

*“Carbon reductants for the
production of chrome &
manganese alloys”*

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June 2010*

Description of Met Coke...

Definition of coke: the solid residue - hard, strong & porous - formed when bituminous coal is heated strongly in the absence of air under pressure.

Methods of production: most commonly in *vertical batteries*, from which by-products - tar, CO gas, ammonia etc - are recovered; In horizontal *non-recovery batteries* in which by-products are burned internally to generate power (existing in the US, India, other countries); Minor production from so-called “*bee-hive*” plants, small-scale primitive ovens, remains in some countries.

Uses: as reductant for metallurgical processes i.e. iron-making in the blast furnace, ferrochrome & manganese alloys, calcium carbide, some base metals processes, soda ash, sugar-refining, lime kilns; also as heat source in cupola furnaces for foundry iron and stone wool.



Coke's Role in Reduction Processes

<i>Grade</i>	<i>Replacements</i>	<i>Approx Coke Rate – a</i>
Pig Iron	Injection of pulverized coal (PCI) or other materials into the blast furnace can cut coke rate down to 0.3-0.35 per tonne HM.	0.5
Ferrochrome	Gas coke and char in South Africa cut coke rate by up to 50%. Phos content critical (<0.015%) adding to constrained supply.	0.65-0.7
Manganese Alloys	Technically, more possibility to reduce coke in Mn alloys than FeCr production. Anthracite and coal are main replacements.	0.3-0.4
Calcium Carbide	Petroleum coke and anthracite are main replacements. European capacity being progressively closed.	0.6
Base Metals	Some smelting processes for lead, zinc and copper use coke, but are increasingly being phased out on cost and environmental grounds.	various
Soda Ash, Sugar	For carbon dioxide production in lime kilns. Coke can be replaced up to 100% with anthracite in this application.	Low (<0.15)
<i>(Production of elemental phosphorous and silicon carbide also require carbon reductants.)</i>		

a – with no coke replacement

Constrained Supply of Coke

Why have coke prices escalated over the past decade?

One, stricter environmental regulations in “western world” especially, leading to higher costs of compliance and sometimes capacity closures.

Two, lower integrated steel production in “western world” leading inevitably to a smaller coke capacity base.

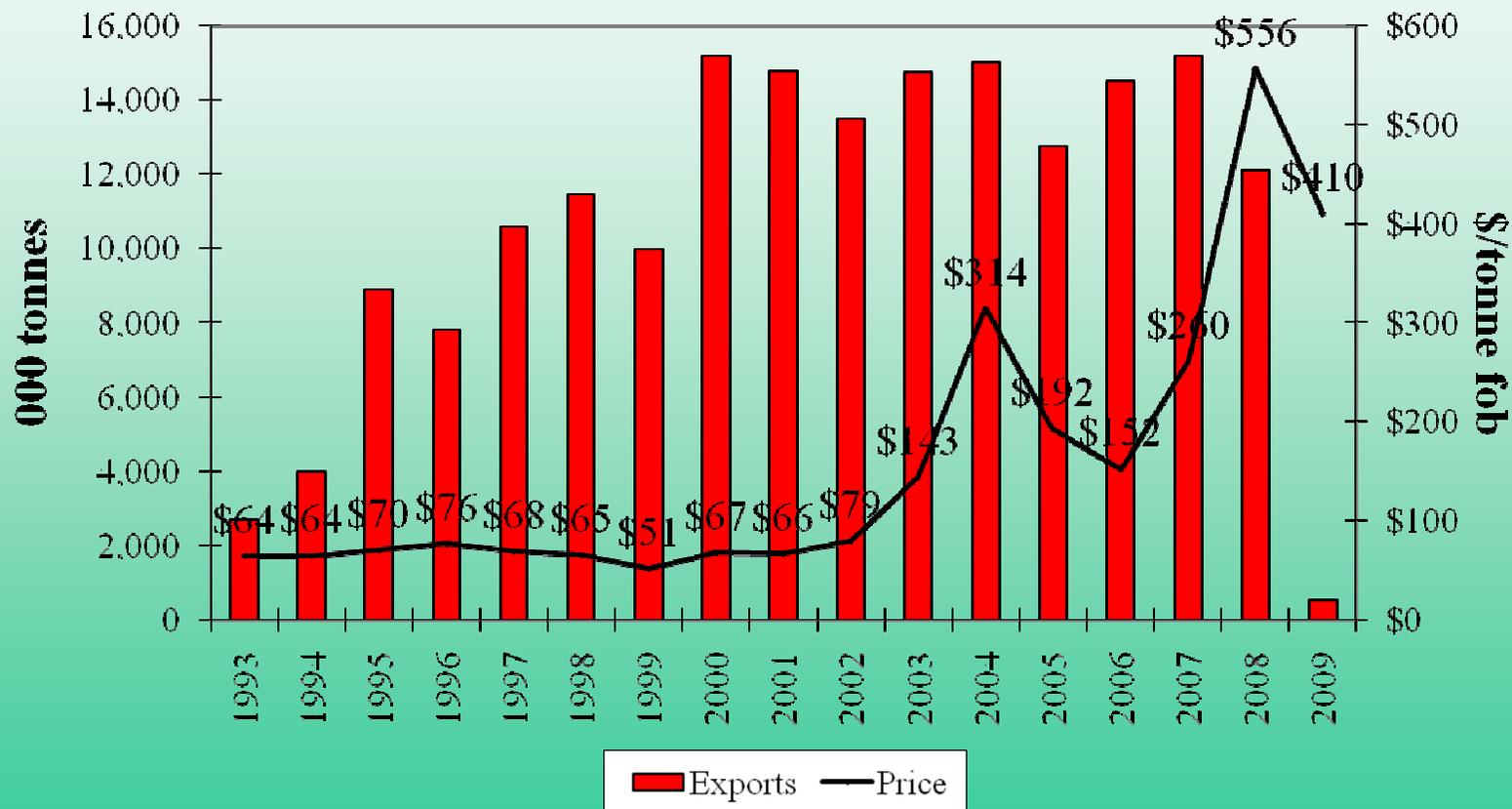
Three, controls on Chinese exports (before 2009 accounting for ½ world trade) eg annual limit of 14m tpy, export taxes. Closures of bee-hive capacity in China; accounted for ½ of its production in mid 1990s.

Finally, higher coking prices due to investments to alleviate port and rail bottlenecks, as well as for new mine capacity.



Example of so-called “bee-hive” coke plant (Santa Catarina, Brazil, 2008).

Chinese Coke Price vs Exports

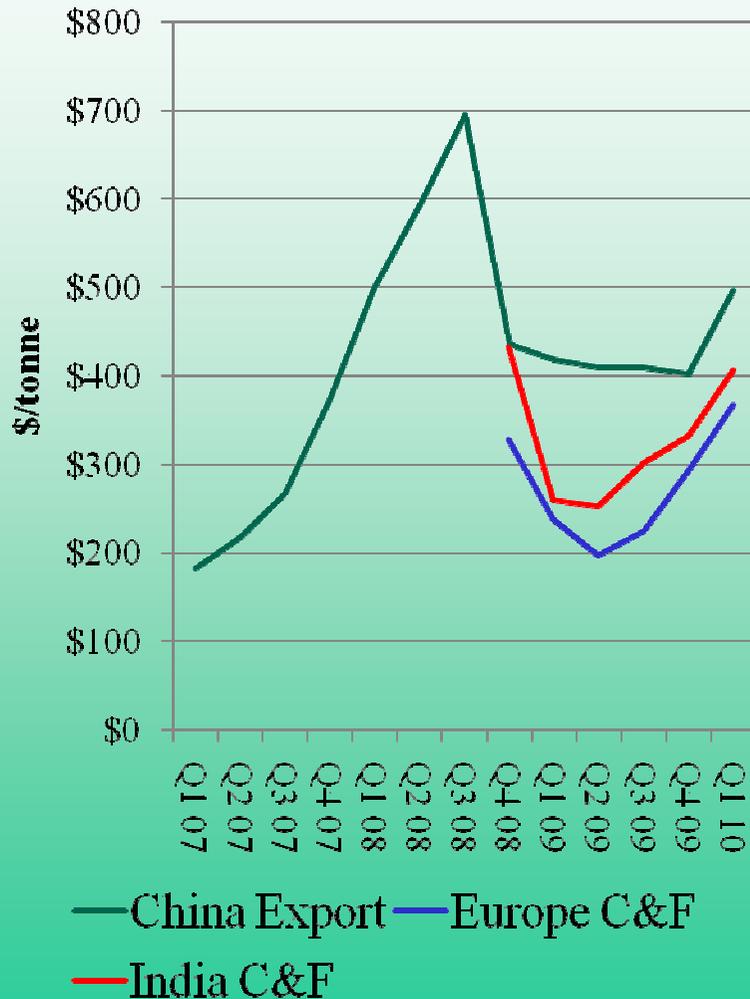


Monthly Market Prices Reported by "Resource-Net"

<i>Grade</i>	<i>Basis, \$/tonne</i>	<i>Market Characterisitcs</i>
Blast Furnace Coke (30/90mm)	Europe c&f, India c&f, China fob	Main benchmark for the coke market, accounting for most of world trade.
Nut (10/25mm)	Europe c&f, China fob	Reductant in some N-F processes (e.g. ferroalloys). Often needs exacting specifications, which can lead to sourcing difficulties. Options exist for coke replacement. Apart from ferroalloys, this market in decline outside China.
Foundry (80/220mm,100/ 250mm)	Delivered Europe (euro), China fob	Cupola furnaces (iron castings, stone wool). Likely capacity shortages in the future, despite long-term decline in iron foundry volumes in developed regions.
Breeze (0/10mm)	Europe c&f	Main uses in ore-sintering and electrodes. Pricing tends to be "localized" due to relatively low value, so limited opportunities for international trade.
Coking Coal (hard)	Export port fob ("spot")	Australia is main reference supplier. Switch to quarterly pricing in 2010.
Anthracite Lumps (10/100m)	Europe c&f	Mainly refers to CIS origin, good quality. Uses in coke replacement especially in soda ash and sugar. Suppliers target 60-70% of coke price.
Anthracite Fines (0/10mm)	Europe c&f	Interchangeable with coke breeze in some applications.

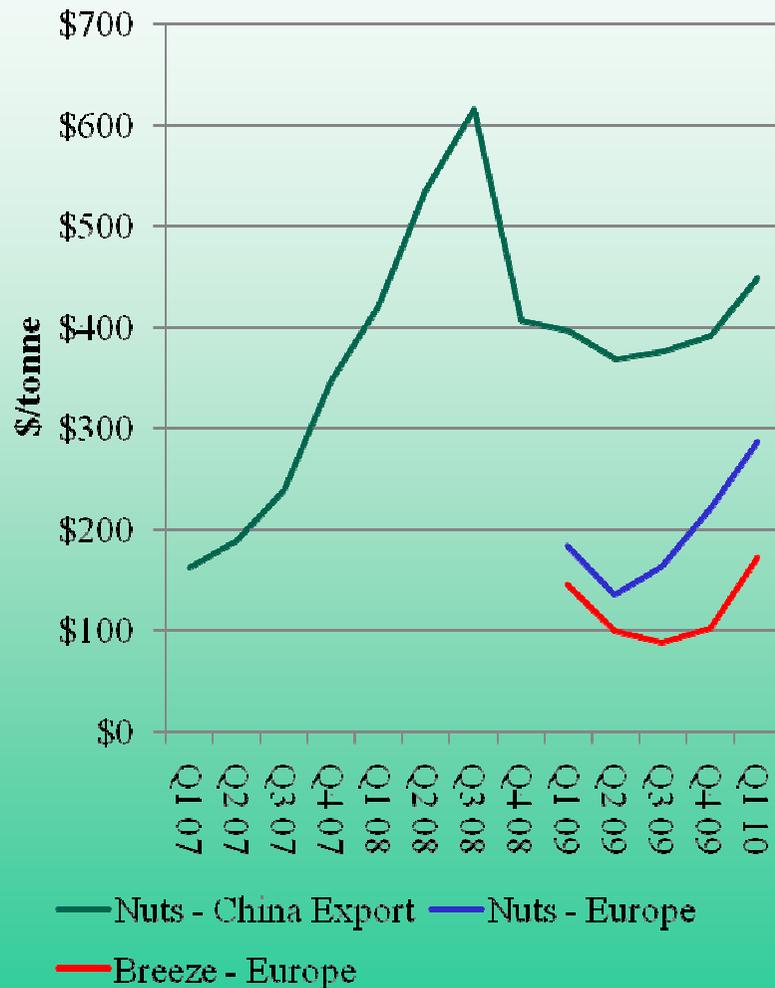
(Prices obtained by informal communication with industry participants i.e. traders, consumers.)

Blast Furnace Coke Pricing



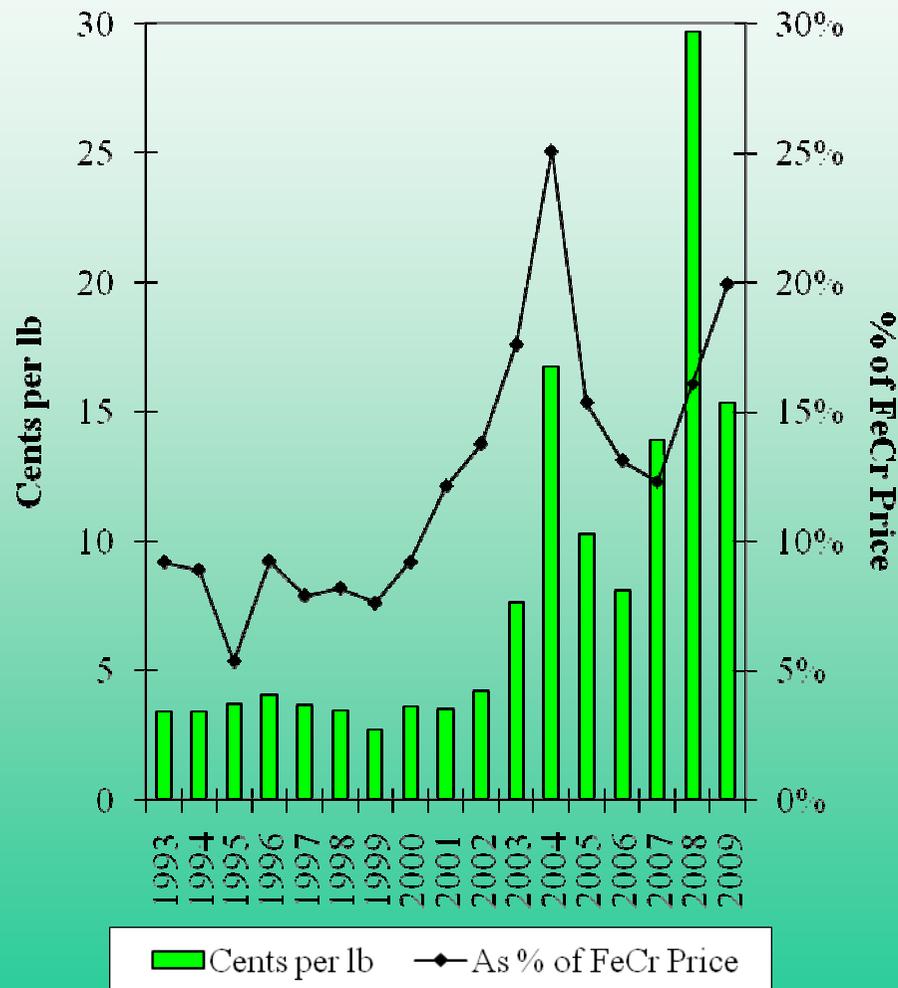
- Due to 40% export tax applied from August 2008, pricing from China was uncompetitive in world markets last year. Its blast furnace coke exports were very low.
- From March, however, there has been renewed interest in Chinese coke by India. The market has risen to a level where it is apparently worthwhile paying 40% tax to export.
- Activity remains low in Europe as far as coke buying goes; more business going through in other markets (Brazil, Middle East etc).
- Important to note that our European price indicates what end-users in Europe pay; it does not indicate the price at which coke is available for export from Europe to other regions.

Pricing for Coke Nuts & Breeze



- Pricing for coke nuts (10/25mm or similar) and breeze (0/10mm or similar) will be of interest to the ferroalloys industry.
- Coke nuts in Europe were priced at approximately 70-80% of the blast furnace price in 2009-10. Additional screening plus tight specs means coke nuts often in tight supply.
- Breeze (used for ore-sintering) tends to be in more ample supply than sized coke, as demand outside sintering is low. Typically 5-10% of coke output is breeze, sometime more.

Estimated Coke Cost As % of Ferrochrome Price



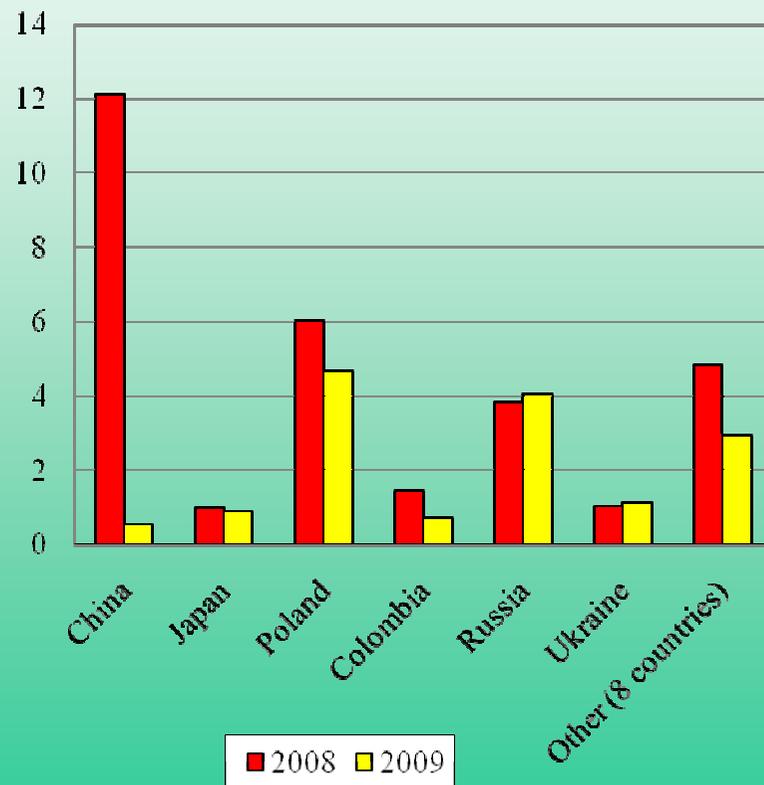
- Here, we show coke cost calculation for charge chrome, assuming 0.6 tonnes of coke per tonne of final product.
- As a percentage of the ferrochrome price, the assessed coke cost increased from a typical level of 5-6% before 2000 to a minimum of 10% in the past decade.
- In 2008 coke accounted for almost 30c per lb of the ferrochrome price on average; declined to 15c/lb last year.

Sources of Supply of Coke for Ferroalloys

<i>Region</i>	<i>Supply Options</i>
Europe	Poland – most important merchant supplier for Europe. Czech Rep, Russia, Ukraine - also options. Scandinavia has historically been supplied from UK.
CIS (Russia, Ukraine, Kazakhstan)	Normally ample coke availability in Russia and Ukraine. Kazakhstan has reduced dependence on China in last few years.
Southern Africa	Availability in South Africa cut by closure of battery for ferroalloys market in 2009. Imports continuing from China due to lack of alternatives. Zimbabwe – high phosphorus, increasingly oriented to central African markets.
Latin America	Colombia has become main supplier. Brazil - some local availability. Mexico – can source from USA.
East Asia (China, Japan, Korea)	Main coke-producing province in China, Shanxi, attracts some ferroalloys production to minimize transport costs. Chinese plants should have lowest cost in world for coke!! Japan has local coke availability, also supplies Korea.
India	Most merchant coke capacity in north-west, demand is dispersed around other states. No alternative to China for imports, although some supply from Japan in the past.

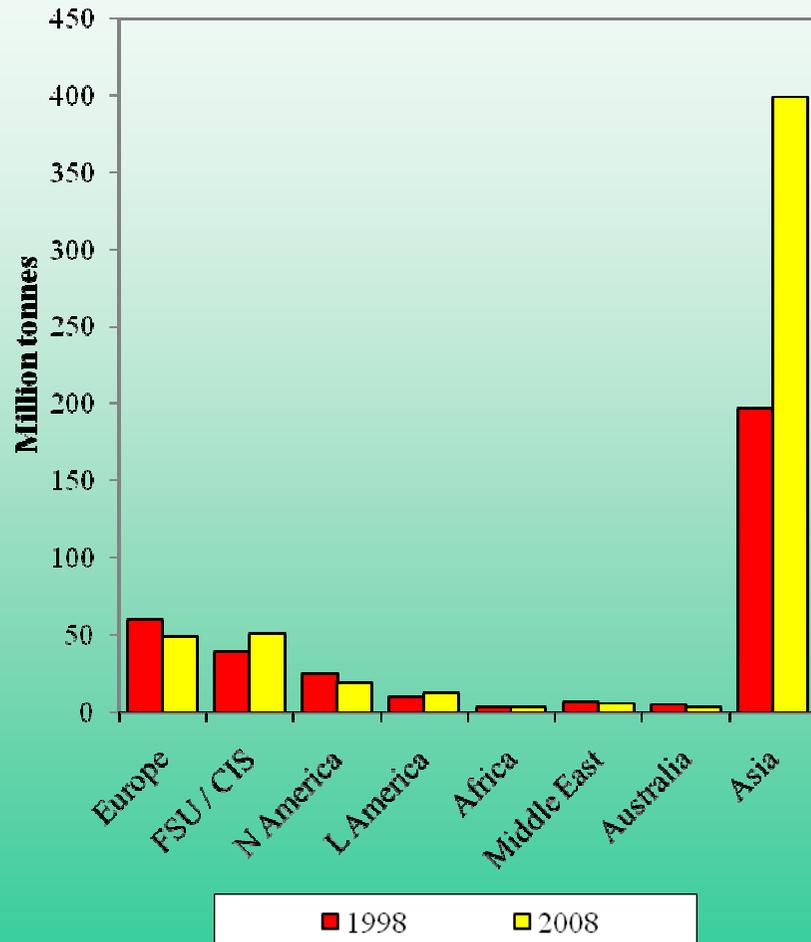
Key World Coke Exporters

**Metallurgical Coke Exports
(Million tonnes)**



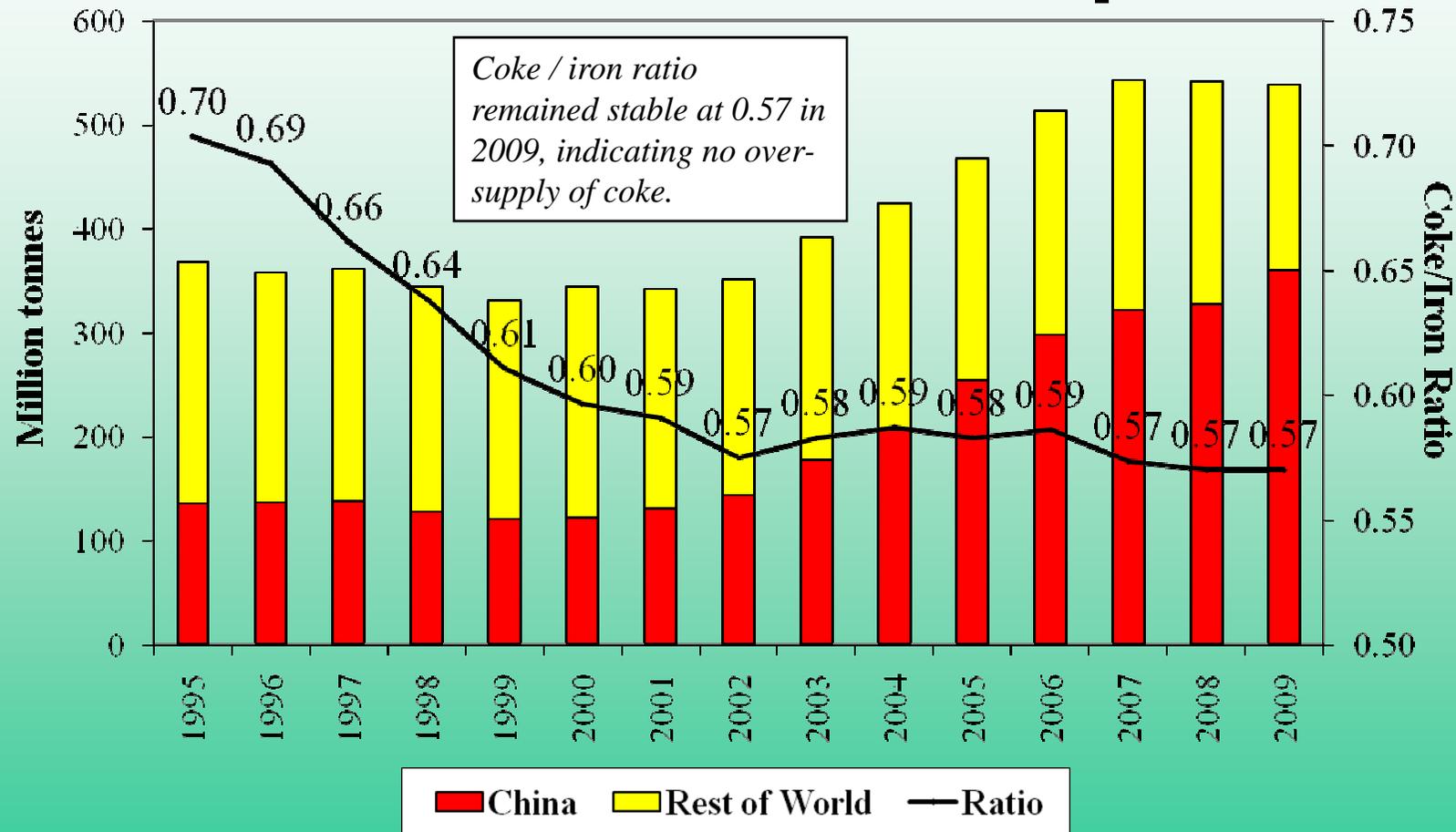
- Whatever Chinese coke was exported in 2009 was foundry and undersize grades. Massive decline from 12m tonnes to around 0.5m tonnes explained by export tax rather than world economic situation.
- Japan: exports in long-term decline, but new opportunities arising in Asian markets due to absence of Chinese coke.
- Poland: mainly supplies other European countries, though sales to India, Iran and Pakistan start in last two years.
- Colombia: traditional markets in Latin & North America, but also supplies Europe and India.
- CIS (Russia & Ukraine): becoming important suppliers to Middle East & India in absence of Chinese coke.

Coke Production by Region

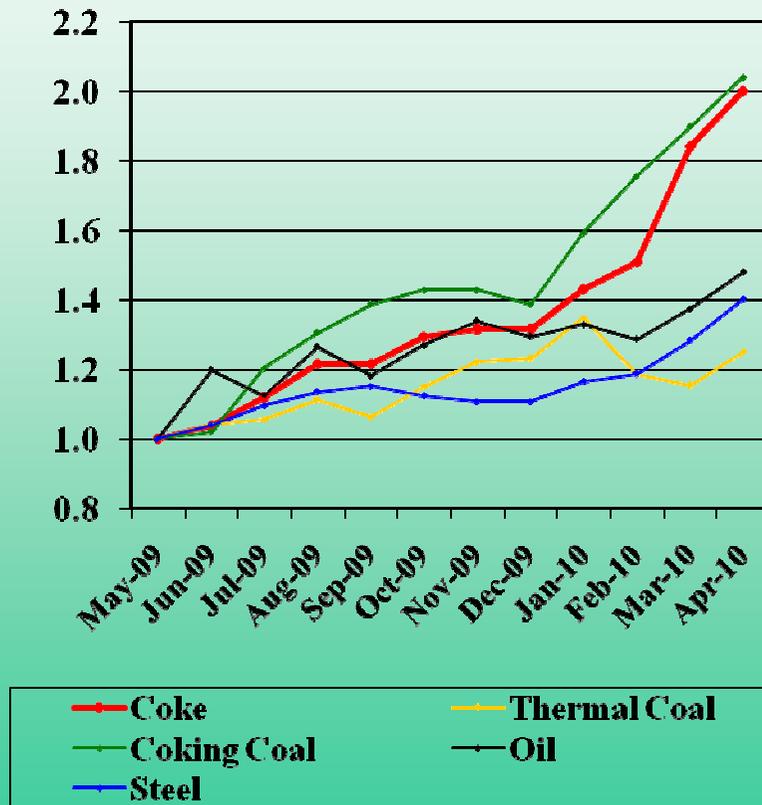


- World coke production has become increasingly dominated by Asia, and in particular China, over the past decade.
- Asian coke production more than doubled from 1998 to 2008.
- In contrast, European coke production has fallen by 18% over the same period. In North America, it has declined by 22% using the same comparison.
- The Fmr Soviet Union (CIS) has also seen some increase in coke production, up by 29% over the past ten years.

World Coke Output versus Ratio to Iron Output



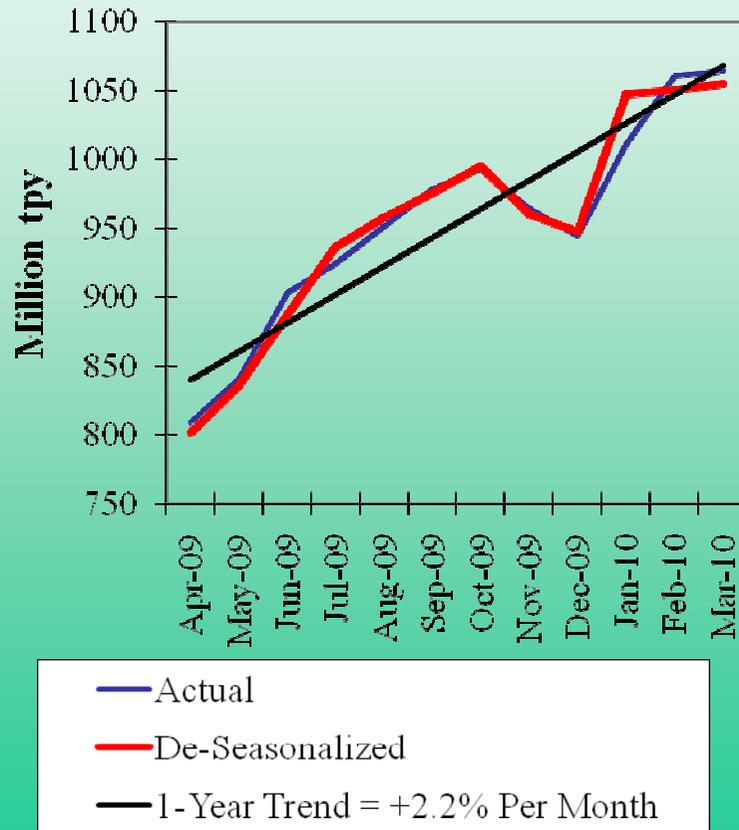
Pricing for Coke Indexed vs Steel & Other Raw Materials – 2009-10



- The past 12 months have seen a recovery in the coke and related commodity markets from the lows of Q2 / Q3 2009, prices almost doubling.
- Prices for BF coke and coking coal (spot) show a correlation as might be expected.
- Coke and coking coal have outperformed the steel market over the past 12 months, also the energy markets (coal, oil).
- Limited supply of coking coal and export tax on Chinese coke means that carbon reductants are a “choke point” for the steel industry.

Global Annualized Pig Iron Output Data

World Iron Output - Actual & Seasonally Adjusted



- World iron output increased from April 2009 low-point; then it declined in the last two months of the year.
- However, there was a rebound in iron output in Q1 2010 to 1.05bn tonnes annualized.
- Strength in world iron output reflects increasing volumes in both Europe (+0.9% average rise per month from 10/09 to 03/10), Americas (1.0% per month) and Asia (+2.3% per month).

Summary of Coke Market

At the start of 2010, world iron output has recovered to 1.05bn tonnes annualized; and coke and coking coal prices have almost doubled over the past 12 months.

In 2009 there were many “unusual” coke transactions; temporary surpluses in Europe and US were shipped to markets where there was need for coke - India as well as other developing countries.

Coke prices “fob China” have lost their previous significance as the main benchmark for the world market. The 40% export tax levied since August 2008 makes most potential transactions unworkable. Little likelihood that China will reverse this tax soon, as from its perspective coke is both a causer of pollution and an energy product. Therefore, production of a surplus for export is discouraged.

As Chinese coke pricing has been largely nominal, we have adopted prices for Europe and Indian imports as alternative indicators for the market.

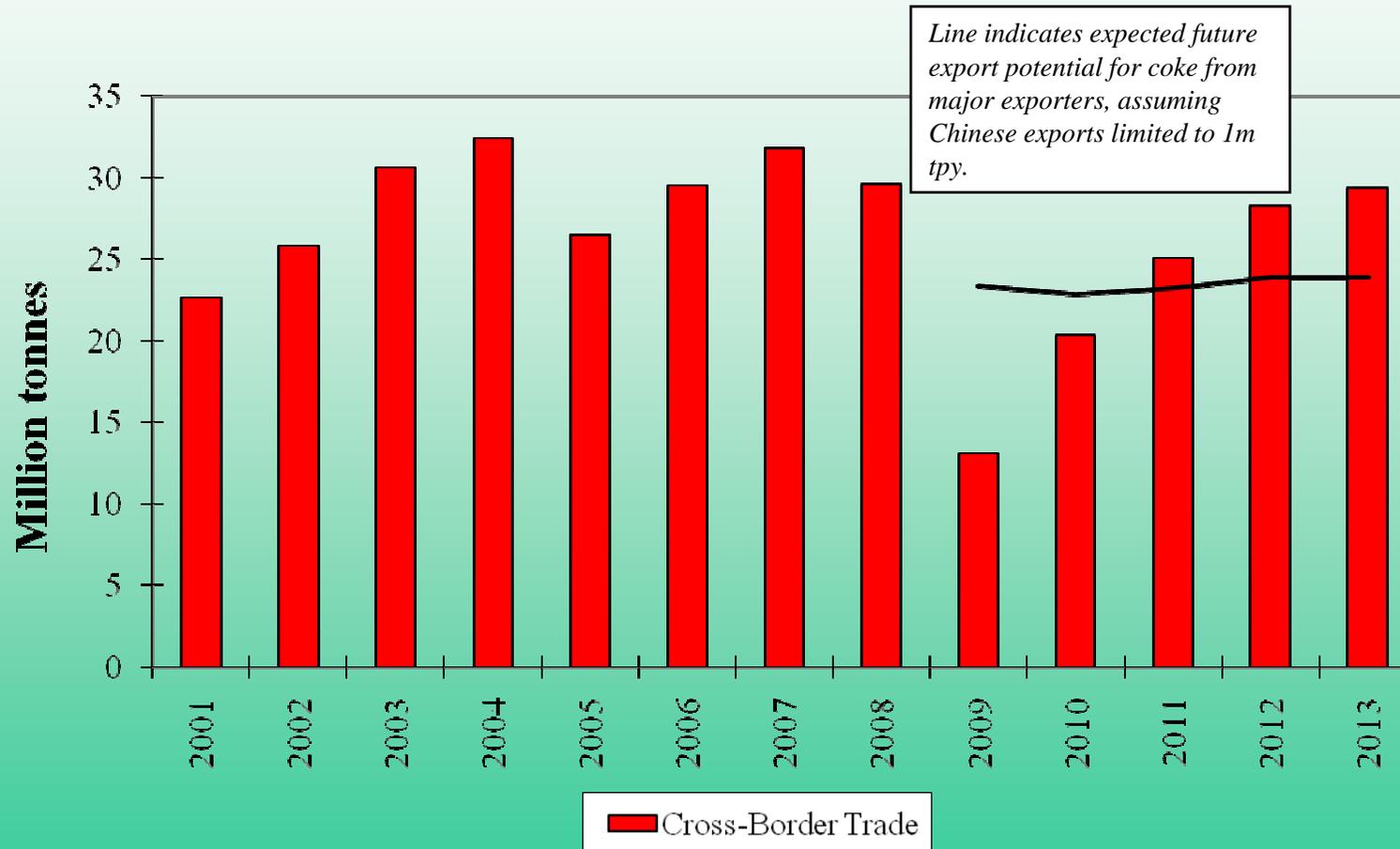
Supply continues from other sources in line with market demand e.g. Poland, Russia, Ukraine, Colombia, Japan etc. Note that most of these sources primarily supply the western hemisphere, whereas demand is growing more in the eastern hemisphere.

If Chinese coke continues to be kept from the market, there is likely to be a market shortage from 2011. Impossible to conceive how supply from other sources could fill the gap.

Coking coal producers have adopted quarterly pricing from this year, adding a new factor to the coke market.

Adding to market tightness is almost 12m tpy of permanent coke capacity closures (mainly in Europe) enforced by the economic crisis of the last two years.

Historical & Forecast Demand for Cross-Border Traded Coke



Reasons Why Coke Likely to Remain in Short Supply

It is most unlikely that China will reduce the 40% tax on coke exports, despite diplomatic pressure from the EU and the US. Once demand for cross-border coke trade returns to historical level of around 30m tpy (by 2011 or 2012?), it is impossible to see how other countries can compensate for the loss of China's 14m tpy export capacity.

Permanent closures in 2008-10 of coke capacity totaling 12m tpy mainly in eastern Europe, largely enforced by the market collapse (total world capacity outside China = 265m tpy end 2009). This will lead to a reduction in coke export capability from Poland and Czech Republic, two main suppliers of merchant coke to the rest of Europe. Also, in 2009 the HKM coke plant expansion (1.1m tpy) in Germany was postponed for a second time, as well as some other projects around the world. (Expansions in Japan, Korea and US still proceeding.)

Start-ups in 2009-10 of blast furnace capacity in Asia with no associated coke plants e.g. Ann Joo in Malaysia, Tata Steel in Thailand (both 0.5m tpy). Adds to large merchant coke demand in India for merchant pig iron, ferroalloys and soda ash production.

Also, coking coal supply will most likely remain under pressure. Development of new reserves in Mongolia and Mozambique will need an era of high prices, as infrastructure in these countries is at low level. (Just as era of "cheap oil" is over, same could be said for coking coal.)

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