Introduction

Comprehensive view of the market structure of 12 steel raw material, including

- Supply: largest suppliers and reserves/resources
- Consumption and trade flows for each raw material
- Price movements and stocks of each raw material
- Export restrictions and environmental/health issues related to the production of each raw material
List of steelmaking raw materials examined in the paper

• Main steelmaking raw materials (3)
  – **Iron ore** and **coking coal** are the two main inputs in the integrated steelmaking process
  – **Scrap** is used mainly in EAF but also in BOF

• Other metals used in smaller amounts (9)
  – In all or most steels: **manganese, silicon**
  – In some steels: **nickel, chromium, zinc and tin**
  – Minor alloying elements: **molybdenum, vanadium and tungsten**

Properties of minor metals in steel

• **Manganese**: Desulpherising (sulphur causes steel to crack) and as alloying element for strength and toughness
• **Silicon**: Used to de-oxidise steel
• **Nickel**: Anti-corrosion (nickel content in high quality stainless steel 8-10%)
• **Chromium**: Resistance to corrosion, temperature and wear (used in stainless steel (average content 18%)
• **Zinc**: Used to galvanise steel (enhances corrosion resistance)
• **Tin**: Brings protective coating to steel (used in food and drink cans)
• **Molybdenum**: Resistance to heat, corrosion(high-end steel). Brings weldability to steel (construction steel)
• **Vanadium**: Brings extreme hardness to steel (high-strength steel)
• **Tungsten**: Brings extreme hardness to steel (high-speed steel)
Steel industry share of the use of these metals, %

- **Manganese**: 90%. Used also in batteries.
- **Silicon**: 60%. Used also in construction materials and production of glass.
- **Chromium**: 75%. Used also in aerospace superalloys, iron castings, refractory products, paints, cosmetics and welding rods.
- **Nickel**: 60%. Used also in aerospace superalloys and batteries.
- **Zinc**: 60%. Used also in die-casting and in the production of brass and bronze.
- **Tin**: 20%. Used also in solder.
- **Molybdenum**: 60%. Used also in aircraft engine parts, chemicals and alloys for making tools.
- **Vanadium**: 85%. Used also in longer-range electric car batteries.
- **Tungsten**: 20%. Used also for making abrasives, knives and armaments, and in fluorescent lighting.

Iron ore (2009)

- **Share of steel industry in demand**: 98%
- **Production**: 1.6 bn tonnes, 1. Australia (25%), 2. Brazil (19%), 3. India (16%)
- **Reserves**: 48 years of output, 1. Russia
- **Exports**: 954mmt, 1. Australia (38%), 2. Brazil (28%), 3. India (12%)
- **Imports**: 937 mmt, 1. China (67%), 2. Brazil (11%), 3. Europe (10%)
Coking coal (2009)

- Share of steel industry in demand: 100%
- **Production**: 794mmt, 1. China (52%), 2. Australia (16%), 3. Russia (7%)
- **Reserves**: 1. US, 2. China, 3. Russia
- **Exports**: 232mmt, 1. Australia (54%), 2. US (15%), 3. Indonesia (13%)
- **Imports**: 199 mmt, 1. China (26%), 2. China (18%), 3. India (12%)

Ferrous Scrap (2009)

- Share of steel industry in demand: 100%
- **Generation**: 424mmt, 1. China (17%), 2. US (16%), 3. Japan (9%)
- **Exports**: 92mmt, 1. US (24%), 2. Japan (11%), 3. Germany (8%)
- **Imports**: 91.2 mmt, 1. Turkey (17%), 2. China (15%), 3. South Korea (8%)
Manganese (2010)

- Share of steel industry in demand: 90%
- **Production**: 14 mmt, 1. South Africa (25%), 2. Australia (19%), 3. China (16%)
- **Reserves**: 44 years of output, 1. Ukraine
- **Exports**: 8mmt: 1. South Africa (37%), 2. Australia (29%), 3. Gabon (15%)
- **Imports**: 7mmt: 1. China (67%), 2. Ukraine (7%), 3. Norway (7%)

Silicon ferro-alloys (2010)

- Share of steel industry in demand: 60%
- **Production**: 8mmt, 1. China (64%), 2. Brazil (6%), 3. Russia (6%)
- **Reserves**: Ample
- **Exports**: 2.5mmt: 1. China (48%), 2. Norway (16%), 3. Russia (12%)
- **Imports**: 2.1mmt: 1. Japan (33%), 2. Germany (24%), 3. US (14%)
Chromium (2010)

- Share of steel industry in demand: 75%
- **Production**: 26 mmt, 1. South Africa (39%), 2. Kazakhstan (17%), 3. India (14%)
- **Reserves**: 13 yrs of output, 1. Kazakhstan
- **Exports**: 9mmt: 1. South Africa (57%) 2. Turkey (19%), 3. Kazakhstan (15%)
- **Imports**: 8mmt: 1. China (85%), 2. Russia (10%), 3. Turkey (1%)

Nickel (2010)

- Share of steel industry in demand: 60%
- **Production**: 1.5 mmt, 1. Russia (25%), 2. Indonesia (13%), 3. Philippines (13%)
- **Reserves**: 50 years of output, 1. Australia
- **Exports**: 20mmt: 1. Indonesia (53%), 2. Philippines (44%), 3. Australia (2%)
- **Imports**: 22mmt: 1. China (74%), 2. Japan (16%), 3. South Korea (5%)
**Zinc (2010)**

- Share of steel industry in demand: 60%
- **Production**: 12 mmt, 1. China (27%), 2. Australia (12%), 3. Peru (11%)
- **Reserves**: 20 years of output, 1. Australia
- **Exports**: 8 mmt: 1. Peru (32%), 2. Australia (28%), 3. Bolivia (11%)
- **Imports**: 8 mmt: 1. China (50%), 2. South Korea (17%), 3. Spain (12%)

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**Tin (2010)**

- Share of steel industry in demand: 20%
- **Production**: 284 mmt, 1. China (34%), 2. Indonesia (32%), 3. Peru (12%)
- **Reserves**: 18 years of output, 1. China
- **Exports**: 30 mmt: 1. Australia (40%), 2. Rwanda (17%), 3. Bolivia (17%)
- **Imports**: 54 mmt: 1. Malaysia (43%), 2. Thailand (33%), 3. China (19%)
Molybdenum (2010)

- Share of steel industry in demand: 60%
- **Production**: 220 mmt, 1. China (40%), 2. US (24%), 3. Chile (17%)
- **Reserves**: 45 years of output, 1. China
- **Exports**: 175mmt: 1. Chile (41%), 2. US (17%), 3. Peru (13%)
- **Imports**: 159mmt: 1. China (39%), 2. Belgium (23%), 3. Chile (19%)

Vanadium (2010)

- Share of steel industry in demand: 85%
- **Production**: 64 mmt, 1. China (47%), 2. South Africa (22%), 3. Russia (11%)
- **Reserves**: 212 years of output, 1. China
- **Exportation**: 10mmt: 1. China (40%), 2. Russia (30%), 3. South Africa (20%)
- **Importation**: 8mmt: 1. Czech Republic (38%), 2. Korea (25%), 3. Japan (25%)
**Tungsten (2010)**

- **Share of steel industry in demand**: 20%
- **Production**: 61 mmt, 1. China (85%), 2. Russia (5%), 3. Canada (3%)
- **Reserves**: 47 years of output, 1. China

### Summary of main findings (1/2)

<table>
<thead>
<tr>
<th>Resource Type</th>
<th>Largest three producing economies (% of world total)</th>
<th>Top producing company</th>
<th>Reserves in years of output at current production rate</th>
<th>Main exporter</th>
<th>Main importer</th>
<th>Trade restrictions</th>
<th>Environmental impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron ore</td>
<td>1. Australia (25%) 2. Brazil (19%) 3. India (16%)</td>
<td>Vale</td>
<td>48</td>
<td>Australia</td>
<td>China</td>
<td>Export duties and quantitative restrictions</td>
<td>Significant environmental impact</td>
</tr>
<tr>
<td>Coking coal</td>
<td>1. China (52%) 2. Australia (16%) 3. Russia (7%)</td>
<td>BHP Billiton</td>
<td>na</td>
<td>Australia</td>
<td>Japan</td>
<td>Export duties and quantitative restrictions</td>
<td>Relatively undamaging</td>
</tr>
<tr>
<td>Ferrous Scrap</td>
<td>1. China (17%) 2. US (16%) 3. Japan (9%)</td>
<td>na</td>
<td>na</td>
<td>United States</td>
<td>Turkey</td>
<td>Export duties and quantitative restrictions</td>
<td>Relatively undamaging</td>
</tr>
<tr>
<td>Manganese</td>
<td>1. South Africa (25%) 2. Australia (19%) 3. China (16%)</td>
<td>Joint venture of BHP Billiton and Anglo American Plc.</td>
<td>44</td>
<td>South Africa</td>
<td>China</td>
<td>Export duties and quantitative restrictions</td>
<td>Toxic and explosive</td>
</tr>
<tr>
<td>Silicon ferro-alloys</td>
<td>1. China (64%) 2. Brazil (6%) 3. Russia (6%)</td>
<td>Erdos</td>
<td>Not estimated because ample</td>
<td>China</td>
<td>Japan</td>
<td>Export duties (on waste) and quantitative restrictions</td>
<td>Relatively undamaging</td>
</tr>
<tr>
<td>Chromium</td>
<td>1. South Africa (39%) 2. Kazakhstan (17%) 3. India (14%)</td>
<td>International Mineral Resources</td>
<td>13</td>
<td>South Africa</td>
<td>China</td>
<td>Export duties (on waste) and quantitative restrictions</td>
<td>Very toxic</td>
</tr>
</tbody>
</table>
## Summary of main findings (2/2)

<table>
<thead>
<tr>
<th>Metal</th>
<th>Largest three producing economies (% of world total)</th>
<th>Top producing company</th>
<th>Reserves in years of output at current production rate</th>
<th>Main exporter</th>
<th>Main importer</th>
<th>Trade restrictions</th>
<th>Environmental impact/toxicity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel</td>
<td>1. Russia (20%) 2. Indonesia (13%) 3. Philippines (13%)</td>
<td>Norilsk Nickel</td>
<td>50</td>
<td>Indonesia</td>
<td>China</td>
<td>Export duties and quantitative restrictions (both on waste)</td>
<td>Toxic</td>
</tr>
<tr>
<td>Zinc</td>
<td>1. China (41%) 2. Indonesia (27%) 3. Peru (11%)</td>
<td>Xstrata Plc</td>
<td>20</td>
<td>Peru</td>
<td>China</td>
<td>Export duties and quantitative restrictions</td>
<td>Middly toxic</td>
</tr>
<tr>
<td>Tin</td>
<td>1. China (34%) 2. Indonesia (32%) 3. Peru (12%)</td>
<td>Yunnan Tin Au Res Ltd</td>
<td></td>
<td>China</td>
<td>Malaysia</td>
<td>Export duties and quantitative restrictions</td>
<td>Least toxic industrial metal</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>1. China (40%) 2. US (24%) 3. Chile (17%)</td>
<td>Freeport McMoran Copper</td>
<td></td>
<td></td>
<td></td>
<td>Export duties and quantitative restrictions</td>
<td>Middly toxic</td>
</tr>
<tr>
<td>Vanadium</td>
<td>1. China (47%) 2. South Africa (22%) 3. Russia (11%)</td>
<td>Evraz Group</td>
<td></td>
<td>United States</td>
<td>Czech Republic</td>
<td>Quantitative restrictions (on waste)</td>
<td>Toxic</td>
</tr>
<tr>
<td>Tungsten</td>
<td>1. China (85%) 2. Russia (5%) 3. Canada (3%)</td>
<td>Xiamen Tungsten Co Ltd</td>
<td>47</td>
<td>China</td>
<td>na</td>
<td>Export duties and quantitative restrictions</td>
<td>Relatively undamaging</td>
</tr>
</tbody>
</table>

### Level of reserves is not a constraint on supply

### Export restrictions are frequent for steelmaking raw materials

## Implications

- The potential for supply shocks is very large -> the costs of making steel might remain volatile
- Export restrictions on raw materials are widespread – hurting the competitiveness of steelmakers who rely on imports
- Ensuring secure and accessible supply of raw materials remains of major importance for the steel industry