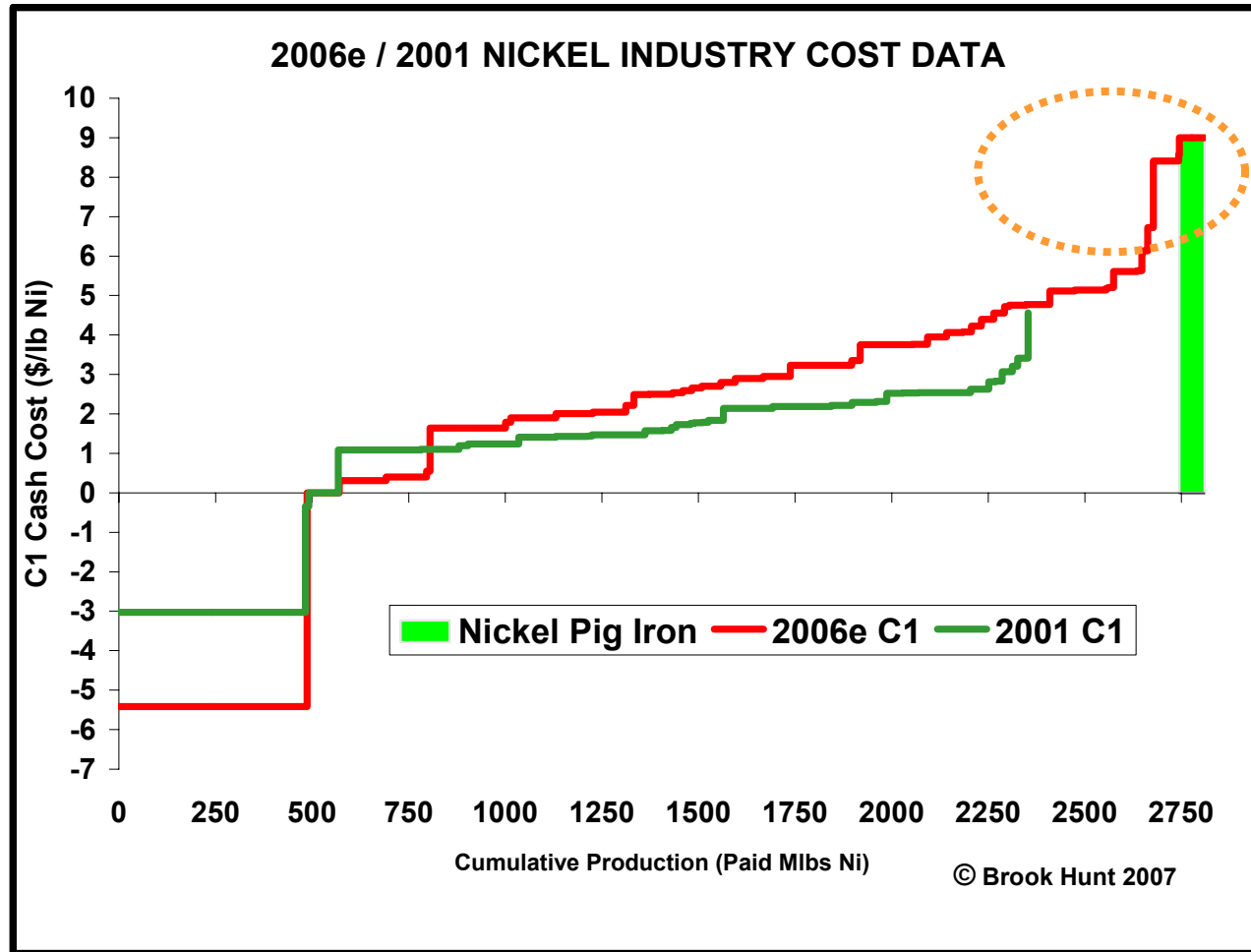


Source: Macquarie Research, May 2007

➔ \$14-16/lb is breakeven for 1.65% grade, \$8-10/lb for 4% grade and around \$5/lb for 7% grade



Impact of nickel pig iron in 2006 – creating a new floor for nickel price?



Source: Brook Hunt, Macquarie Research, May 2007

Final observations

- ➔ **Nickel pig iron is an “emergency” source of supply to the market**
- ➔ **Costs are high and rising but are at a significant discount to primary nickel (and scrap) prices**
- ➔ **A rapidly evolving market with increasing sophistication on grade/quality and a move by the main producers to sustainable production**
- ➔ **Questions on sustainability or ore exports, especially of higher grade**
- ➔ **Potential to move demand and supply “off-shore”**
- ➔ **Is a significant support for nickel, initially at around \$15/b and then around \$8/lb...until the industry gets its act together!**