Nickel Industry Analysis 2016

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Executive Summary

Nickel (Ni) is a hard, malleable, ductile, silvery-white lustrous metal with a slight golden tinge. It has high resistance to corrosion and oxidation, strength and toughness at elevated temperatures and alloys with other metals.

Economic concentrations of nickel occur in magmatic sulphide and lateritic deposits. World nickel deposit reserves total 81 million tonnes. Production and consumption of nickel has increased over time and is correlated with economic development. Since 2005 China’s consumption of nickel has grown from 15% of world consumption to 51% of world consumption in 2013.

Nickel is primarily used in the manufacturing of stainless steel products. This first use accounts for two thirds of nickel demand worldwide up from one third over the past three decades. In the 2000’s production in the Americas and Europe peaked in 2006 with both regions still not yet recovered from the GFC. In China stainless steel production has increased significantly over the last ten years reaching 52% of world consumption in 2014. The growth in demand for nickel metal can be correlated with the forecast production of stainless steel. Consumption of nickel metal is forecast to be 2,400kt in 2020.

The price of nickel has shown considerable volatility over the last forty years with the supply-demand balance determining the price of nickel. The history of the nickel spot price shows unexpected events such as industrial action, geopolitical events, government policy and stockpile inventories influence short term price variations.

Economic growth influences longer term trends in supply and demand. Countries as they develop demand raw materials, like nickel for use in stainless steel production, in a way that depends on their current economic position with demand higher during periods of positive economic growth. The Gross Domestic Product (“GDP”) economic indicator says the most about the health of a country or the world economy.

While China remains the dominant consumer of nickel and producer of stainless steel, the longer term trend for the price of nickel metal can be correlated with the forecast for China’s real GDP growth with the magnitude of change in price over short term periods determined by unexpected events.
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1.0 Introduction

Nickel (Ni) is a hard, malleable, ductile, silvery-white lustrous metal with a slight golden tinge (see Figure 1). It has high resistance to corrosion and oxidation, strength and toughness at elevated temperatures and alloys with many other metals to make use of these characteristics\(^1\).

Nickel is sold as refined metal (cathode, powder, and briquette), ferronickel or laterite ore. About 65% of the nickel consumed in the Western World is used to make stainless steel. Another 12% goes into superalloys or nonferrous alloys. The remaining 23% of consumption is divided between alloy steels, rechargeable batteries, catalysts and other chemicals, coinage, foundry products, and electroplating\(^1\).

Figure 1: Nickel Metal\(^2\)

Figure 2: Nickel First Use\(^1\)

Figure 3: Industrial Uses\(^1\)
2.0 Nickel Deposits and Reserves

Economic concentrations of nickel occur in magmatic sulphide and lateritic deposits (see Figure 4). The principal ore mineral in sulphide deposits is pentlandite. The main ore mineral in laterite deposits is Fe hydroxides (goethite) and hydrated Mg-Ni silicates (incl. garnierite).

Sulphide Deposits

Magmatic nickel sulphide deposits are hosted by iron and magnesium rich rocks called mafics or ultramafics derived from the Earth’s mantle. The mafic rocks such as gabbro form in a plutonic setting intruding into the surrounding bedrock.

Laterite Deposits

Lateritic nickel deposits are formed by tropical weathering of olivine-rich ultramafic rocks such as dunite, peridotite and komatiite which causes nickel to become enriched in the residual weathered rocks. The two main types of lateritic nickel deposits are limonite and silicate. Limonite nickel laterites (or oxide) are highly enriched in iron due to very strong leaching of magnesium and silica.

They consist of goethite with a mean grade of 1.06% Ni. Silicate nickel laterites (or saprolite) form beneath the limonite zone and are enriched in silica and magnesia. They consist of hydrated Mg-Ni silicates with a mean grade of 1.79% Ni.

Figure 4: Map of Nickel Sulphide and Laterite Deposits

The US Geological Survey in its nickel mineral commodity summary for 2015 lists world nickel deposit reserves totalling 81 million tonnes (see Figure 5).

Identified resources averaging 1% nickel or greater contain at least 130 million tonnes. About 60% is in laterites and 40% in sulphide deposits.
Production and consumption of nickel has increased over time and is correlated with economic development. However the upward trend has peaks and valleys. In the 1990's smelter/refinery production of nickel had a compound annual growth rate ("CAGR") of 1.1% and consumption of nickel a CAGR of 1.7%. In the 2000's smelter/refinery production of nickel had a CAGR of 2.5% and consumption of nickel a CAGR of 1.3% due to the global financial crisis ("GFC"). If the period covering the GFC when demand for nickel declined is excluded, then from 2000 to 2006 smelter/refinery production of nickel had a CAGR of 4.0% and consumption of nickel a CAGR of 3.7%. From 2010 to 2013 smelter/refinery production of nickel has a CAGR of 10.2% and consumption of nickel a CAGR of 9.5\( ^6 \), a return that is not considered sustainable (see Figure 6).
Historically the major source of nickel has been magmatic nickel sulphide deposits located in Canada, Russia and Australia. However in 2005 China commenced production of nickel pig iron ("NPI") sourcing the nickel from laterite deposits in Indonesia and the Philippines. NPI is used domestically in China in the production of stainless steel and has replaced traditional products like nickel metal. From 2007 to 2014 laterite deposits became the major source of nickel with production from magmatic nickel sulphide deposits remaining around the same levels since 2007\textsuperscript{5,6} (see Figure 7).

![Top Five Nickel Producing Countries](image)

Figure 7: Top Five Nickel Producing Countries\textsuperscript{5,6}

Since 2005 China’s consumption of nickel has grown from 15% of world consumption to 51% of world consumption in 2013\textsuperscript{6} (see figure 8).

![World vs China Nickel Consumption](image)

Figure 8: World verses China Nickel Consumption\textsuperscript{6}
Nickel stocks are held by both the London Metal Exchange (“LME”) (see Figure 7) and by major producers. In times of extreme shortage or over supply of nickel metal the LME provides producers and consumers with a physical market of last resort. The LME has 732 storage facilities across 37 locations in 15 countries.

In the first half of the 1990's the economic collapse of the USSR resulted in a surge of nickel exports and an increase in the LME nickel stockpile. Following the start of the GFC, as demand for nickel decreased from 2007 to 2009, the LME stockpile increased, peaking at 166,476 tonnes in early 2010. Destocking of the stockpile followed reaching a low of 83,160 tonnes in late 2011.

Since 2012 the LME nickel stockpile has grown exponentially to a record high. By end of June 2015 the stockpile was 456,000 tonnes as a result of the relocation of nickel metal from Chinese bonded warehouses and because of weakness in the stainless steel industry.

![Figure 9: LME Nickel Stockpile data](image)

### 4.0 Global Stainless Steel Production

Nickel is primarily used in the manufacturing of stainless steel products. This first use accounts for two thirds of nickel demand worldwide up from one third over the past three decades. Stainless steel is corrosion resistant, heat resistant, strong, easy to fabricate and is aesthetically appealing. Throughout the world it is produced for use as a material in urbanisation, transportation and the production and consumption of food and drinks.

In the 2000’s production in the Americas and Europe peaked in 2006 with both regions still not yet recovered from the GFC. In China stainless steel production has increased significantly over the last ten years reaching 52% of world consumption in 2014 (see figure 10). From 2006 to 2014 production of stainless steel by China has a CAGR of 21%.
5.0 Nickel Supply and Demand Forecast

From 1990 to 2013 mine nickel production for each year has exceeded consumption except for 1999\(^6\) (with consumption of nickel averaging 90% of mined nickel over the period). Smelter/refinery nickel production in the 1990’s exceeded consumption of nickel in five of the ten years, while in the 2000’s it exceeded consumption in seven of the ten years\(^6\). With nickel reserves totalling 81Mt\(^5\) and the LME providing a physical market of last resort, the supply of nickel is considered to be readily available to meet demand.

The trend in nickel demand can be correlated with the production of stainless steel. When the production of stainless increases so does the demand for nickel and vice versa\(^6,9\) (see Figure 11).

![Figure 10: Stainless Steel Production by Region\(^9\)](image)

![Figure 11: World Stainless Steel Production and Nickel Consumption\(^6,9\)](image)
Growth in future supply and demand for nickel metal will be in line with the forecast production of stainless steel. For 2015 to 2020 Outokumpu in its Capital Markets Day 2015 presentation forecasts a CAGR of 3% p.a. for world production of stainless steel predominantly driven by China at +5% p.a. against the rest of the world at +2% p.a. Consumption of nickel metal is forecast to be 2,400kt in 2020.

6.0 Nickel Spot Price History

The price of nickel metal is quoted in United States Dollar per pound (US/lb) or tonne (US/t) (1 tonne = 2,204.62 pounds). The history of the nickel spot price can be summarised as follows:

- In 1968 Canadian producers, Inco and Falconbridge accounted for 48% of world nickel production. In July 1969 labour strikes commenced at Inco’s mines and a month later strikes closed the Falconbridge mines. The Inco strike lasted 128 days ending on 15 November 1969. With the decrease in nickel production, nickel prices on the dealer market soared rising from Inco’s producer price of $2,271/tonne ($1.03/lb) to $19,842/tonne ($9/lb). New mines and processing plants were established in Australia, New Caledonia, and the Dominican Republic. Inco and Falconbridge lost their world domination and their ability to set the nickel price.

- A nine month labour strike at Inco, from 15 September 1978 until 7 June 1979, would again cause a jump in nickel prices in 1978. In 1979 nickel became the seventh metal to be traded on the LME. Nickel prices would now be set by worldwide supply and demand. After increasing in price by 33% in two years, the ending of the Inco strike brought about a surplus of nickel and prices fell to near pre-strike levels and continued to slide until the end of 1986 with the price as low as $3,527/tonne. Many world producers of nickel discontinued production.

- In 1987 stainless steel usage increased dramatically and demand exceeded supply. The Dominican Republic government levied a duty on exported nickel, which forced Falconbridge, who maintained the Dominican mines, to cancel shipments. By April of 1988, nickel prices had soared to a high of $18,012/tonne. While nickel demand remained strong, producers were able to catch up but nearly as quickly the nickel price collapsed.
• In 1991 the fall of the Soviet Union allowed Norilsk Nickel to increase exports of nickel metal as demand in the former military USSR government crumbled. This further depressed nickel prices except for a slight surge in 1995 when an explosion and fire at a power plant temporarily crippled Norilsk's ability to produce and ship nickel. At the same time a major earthquake in Japan increased the demand in stainless for reconstruction. A depressed Far East economy then forced nickel prices back down as stainless steel demand fell.

• Once again a rebound in stainless steel demand in 1999 caught nickel producers off guard. Inco suffered another shut down due to a strike and struggled to re-open closed mines. Falconbridge suffered smelter problems and WMC had to shut down for two months. Norilsk was unable to ship nickel as the annual Arctic freeze lasted longer than usual. With demand exceeding supply, nickel prices increased until production caught up in 2000 and prices peaked. In 2001 nickel prices fell but a strike at Inco once again saw the nickel price increase in 2003.

• The nickel price reached $14,000/tonne in 2005 and then escalated dramatically through 2006 as a result of the urbanisation and industrialisation of China, an increase in demand for stainless steel worldwide and a depletion of the LME nickel stockpile reaching a low of 3,000 tonnes in early 2007. The nickel price peaked at $54,200/tonne in May 2007.

• With the onset of the GFC, as the demand for nickel metal decreased, nickel prices declined until the end of 2008 when the price in October hit a low of $8,810/tonne. In early 2009 nickel prices began to rise again with increased stainless steel production and positive economic growth in China reaching $27,600/tonne in April 2010. After dropping to $17,955/tonne in June 2010 the nickel price peaked at $29,030/tonne in February 2011 and then declined reaching a low of $13,160/tonne in July 2013.

• In January 2014 Indonesia, with 20% of world nickel production, introduced a ban on exports of nickel ore creating supply concerns. The nickel price peaked at $20,850/tonne in May 2014 but has since been in a steady decline falling below $12,000/tonne in June 2015 due to a slowing China economy, weakness in the stainless steel market and LME nickel stockpiles reaching an all time high of 470,376 tonnes.

7.0 Nickel Spot Price Forecasting
The price of nickel has shown considerable volatility over the last forty-five years with the supply-demand balance determining the price of nickel. The history of the nickel spot price shows unexpected events such as industrial action, geopolitical events, government policy and stockpile inventories influence short term price variations.

Added to these factors is the ‘anticipation’ factor resulting from futures trading which play a role in determining price. Consumers and producers of nickel can manage nickel price risk by purchasing and selling nickel futures. Nickel producers can employ a short hedge to lock in a selling price for the nickel they produce while businesses that require nickel can utilize a long hedge to secure a purchase price for the commodity they need.

Nickel futures are also traded by speculators who assume the price risk that hedgers try to avoid in return for a chance to profit from favourable nickel price movement. Speculators buy nickel futures when they believe that nickel prices will go up. Conversely, they will sell nickel futures when they think that nickel prices will fall.
The nickel production cost curve has also been used as a guide to the nickel price. The 90th percentile of the cost curve has tended to be a good determinate of long term pricing and the 70th percentile of the cost curve a good indicator of the short term floor price (see Figure 13). However the cost curve should be used with caution when forecasting the price of nickel. Companies with established mining operations, provided operating profit increases, will raise production by mining lower grade ore at a higher C1 cash cost and mining companies establishing operations in times of a high commodity price will be forced to reduce their C1 cash costs when the commodity price declines to keep mining.

![Nickel Industry Costs and LME Nickel Price](image1.png)

**Figure 13: Nickel Industry Costs and LME Nickel Price**

Economic growth influences longer term trends in supply and demand. Countries as they develop demand raw materials, like nickel for use in stainless steel production, in a way that depends on their current economic position with demand higher during periods of positive economic growth. The Gross Domestic Product ("GDP") economic indicator says the most about the health of a country or the world economy. Investors will look for the long term growth rate to stay near the 3% level (see Figure 14).

![World GDP Real Growth Rate](image2.png)

**Figure 14: World GDP Real Growth Rate**
China’s economic rise commenced in 1979 with the introduction of economic reforms following the death of Chairman Mao in 1976. From 1979 to 2014 China's real GDP growth has averaged nearly 10% (see Figure 15) meaning that China has been able to double the size of its economy in real terms every eight years.

The GFC, which began in 2007, impacted the Chinese economy with real GDP growth falling from 14.2% in 2007 to 9.6% in 2008 to 9.2% in 2009. In response, the Chinese government in 2008-2009 implemented an economic stimulus package and an expansive monetary policy. These measures boosted domestic investment and consumption and helped prevent a sharp economic slowdown in China.

However China’s economy has slowed in recent years as it transitions from an economy based on investment to one based on consumption. Real GDP growth has fallen from 10.4% in 2010 to 7.8% in 2012, to 7.4% in 2014. The IMF projects that over the next six years, from 2015 to 2020, China’s real annual GDP growth will average 5.9%.

From the commencement of the GFC in August 2007 the LME nickel stockpile increased from 18,324 tonnes to 166,476 tonnes in February 2010 (see Figure 12). This rise in inventory should have resulted in a fall in the nickel price but due to China implementing an economic stimulus plan in November 2008, the nickel price actually increased from a low of $8,810/tonne in October 2008 to peak at $29,030/tonne in February 2011.

China's real GDP growth peaked in 2010 at 10.4% and destocking of the LME stockpile reached a low of 83,160 tonnes in November 2011. Since then as China's real GDP growth has fallen, so has the demand for nickel declined and the LME stockpile has grown exponentially to a record high.

Comparing Figure 12 and Figure 15, this correlation between China's real GDP growth and the nickel price can also be seen to apply between 2000 and early 2007 with both showing an upward trend and from late 2007 to 2009 with both showing a sharp downward trend due to the GFC. Excluding unexpected events (like the Indonesian ban on exports of nickel ore) long term trends in the nickel price can be correlated with trends in China's real GDP growth (see Figure 16).
In August 2015 the nickel price fell below $10,000/tonne, a price not unexpected because of the continued slowdown in the Chinese economy and the IMF projection that China's real GDP growth will average 5.9% over the next six years from 2015 to 2020.

At $10,000/tonne over half the world nickel production is not profitable, in particular the laterite nickel mines in Indonesia and the Philippines. History shows nickel producing companies will be looking to reduce their C1 cash costs and those that cannot, will close operations. Should significant closures eventuate and the LME stockpile is drawn down, it will cause a short term upward movement in the price of nickel.

However while China remains the dominant consumer of nickel and producer of stainless steel, the longer term trend in the price for nickel metal can be correlated with the forecast for China's real GDP growth with the magnitude of change in price over short term periods determined by unexpected events.
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