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The manganese industry worldwide – trends and opportunities

IMnI's 39th Annual Conference

Istanbul – 6th June 2013

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The manganese industry worldwide – trends and opportunities

- Global steel production and future prospects
- Intensity of manganese usage in steelmaking
- China's role as manganese consumer and producer
- Selection and use of manganese ferroalloys in steelmaking
- Manganese ore supply
- Summary and conclusions

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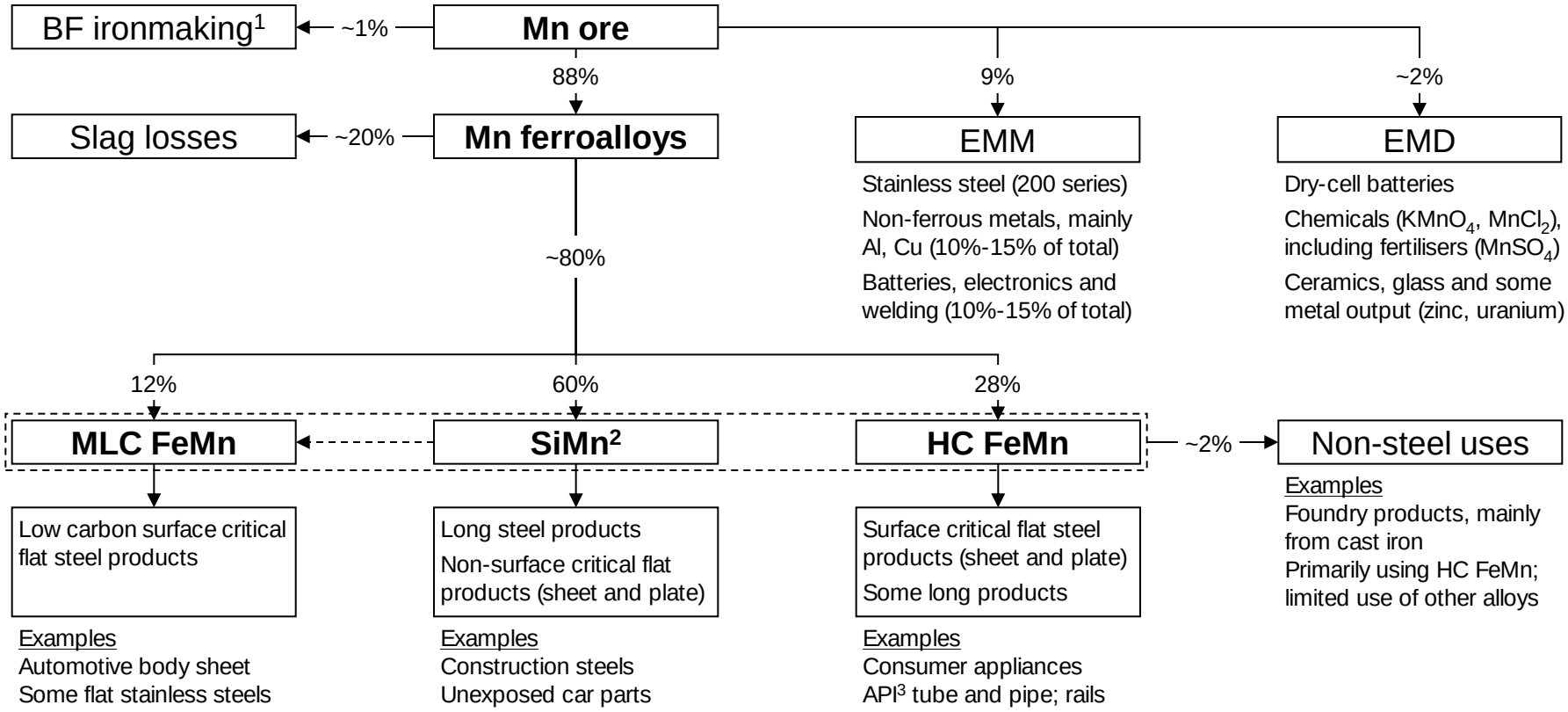
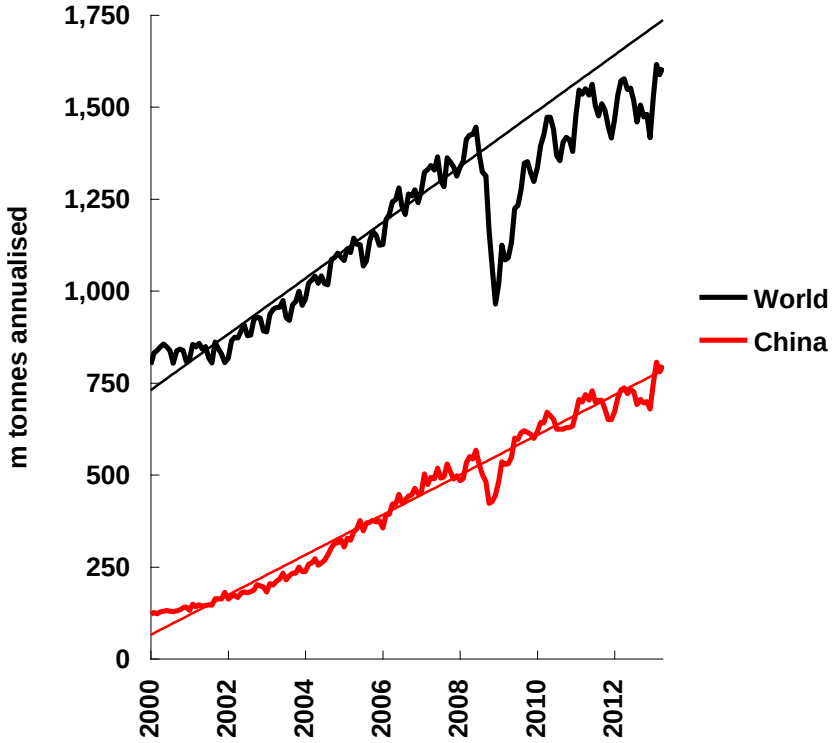
Mn market overview – most ore is used to produce Mn ferroalloys for the steel industry

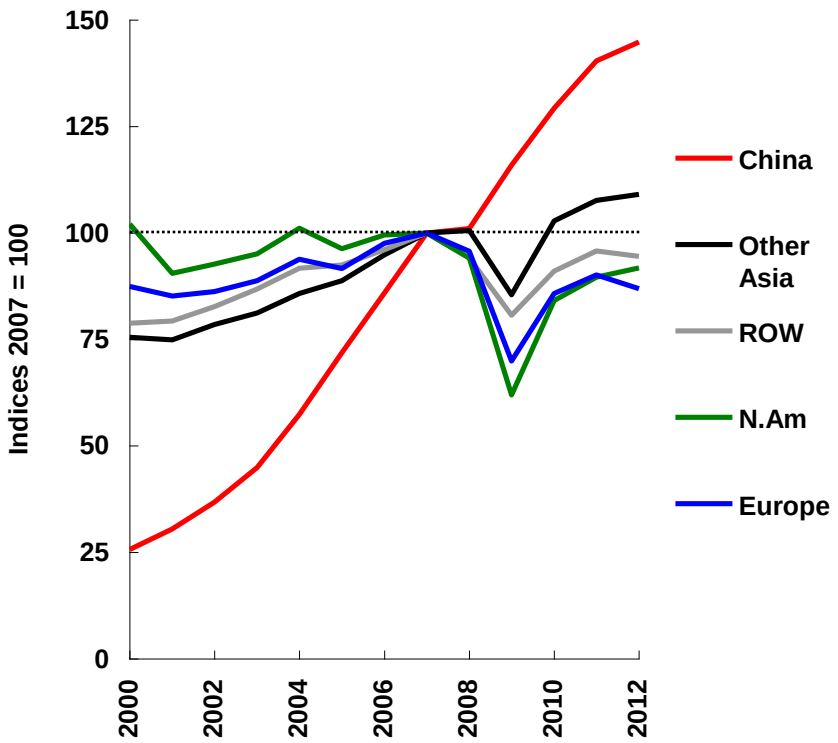


Source: CPM, K.Fowkes, Hatch, Macquarie Research, June 2013. Note: 2012 data, basis Mn units. 1. Some Mn ore is charged directly in blast furnace ironmaking, mainly in Japan and Korea. 2. Some SiMn is used to produce MC FeMn by silicothermic reduction, mainly in China. 3. American Petroleum Institute

China drives world crude steel output to new records. Ex-Asia production still below pre-crisis peaks

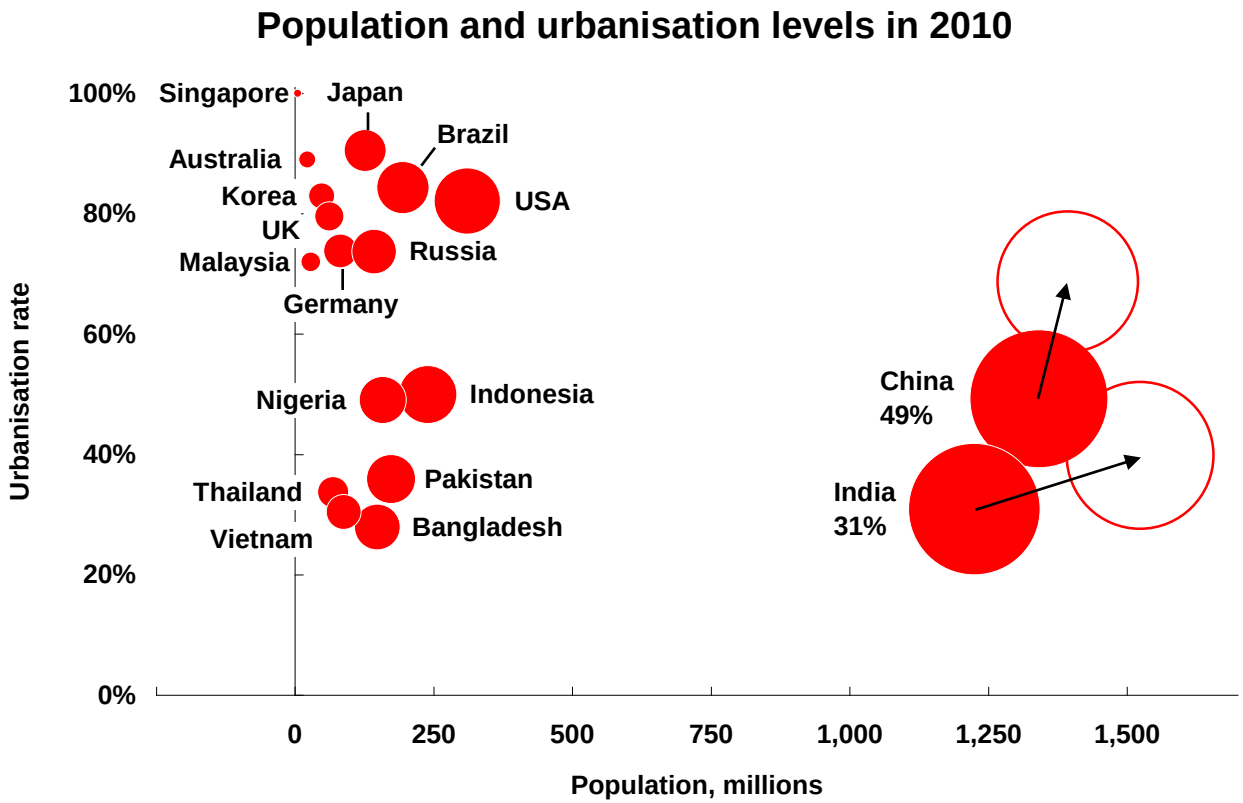
Global crude steel production





Source: Worldsteel, Macquarie Research, June 2013. Note: Pre-GFC trend lines basis Jan 2000 – Jun 2008

Long term there is still substantial potential for growth in steel demand built on urbanisation



- Raising China's urbanisation rate to levels similar to those in developed Asian or European countries will involve moving more than 300m people into towns and cities
- This number is equal to the entire population of the USA today and to China's urbanisation since the early 1990s

Source: UN, Macquarie Research, June 2013. Note: 2010 data. China and India forecasts are for 2030. Size of circles proportional to population in each country

Steel demand will come not only from newbuilding but also rebuilding of some existing urban areas

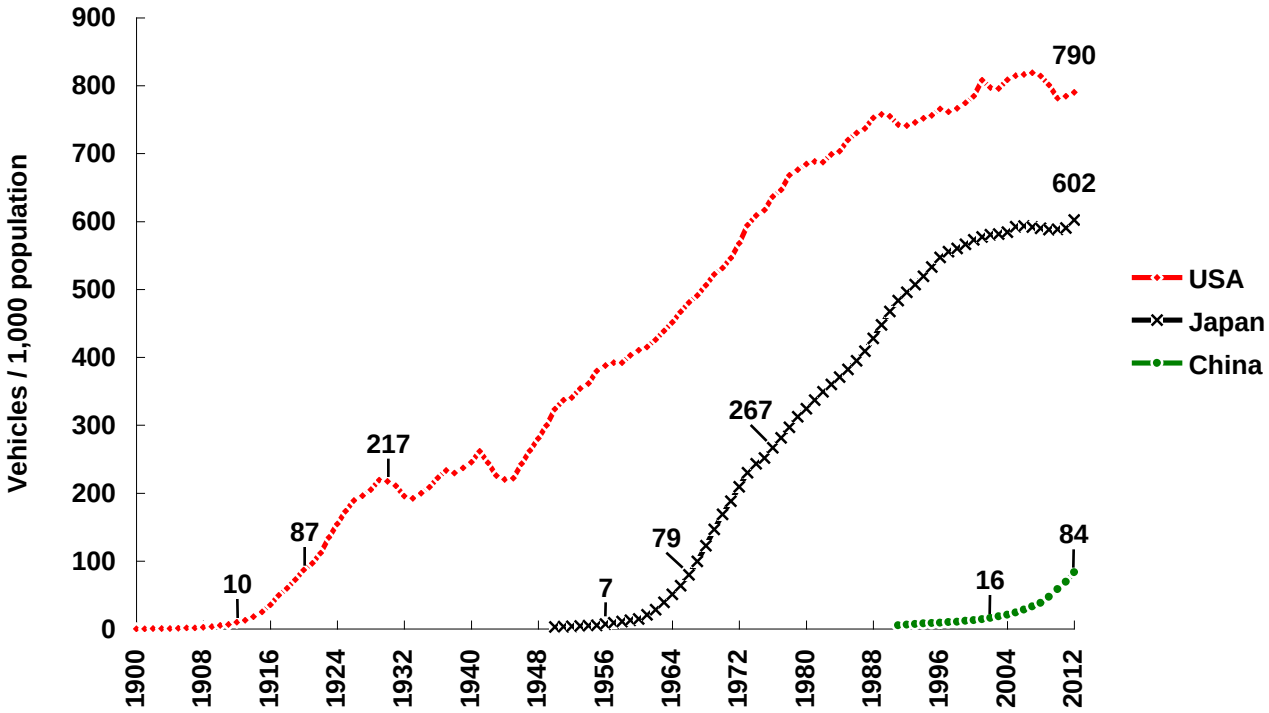
China's existing urban landscape is changing – from hutong to high-rise!!

- Commodities consuming urbanisation is not only about expansion of the existing urban footprint
- It is also about redevelopment of some of the existing urban environment to meet demands for improved living conditions
- China's urban residential floorspace per capita of urban population is less than two-thirds of high-income countries in Asia and Europe
- Redevelopment can of course make some use of recycled materials with obvious implications for primary commodities demand
- For manganese, however, usage is similar in EAF scrap-based steel making to input levels in primary steel making by the BF / BOF route

Source: Macquarie Research, June 2013

More and more cars will be coming onto the roads, helping to drive steel demand higher

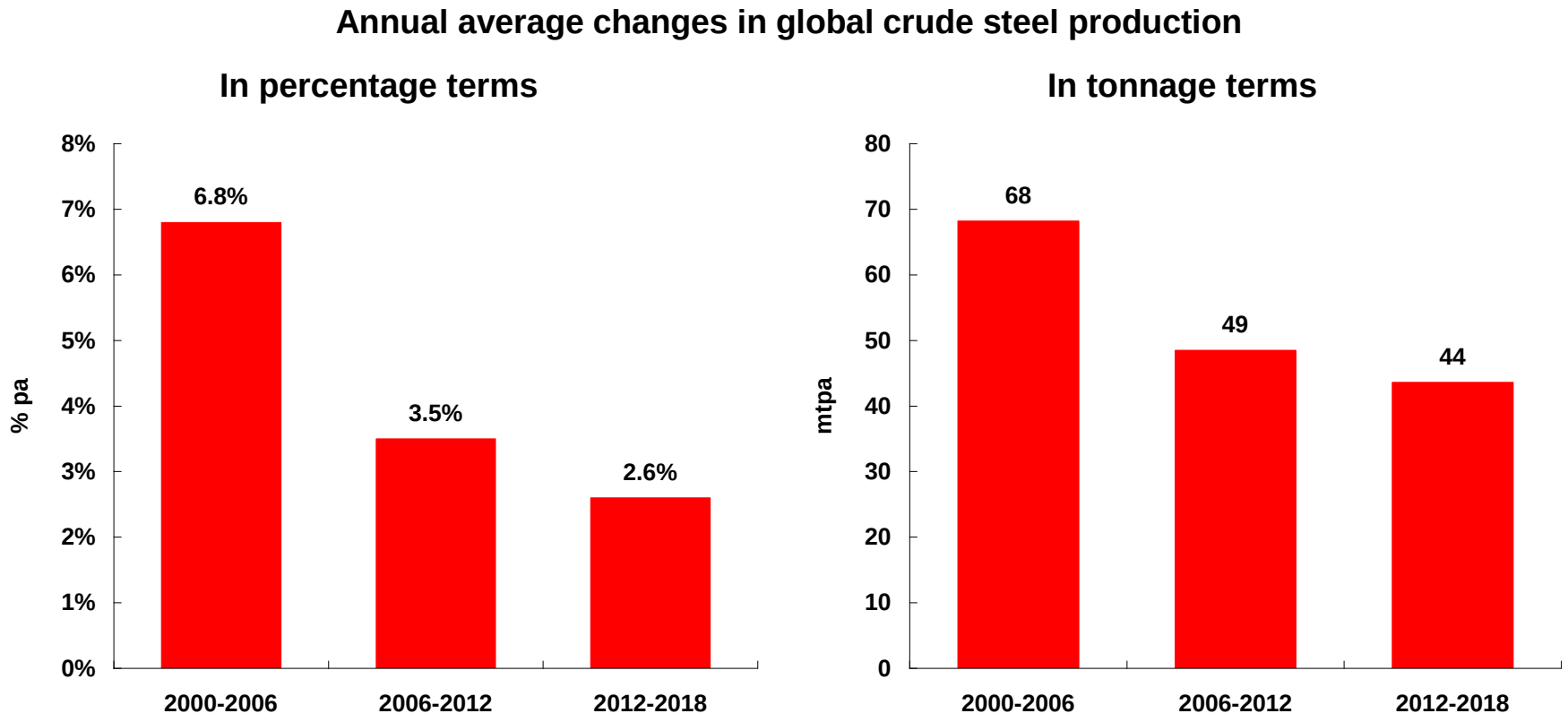
Levels of motor vehicle ownership relative to population



- US motor vehicle ownership increased 2½ times 1920-1930
- Japan recorded an ever fast roll out from mid-60s to mid-70s
- Increasing China's ownership 2½ times in next ten years will add ~170m vehicles to roads by early 2020s
- That's equal to over two-thirds of the entire US vehicle fleet today
- China already adding over 20m units pa

Source: CEIC, JAMA, US Federal Highway Administration, US Census Bureau, Macquarie Research, June 2013

Growth in global crude steel output slowing in percentage terms but steady in tonnage terms



Source: Worldsteel, Macquarie Research, June 2013. Note: 2018 data are forecasts

Future steel production will be shaped by several factors driving demand and supply

Demand-side drivers

- Steel demand in populous developing countries
  - China, India and others
  - Emerging consumer class
  - Urbanisation and infrastructure development
  - Industrialistion
- Scope for substitution into and out of steel
  - Construction
  - Automotive
- Scope for thrifting in steel-based manufacturing
  - Lightweighting
- Migration of steel-based manufacturing industry

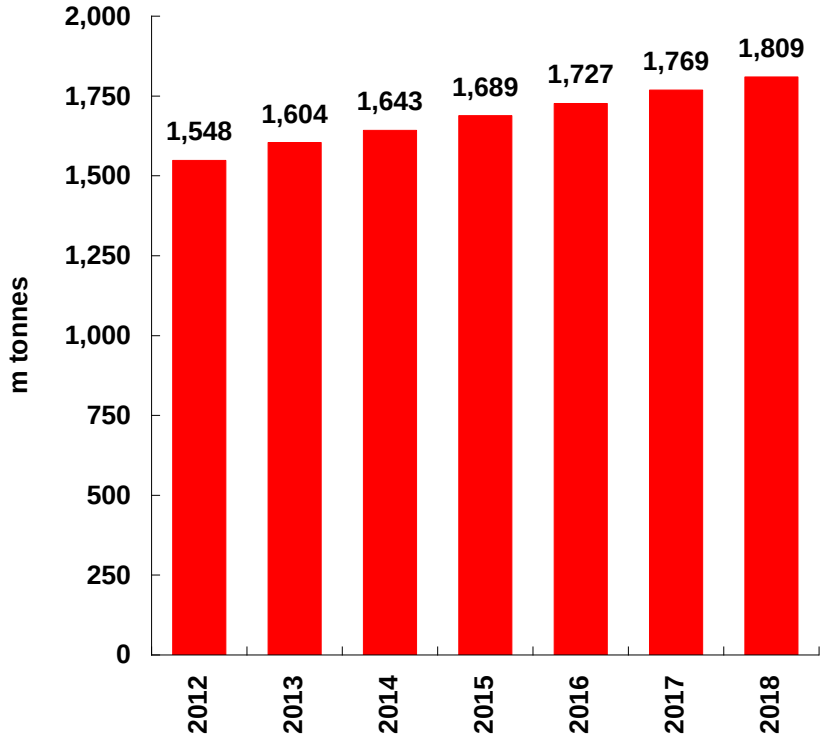
Supply-side drivers

- Consolidation of ownership and control
- Backward integration into raw materials
- De-integration of steelmaking and rolling, which has advantages and disadvantages
- Costs of iron and steelmaking, which vary widely by country and region
- Cost and availability of alternative raw materials and energy supplies
- Environmental and industrial policies
- Change in iron and steelmaking technology

Source: Macquarie Research, June 2013

Global crude steel output forecast to increase by over 15% from 2012-2018; China contributes 50% of total

Global crude steel production



Crude steel production by region (m tonnes)

	2012	2018F	CAGR	Key changes
N.America	121	128	1.0%	
S.America	48	61	4.0%	
Europe	209	226	1.3%	
CIS	112	126	2.0%	
China	717	847	2.8%	130
India	77	118	7.5%	42
Japan	107	111	0.6%	
Other Asia	111	136	3.0%	25
ROW	46	56	3.5%	
Total	**1,548**	**1,809**	**2.6%**	

Source: Worldsteel, Macquarie Research, June 2013. Note: 2013-2018 data are forecasts

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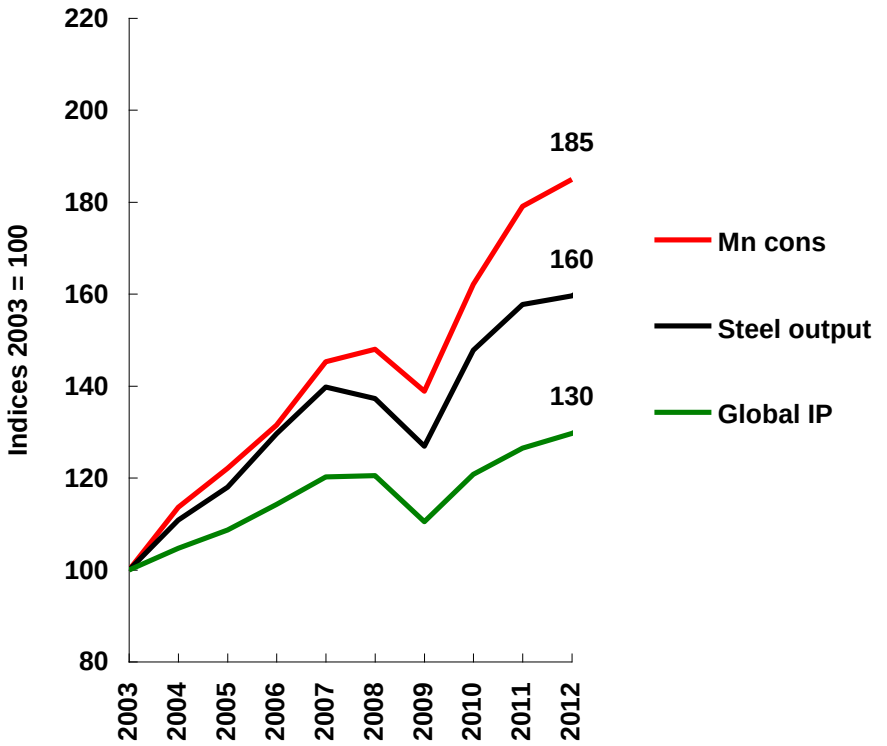
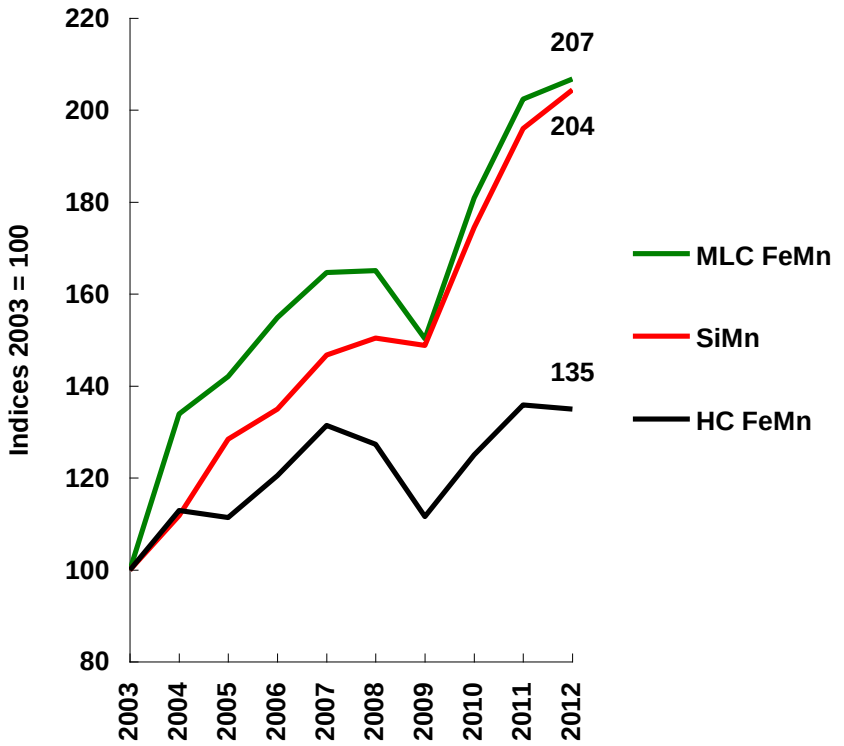
Steel output has outgrown industrial production. Mn consumption has increased faster still

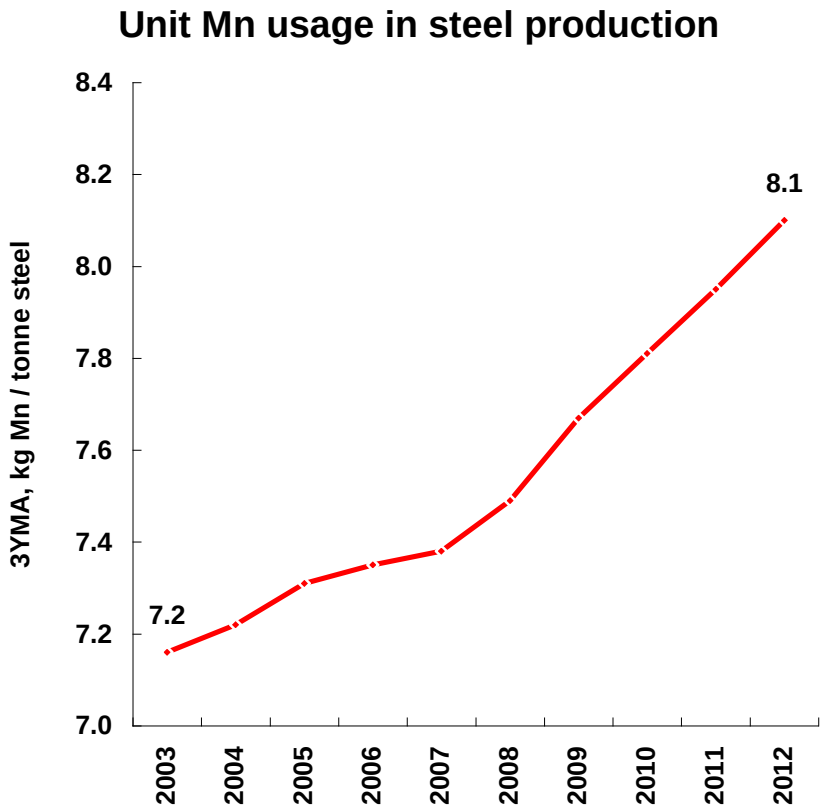
Global industrial production, crude steel output and Mn ferroalloys consumption

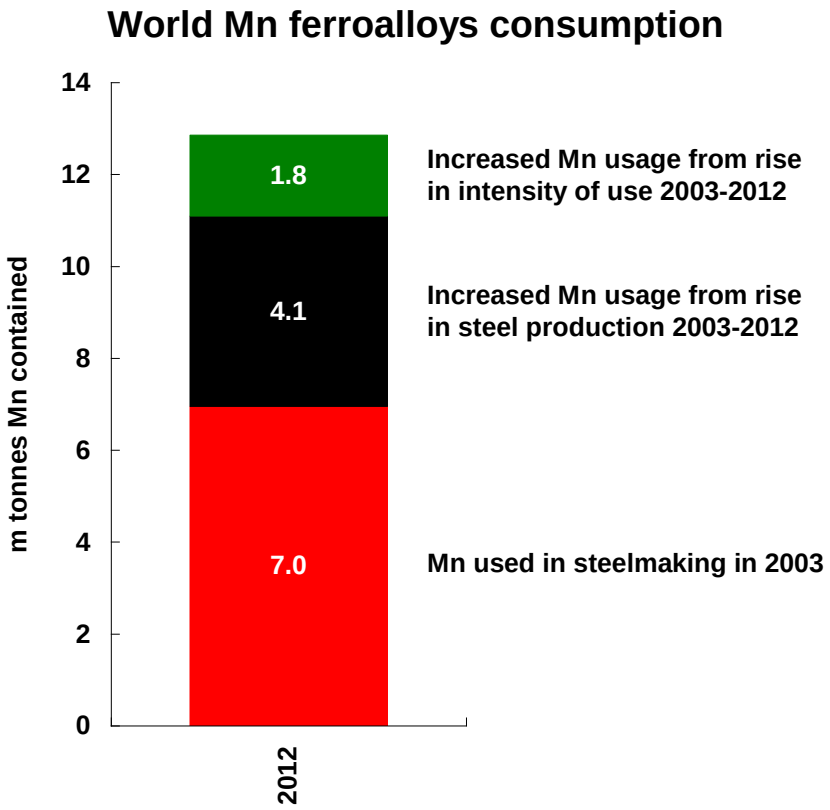




Source: CRU, IMnI, K.Fowkes, Worldsteel, Macquarie Research, June 2013

Intensity of manganese use in steelmaking has increased by 15% in the last decade





Source: K.Fowkes, IMnI, Worldsteel, Macquarie Research, June 2013. Note: data include EMM and direct charged Mn ore

Intensity of manganese usage is a function of process and product mix; there are opposing forces at work

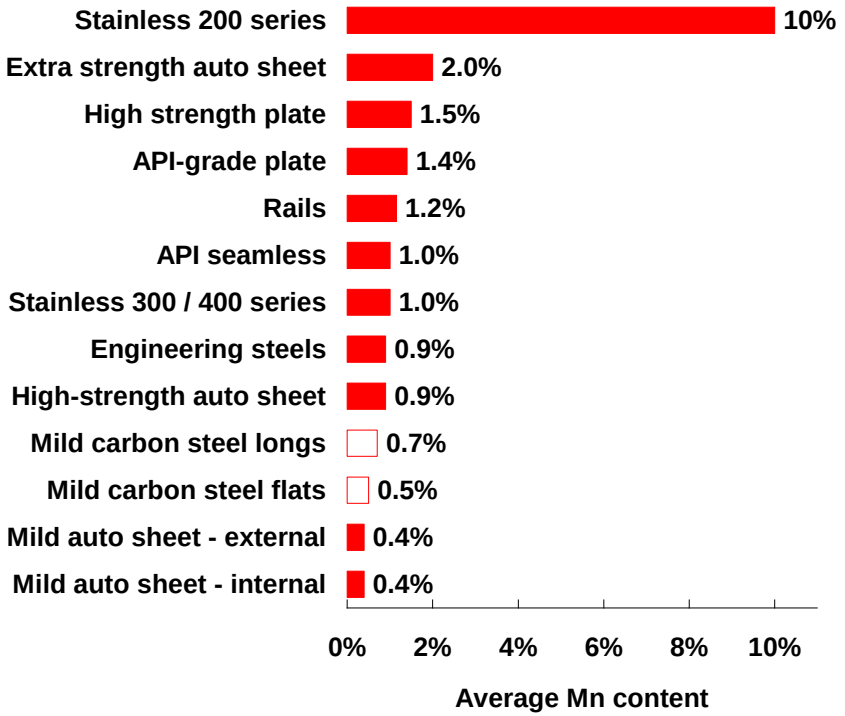
Reducing intensity of manganese usage

- Falling OHF steel output and ingot casting
- Increasing proportion of flat steel products

Raising intensity of manganese usage

- Rising output of selected high-manganese steels outpacing rate of increase in overall crude steel output, especially for auto and energy sectors
- Key contribution from 200-series stainless steels (low-nickel austenitic stainless steels in which manganese is substituted for nickel)

Mn content of selected steels

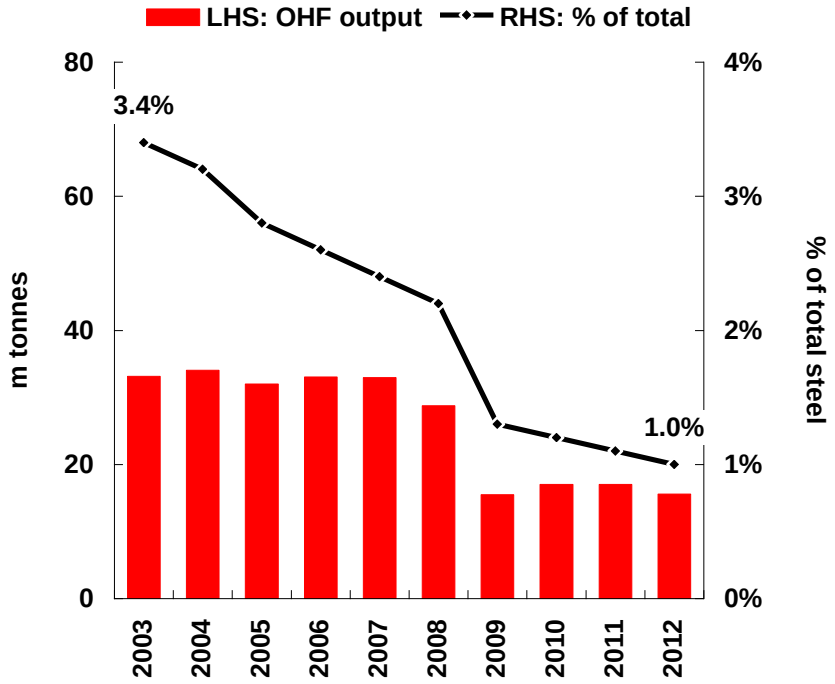


Source: Macquarie Research, June 2013

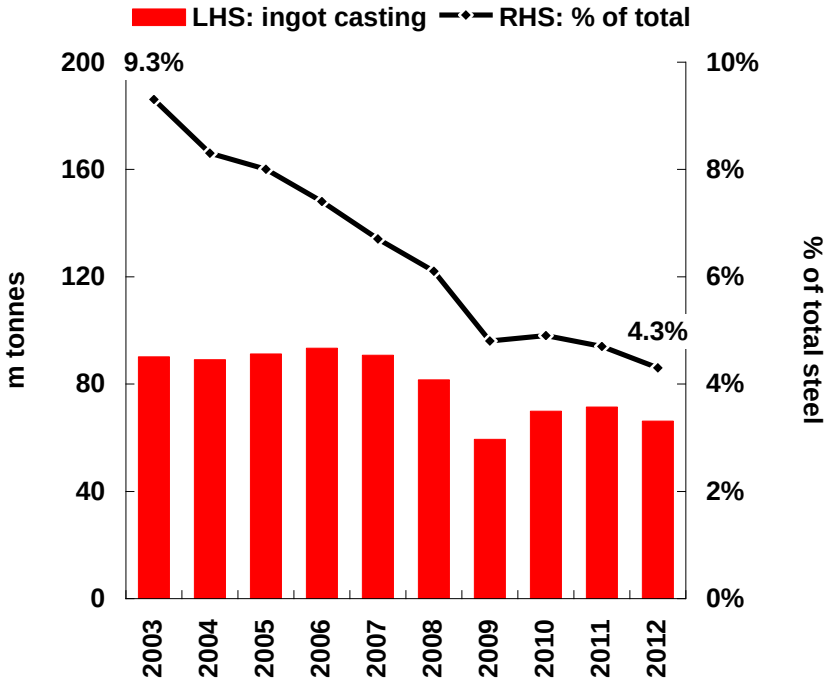
OHF steelmaking and ingot casting continue to decline in tonnage terms and as share of total steel output

➔ Mn yield losses higher in OHF steelmaking / ingot casting than BOF / EAF steelmaking / continuous casting

World OHF steel output



World ingot casting

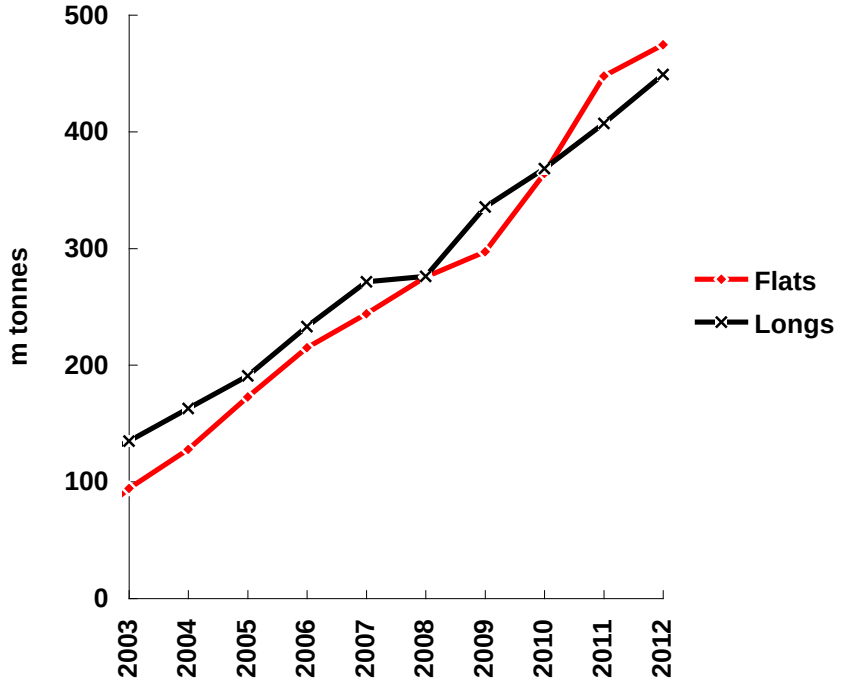


Source: Worldsteel, Macquarie Research, June 2013

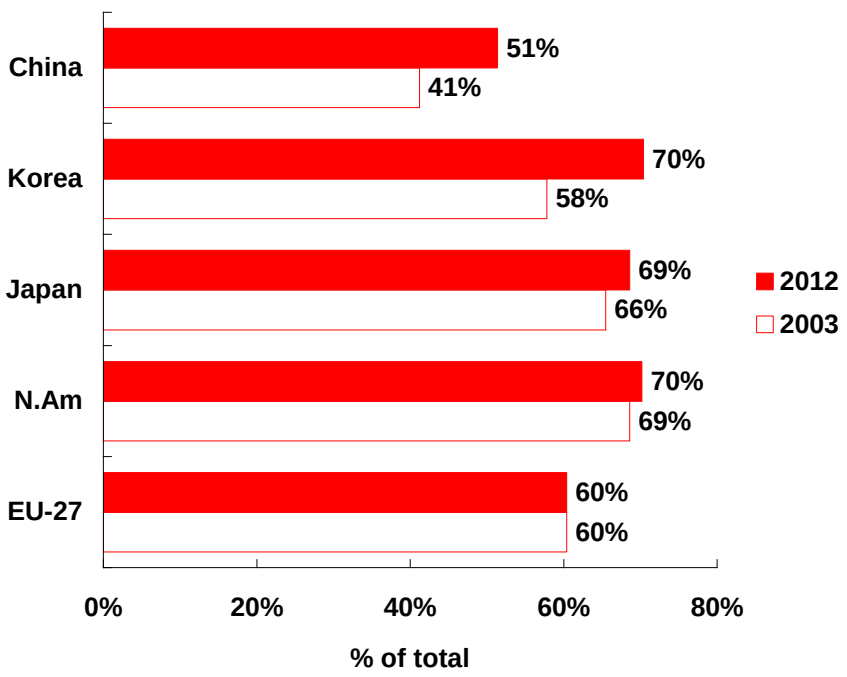
China's output of flat steel products rising as a share of total output but still less than industrial countries

➔ Mild carbon steel flat products typically contain ~0.5% Mn, versus ~0.7% contained in long products

China's steel output by product



Output of flat steel products

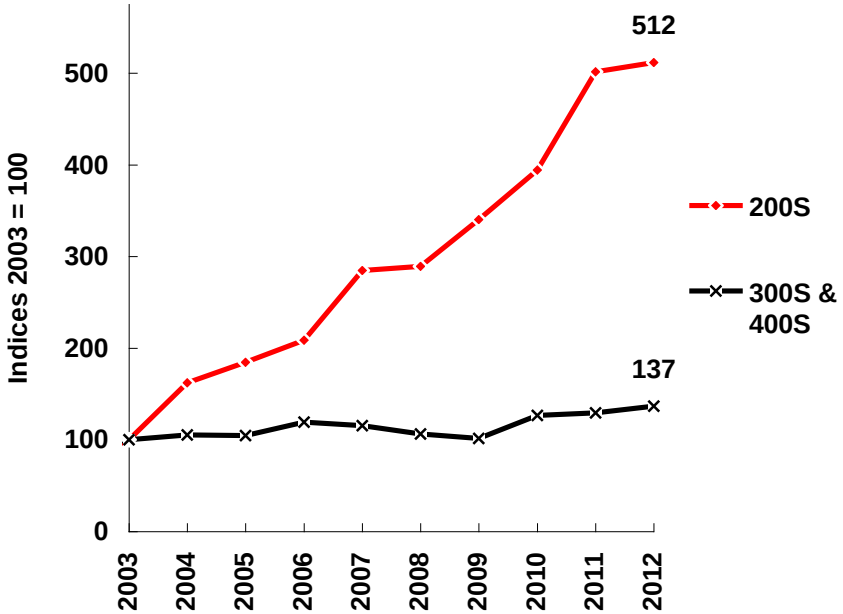


Source: K.Fowkes, IMnI, Worldsteel, Macquarie Research, June 2013

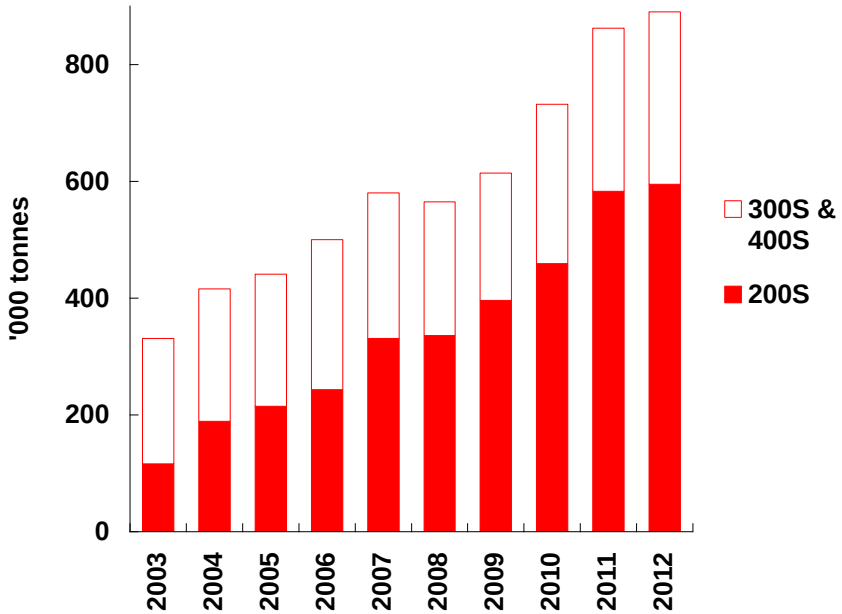
Adding Mn: 200-series stainless steel output has increased fivefold in the last decade

- 200S stainless steels typically contain 6%-15% Mn; 300S & 400S contain on average only ~1% Mn
- 200S <20% of total stainless steel output but accounts for two-thirds of Mn usage in stainless steel

World stainless steel output by grade



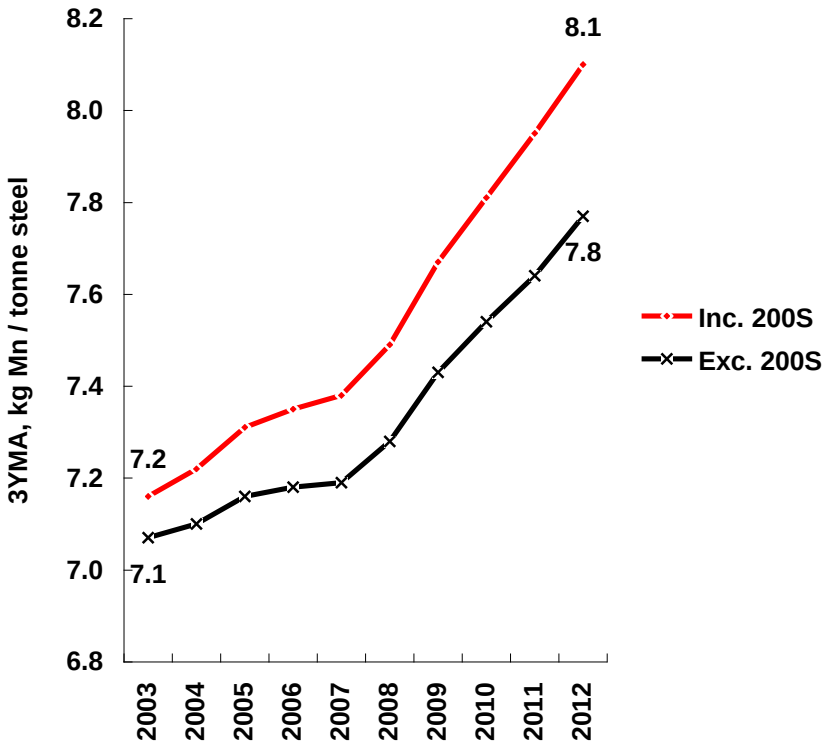
Mn usage in stainless steel output



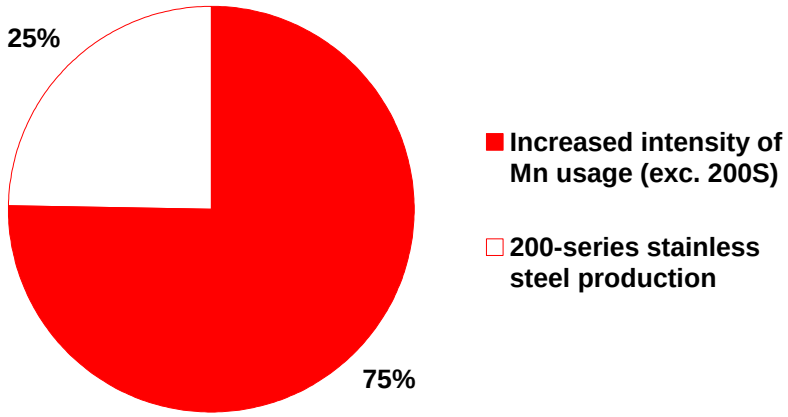
Source: CSSC, IMnI, ISSF, K.Fowkes, Macquarie Research, June 2013

Adding Mn: 200-series stainless steel has contributed 25% to increased intensity of manganese use

Unit Mn usage in steel production



Contributors to increased intensity of manganese usage in steel 2003-2012

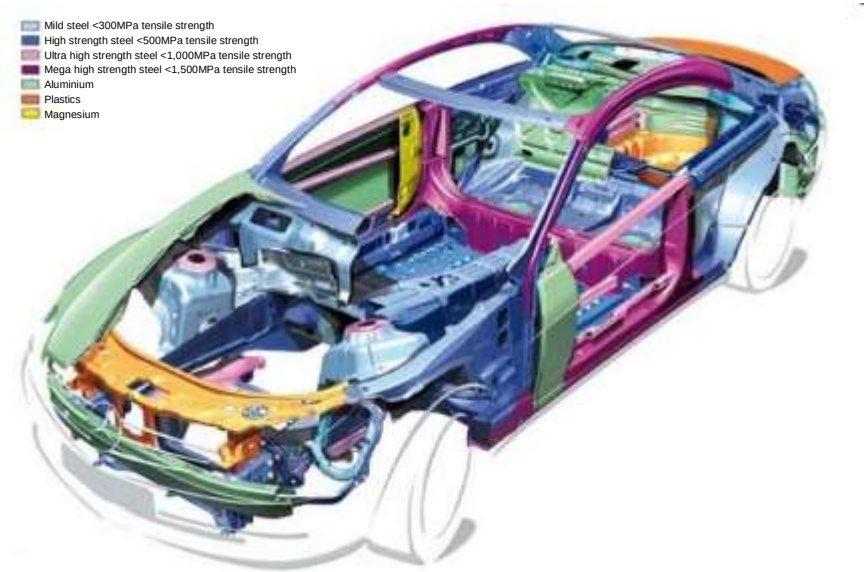


Source: K.Fowkes, IMnI, ISSF, Worldsteel, Macquarie Research, June 2013

Adding Mn: auto output outpacing steel production and using more high strength steel to save weight

Ex-China autos and steel output

- Ex-China auto output has outpaced steel output
- More autos are using more high-strength steels, adding to intensity of manganese use



Source: LMC, OICA, Worldsteel, Macquarie Research, June 2013

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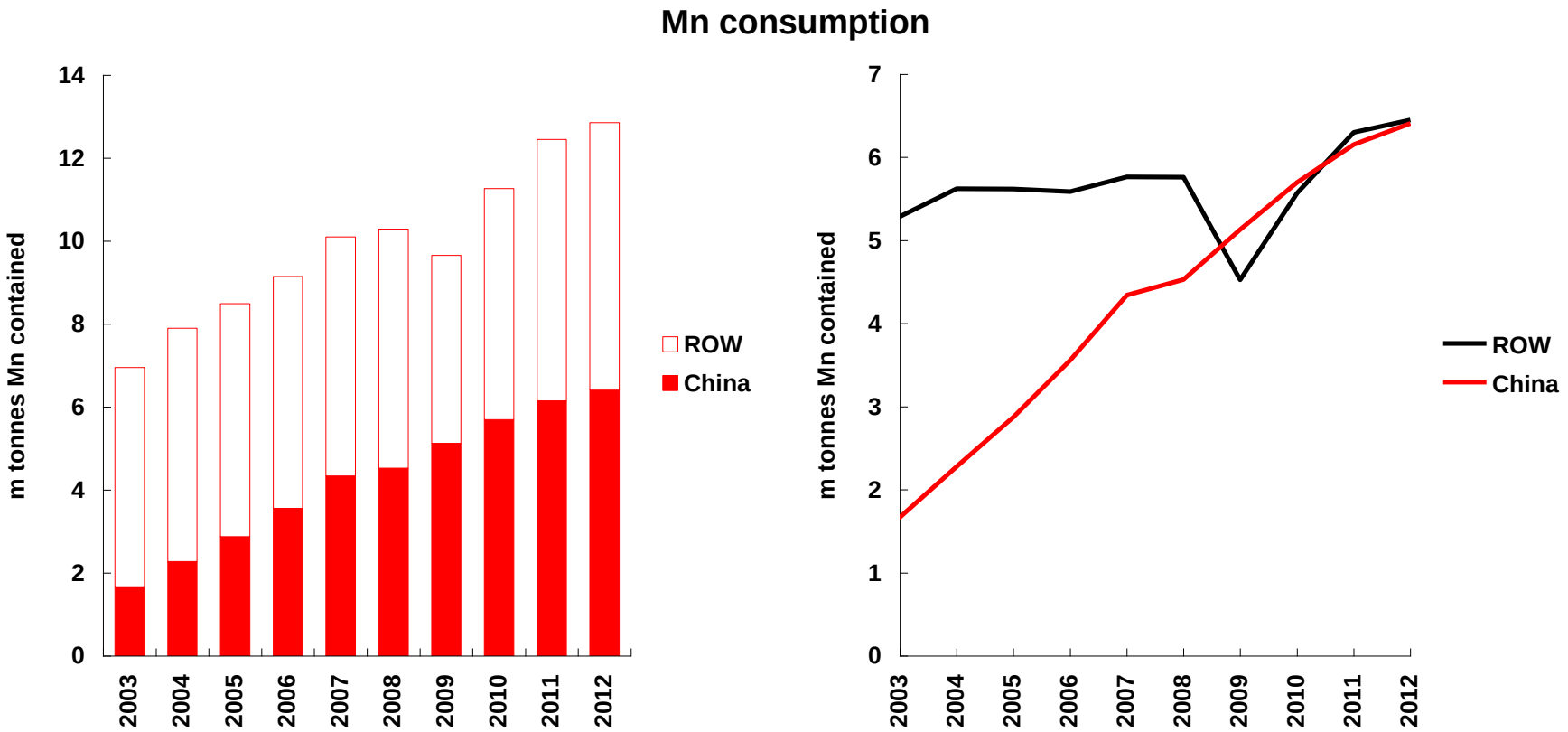
Global Mn consumption running at record levels. China makes main contribution, now half of total



Source: K.Fowkes, IMnI, Macquarie Research, June 2013

China's Mn ore resources: large but low-grade and limited relative to domestic demand

China's major manganese regions

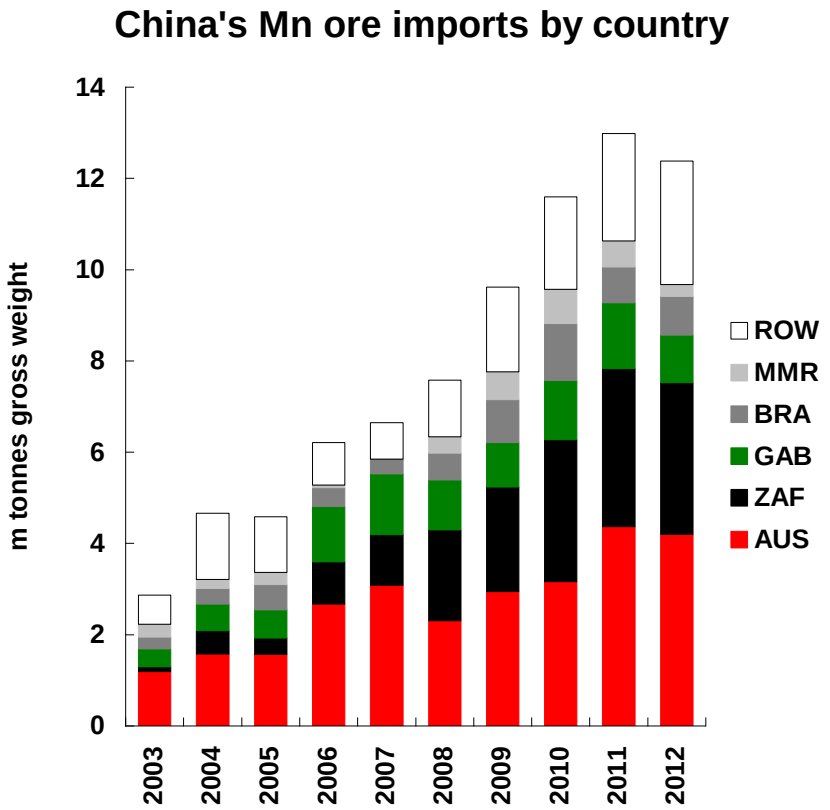
- China's Mn ore resources are reported at almost 400m tonnes, on average grading ~22% Mn and occurring mainly in the south of the country, sufficient for >25 years at recent operating rates, although some regions are close to depletion
- Most resources are siliceous carbonate ores, suitable for SiMn and MRS but not HC FeMn, and cannot be significantly upgraded by concentration

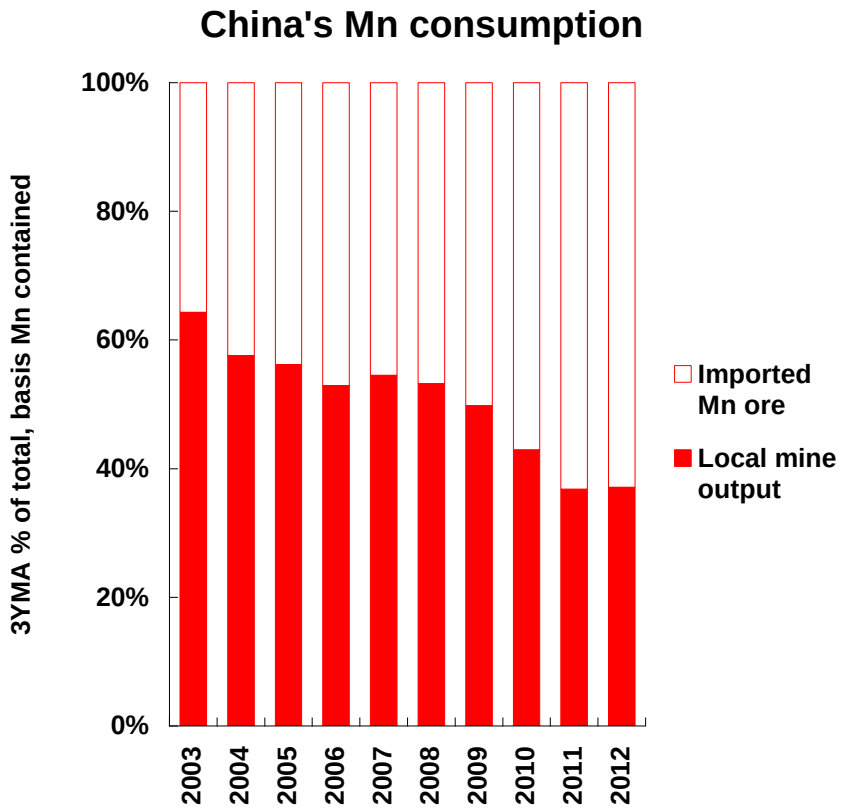
China's Mn ore resources[1]

Province	Mn ore grade	Mn:Fe ratio	Silica	P	Mn ore resources m tonnes	Mn ore resources % of total
Guangxi	Oxide ores ~32% Carbonate ores ~22%	4:1	18%	0.1%	133	34%
Hunan	~20%	10:1	10%	0.1%	69	18%
Other provinces	..	..	..	..	187	48%
China total	~22%	6:1	16%	0.1%	389	100%

Source: C&M, K.Fowkes, Hatch, SRK, USGS, Macquarie Research, June 2013. Note: 1. data are estimates for measured and indicated resources only at end-2010

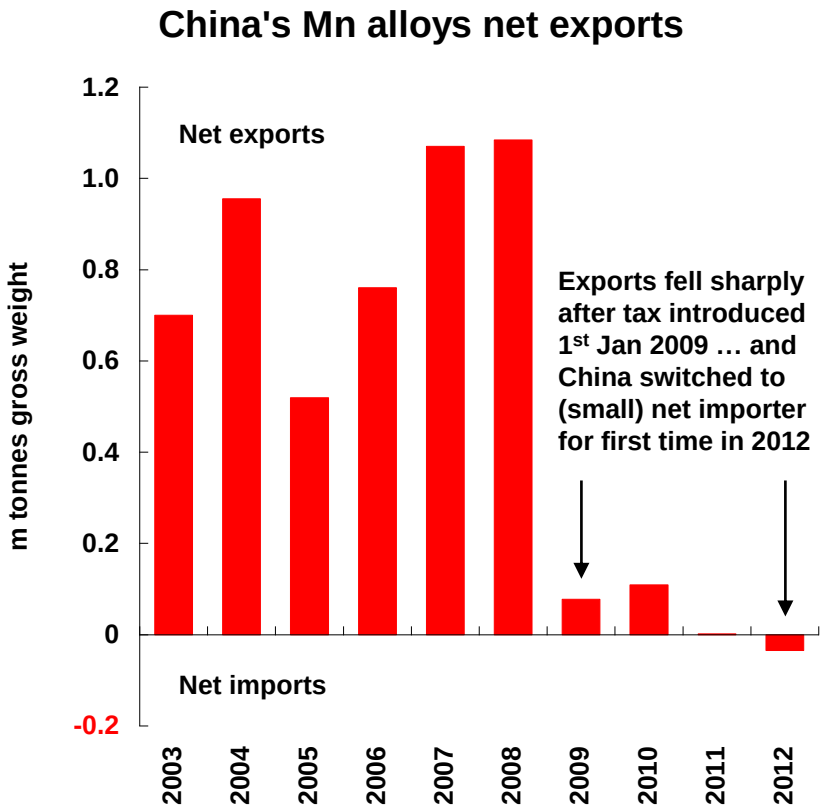
China's Mn ore imports have increased fourfold in last decade; now supply 60% of local consumption

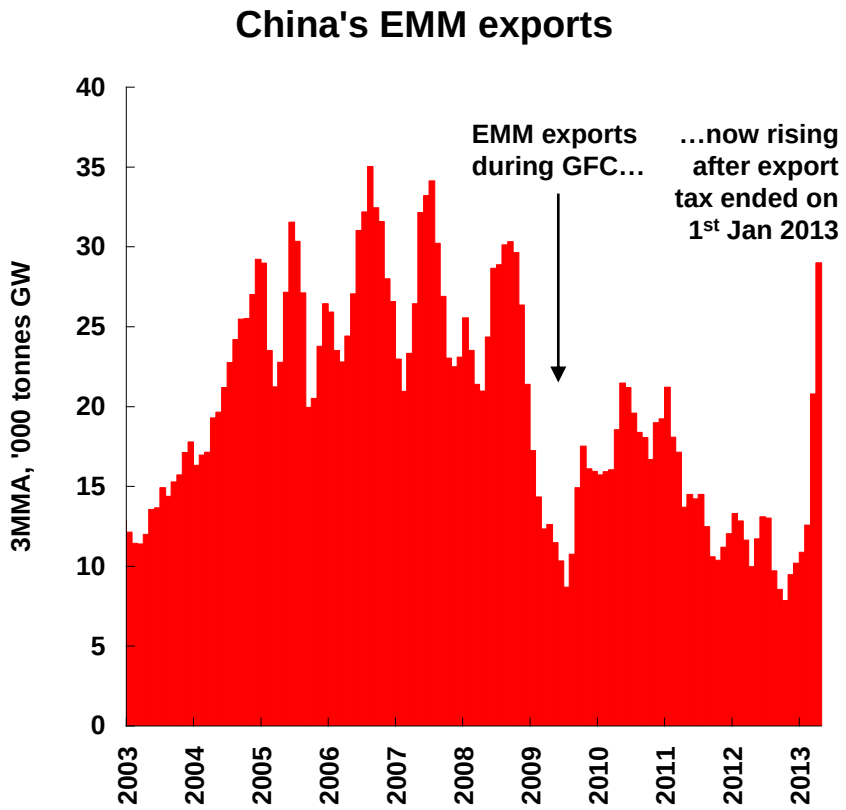




Source: China Customs, K.Fowkes, IMnI, Macquarie Research, June 2013

China swings from major net exporter to importer of Mn ferroalloys; EMM exports also falling until recently



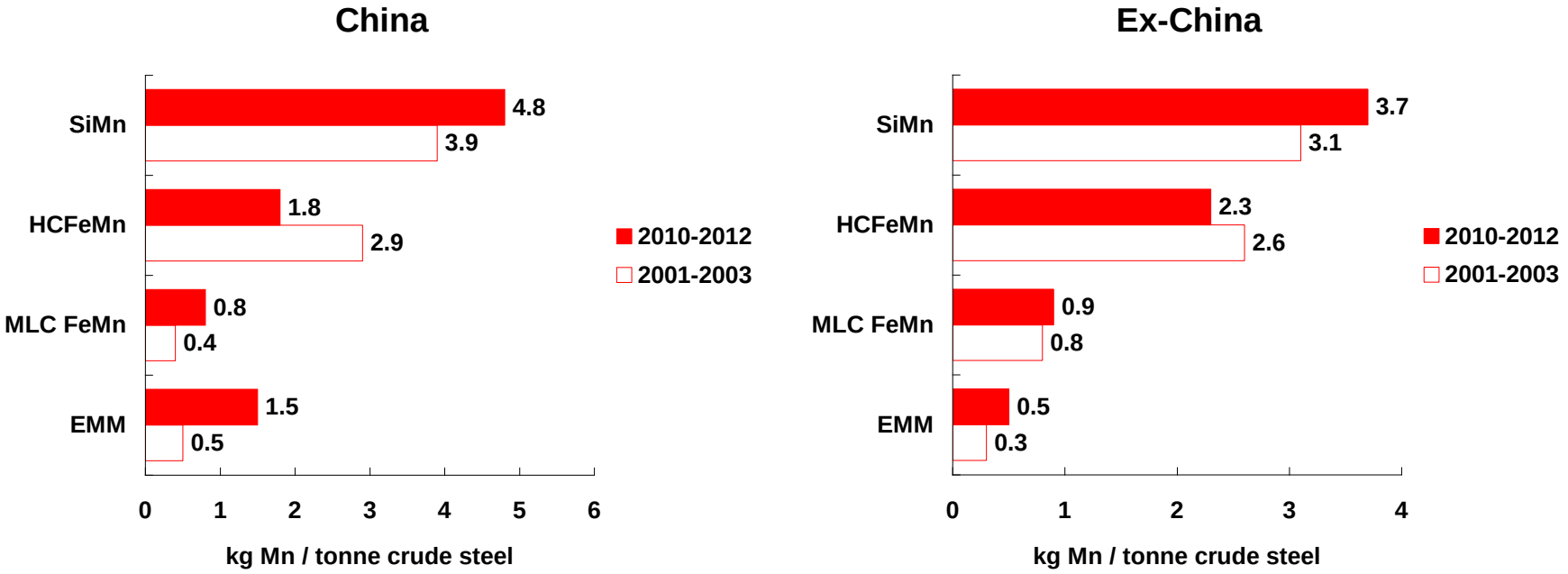


Source: China Customs, Macquarie Research, June 2013

China's Mn ferroalloys usage differs from elsewhere. More SiMn, MLC FeMn rising faster, HCFeMn falling

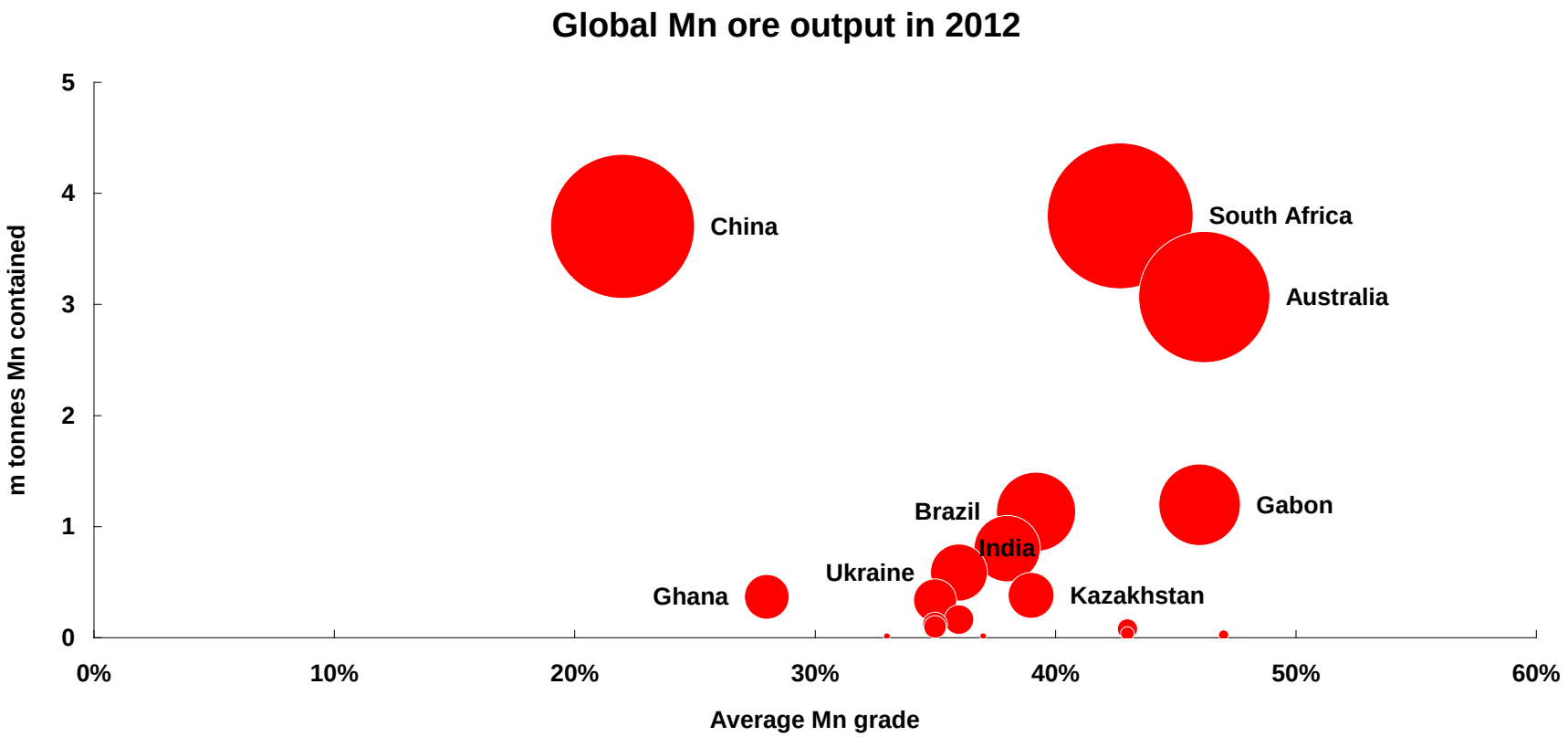
- Unit SiMn usage in steelmaking has increased in the last decade; typically alloy of choice *where* practical
- HCFeMn usage has fallen as MLC FeMn has risen, especially in China in part for reasons related to MRS[1]

Use of Mn ferroalloys in steelmaking



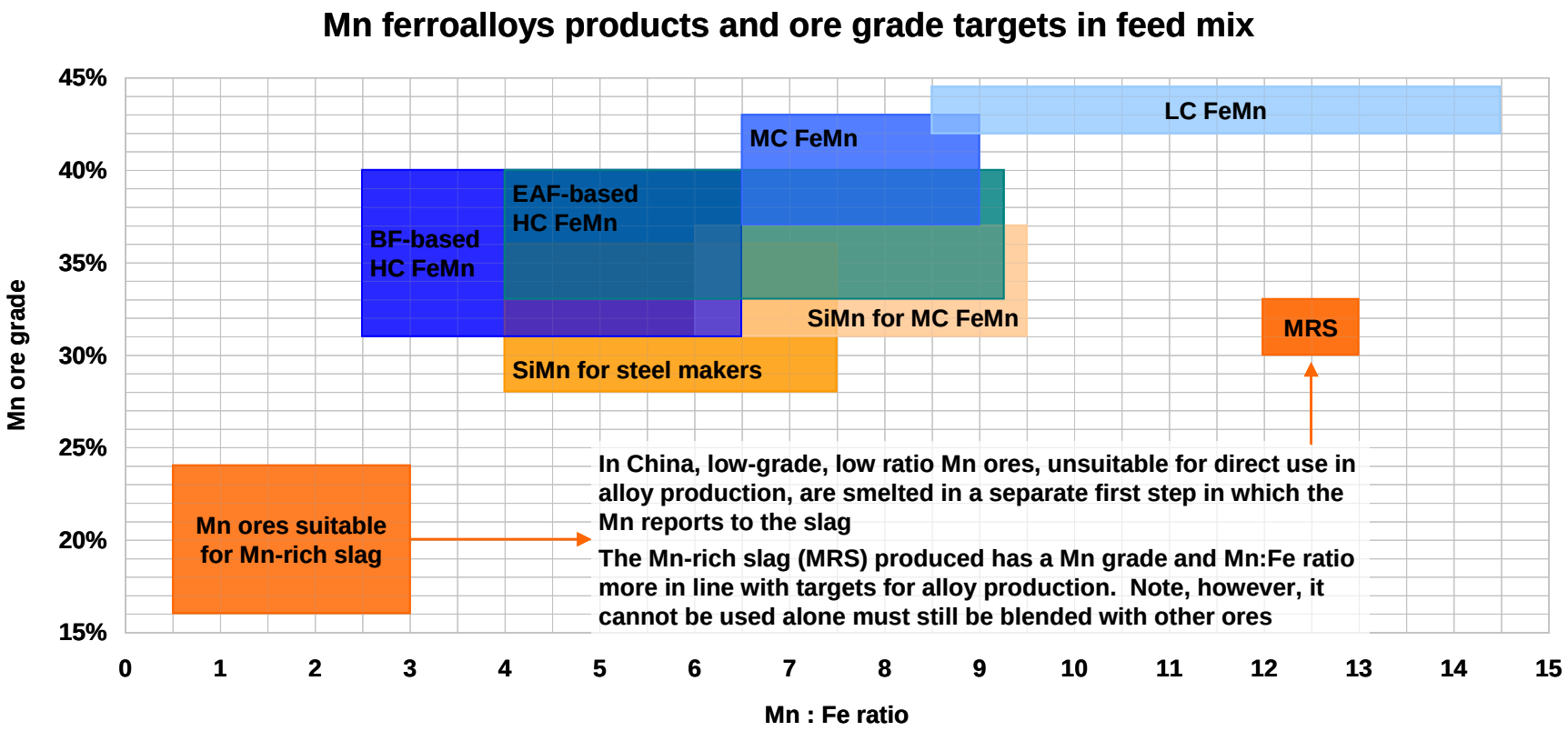
Source: K.Fowkes, IMnI, Worldsteel, Macquarie Research, June 2013. Note: 1. MRS is manganese rich slag

China's Mn contained in mine output second only to South Africa but ore grades are low



Source: K.Fowkes, IMnI, Macquarie Research, June 2013

China's Mn ferroalloys producers make use of local low-grade, low-ratio ores, reducing import demand



Source: C&M, Metallurgy of Manganese, Macquarie Research, June 2013

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Mn use in steelmaking – a summary

➔ **Mn has two main uses in modern steelmaking**

1. As an alloying agent
   Mn increases tensile strength, hardness, toughness, wear resistance and machinability
2. To "fix" residual sulphur
   No substitutes and essential in all steelmaking but use reduced by adoption of hot metal desulphurisation as standard practice today

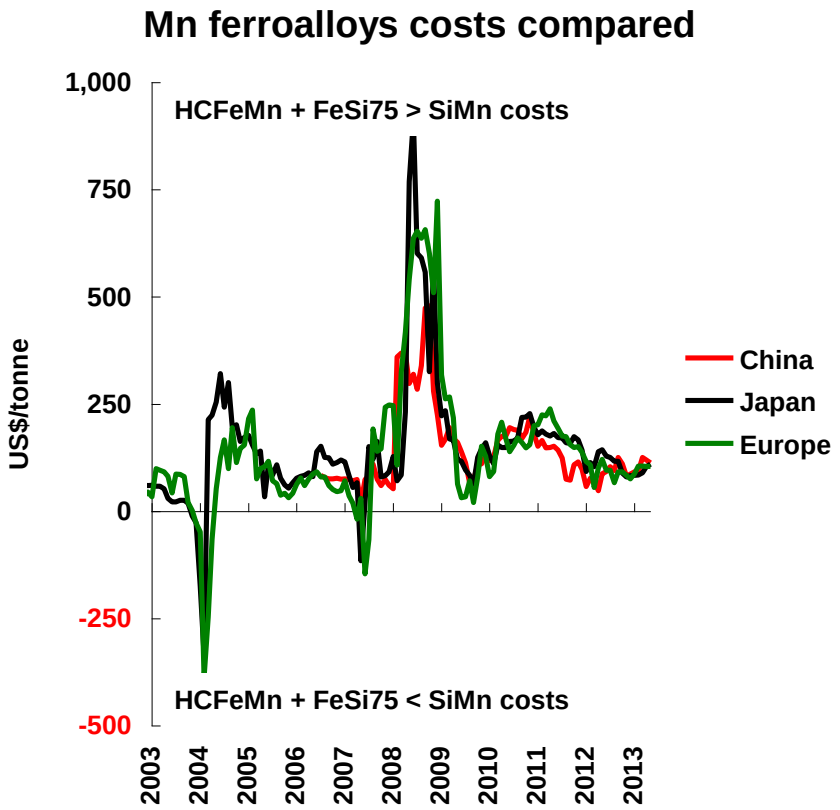
➔ **Mn ferroalloy(s) and amount used are a function of three main factors**

1. The aim chemistry of the finished steel product
   Mn content allied to carbon and silicon control. Flat steel products typically lower in carbon than long steel products. Silicon control important in surface critical flat products
2. Steelmaking process and practice, which affect efficiency in achieving aim chemistry
   No significant difference between BF / BOF and EAF steelmaking, except where bottom-stirring used to reduce carbon on tapping in primary steelmaking
3. Cost of alternative alloying additions within constraints of aim chemistry and steel plant design
   Configuration of hoppers feeding furnaces

Source: Hatch, K.Fowkes, Macquarie Research, June 2013

SiMn typically steelmakers' alloy of choice when practical within product and process constraints

- Steelmakers' Mn ferroalloys selection driven first and foremost by aim chemistry of steel product within constraints of steelmaking process and plant design
- Subject to product and process constraints, SiMn typically alloy of choice for three reasons:
  1. Two alloys are added in one product
  2. De-oxidising performance of Si in SiMn is more powerful than in FeSi
  3. Adding SiMn avoids losing heat to the melting of additional iron units in the LMF, (important for cycle time and productivity)
- SiMn often more cost effective than equal mix of HCFeMn and FeSi in most markets (US market excepted due to AD duties on imports of SiMn)



Source: CRU, Hatch, K.Fowkes, Macquarie Research, June 2013

Future shifts in steel product mix may alter balance of Mn ferroalloys used by steelmakers

- Forecasts of an increasing uptake of higher strength, higher manganese steels in certain applications, especially auto and energy steels, may see steelmakers seek adaptations and / or new products in Mn ferroalloys
  - Products that mix better and melt faster with greater consistency in sizing and alloy chemistry. Melting speed is important for cycle time. Mn recovery from ferroalloy to steel is a function of steelmaking practice but also alloy quality; consistent recovery reduces risk of "off-spec" steel
  - Higher Mn grade to reduce volume additions required and resultant drop in steel temperature, with positive implications for cycle time, productivity and cost control
  - Lower content of carbon and deleterious residuals, notably hydrogen, nitrogen, phosphorous
- In future, steelmakers may consider melting Mn ferroalloys to add in liquid form at tapping and in the LMF with the advantages this would be easier to add to the liquid steel stream and reduce energy use. This is already practiced by some stainless and speciality steelmakers

Source: Hatch, K.Fowkes, Macquarie Research, June 2013

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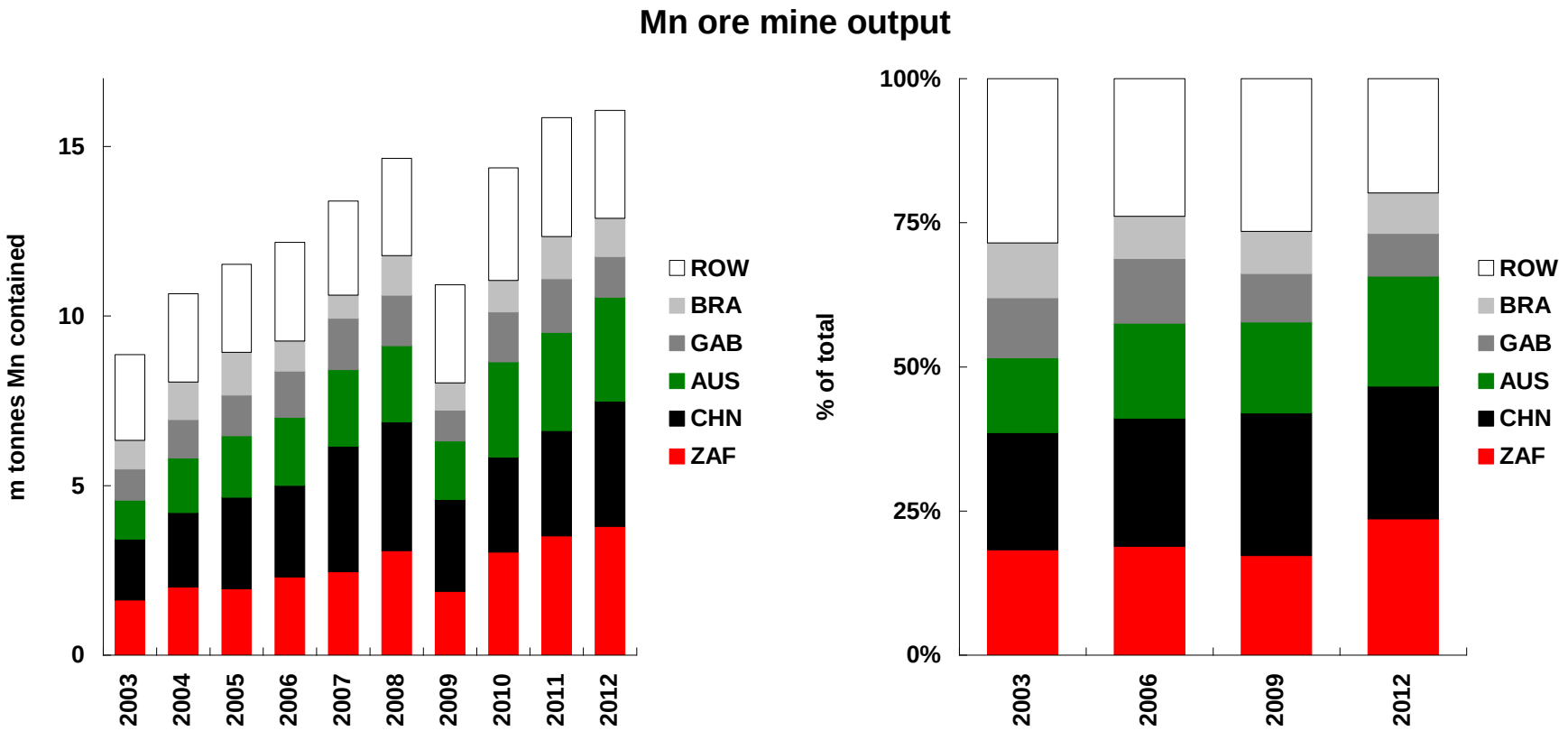
South Africa, China, Australia drive rise in global Mn ore mine output; China's share now slipping



Source: K.Fowkes, IMnI, Macquarie Research, June 2013

Prospects for supplies of Mn ore from key producer countries in the coming years; no obvious shortage

Key countries	Output, mt[1]	Comments
Australia	3,795	BHPB driving output but commitment uncertain. Exploration prospects in NT, WA
Brazil	1,130	Medium to high grade resources but depleting. Not a priority for all operators
Burkina Faso	-	High-grade resources but lacking infrastructure. Tambao project
China	3,700	Domestic resource base low grade, progressively depleting. Import dependency set to rise
Gabon	1,195	Large, high-grade undeveloped resources. Moanda expansion. Bembélé ramp up
Ghana	365	Low-grade but clean ore. Low cost mining, large resource. Expansion expected
India	800	Domestic oriented output, recently falling with offset from higher imports
Kazakhstan	380	Remote, low grade, high cost mines. Challenges at corporate level
Russia	-	Chek-Su, SGMK projects but uncertain time line
S.Africa	3,790	Huge resources, high-grade and low cost by global standards but limited infrastructure
SE Asia	460	Indonesia, Malaysia, Myanmar, Vietnam. Low cost but mainly low grade; under-explored
Ukraine	585	Large resources but low-grade. Tavrichesky mine could be re-opened
W.Africa	90	DRC, Côte d'Ivoire, Namibia, Zambia. High grade, potentially low cost; under-explored, lacking infrastructure

Source: CRU, K.Fowkes, Macquarie Research, June 2013. Note: 1. 2012 Mn contained

S.Africa's infrastructure for Mn ore exports is limited. Long lead times to expand (limiting supply meanwhile)

Route	Capacity	Latest status
Port Elizabeth by rail	5.5m tpa	Previous commitment to discontinue exports through Port Elizabeth by 2016 now looks unlikely before 2017-18. Rail allocation among competing producers in the meantime still to be decided
Saldanha Bay by rail	~13m tpa	Transnet is no longer considering allocation of capacity for Mn ore shipments in the next Sishen–Saldanha Bay rail expansion. New capacity will not be available before 2016/17 in any case
Durban by rail and road	3m–4m tpa	BMA terminal is expanding and offers option of container shipping. Rail access increasing but some road haulage still required and remains expensive (~US$1.80-1.90/dmtu for "low" grade ore)
Richards Bay by road	~1m tpa	Trucking to Richards Bay up to ~15% more expensive than to Durban. Mn ore exports must compete with (increasing) chrome ore and iron ore shipments and volumes are falling
Coega by rail	10m–16m tpa	Transnet's preferred option. ZAR2.7bn first phase approved by TRF CEO in May. Ambitious target to reach 12mtpa by mid-2017. However, industry worries over cost estimated at ~ZAR11bn. Local Mn ferroalloys smelter unlikely to be built

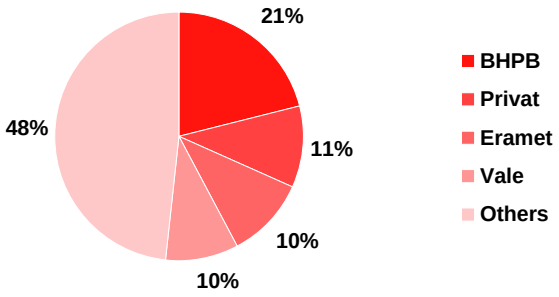
Less expensive

More expensive

Source: Assmang, Macquarie Research, June 2013

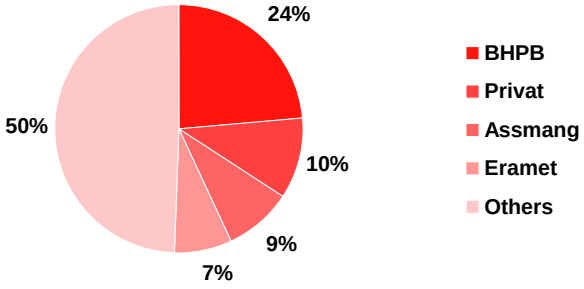
Mn mining consolidation unchanged in ten years. Possible ownership changes may offer opportunities

Mn ore output by company - 2003

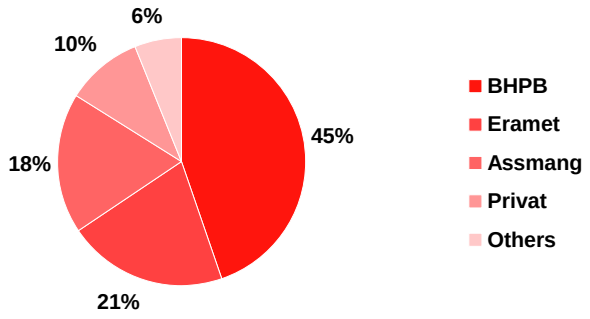


- Mn mining consolidation unchanged in ten years. China has offset rising output among the majors. Four firms ratio ~50%
- Market for higher grade ores highly concentrated. Four firms ratio >95%
- Some major miners reported reviewing ownership (issues of scale among others) offering opportunity for new entrants; vertical integration unlikely

Mn ore output by company - 2012



High-grade ore output by company - 2012



Source: Company Reports, K.Fowkes, IMnI, Macquarie Research, June 2013. Note: high-grade ore defined as ≥40% Mn contained

The manganese industry worldwide – trends and opportunities

- Global steel production and future prospects
- Intensity of manganese usage in steelmaking
- China's role as manganese consumer and producer
- Selection and use of manganese ferroalloys in steelmaking
- Manganese ore supply
- Summary and conclusions

The manganese industry worldwide – trends and opportunities

Summary and conclusions

- Global steel output running at record levels. Prospects for further increases promising driven by urbanisation and additions to auto fleet, especially in China
- Intensity of manganese use in steelmaking has been rising and likely to continue albeit at probably more moderate rate (scope for further efficiency gains reduced)
- Don't doubt demand side potential for manganese!!
- China likely to remain world's largest consumer of manganese for many years yet and import dependence likely to increase with local resources relatively limited
- Steelmakers demands of Mn ferroalloys likely to continue changing but with SiMn remaining alloy of choice subject to product / process constraints
- Sufficient supply in prospect to meet demand into second half of decade, despite South African infrastructure constraints. Longer term expansion with care

Important disclosures:

Recommendation definitions

Macquarie - Australia/New Zealand
Outperform – return > 3% in excess of benchmark return
Neutral – return within 3% of benchmark return
Underperform – return > 3% below benchmark return

Benchmark return is determined by long term nominal GDP growth plus 12 month forward market dividend yield.

Macquarie – Asia/Europe
Outperform – expected return >+10%
Neutral – expected return from -10% to +10%
Underperform – expected <-10%

Macquarie First South - South Africa
Outperform – return > 10% in excess of benchmark return
Neutral – return within 10% of benchmark return
Underperform – return > 10% below benchmark return

Macquarie - Canada
Outperform – return > 5% in excess of benchmark return
Neutral – return within 5% of benchmark return
Underperform – return > 5% below benchmark return

Macquarie - USA
Outperform – return > 5% in excess of benchmark return
Neutral – return within 5% of benchmark return
Underperform – return > 5% below benchmark return

Volatility index definition*
This is calculated from the volatility of historic price movements.

Very high–highest risk – Stock should be expected to move up or down 60-100% in a year – investors should be aware this stock is highly speculative.

High – stock should be expected to move up or down at least 40-60% in a year – investors should be aware this stock could be speculative.

Medium – stock should be expected to move up or down at least 30-40% in a year.

Low–medium – stock should be expected to move up or down at least 25-30% in a year.

Low – stock should be expected to move up or down at least 15-25% in a year.

* Applicable to Australian/NZ stocks only

Recommendation – 12 months

Note: Quant recommendations may differ from Fundamental Analyst recommendations

Financial definitions

All "Adjusted" data items have had the following adjustments made:

Added back: goodwill amortisation, provision for catastrophe reserves, IFRS derivatives & hedging, IFRS impairments & IFRS interest expense
Excluded: non recurring items, asset revals, property revals, appraisal value uplift, preference dividends & minority interests

EPS = adjusted net profit /efpowa*
ROA = adjusted ebit / average total assets
ROA Banks/Insurance = adjusted net profit /average total assets
ROE = adjusted net profit / average shareholders funds
Gross cashflow = adjusted net profit + depreciation
*equivalent fully paid ordinary weighted average number of shares

All Reported numbers for Australian/NZ listed stocks are modelled under IFRS (International Financial Reporting Standards).

Recommendation proportions – for quarter ending 31 March 2013

	AU/NZ	Asia	RSA	USA	CA	EUR	
Outperform	45.12%	53.24%	50.00%	40.70%	62.98%	43.30%	(for US coverage by MCUSA, 6.10% of stocks covered are investment banking clients)
Neutral	41.52%	28.01%	41.43%	55.01%	32.60%	34.10%	(for US coverage by MCUSA, 4.91% of stocks covered are investment banking clients)
Underperform	13.36%	18.74%	8.57%	4.29%	4.42%	22.60%	(for US coverage by MCUSA, 3.33% of stocks covered are investment banking clients)

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