DRI at Haitong Bank

Overview on the Global Steel Industry

Report for Shandong Iron & Steel Group Co., Ltd

Tongshuo Li
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Abstract

This report is created by the author during his internship at Haitong Bank ("Haitong"), to present an overview of the global steel industry to Shandong Iron & Steel Group Co., Ltd ("SISG" or "the client"). In this report, a brief introduction of the industry and the client is offered first, followed by the overview of the global steel industry, including the raw material market, and steel market. The analysis of the steel market focuses on the supply, where a forecast is provided, demand, and global trades. To offer further insights, major issues that the client is facing, along with current M&A trends in the sector, are also included in the report.

Key Words steel; forecast model

Methodology

The preparation of this report relies on public information and the author's knowledge of the sector. The sources of information include industrial associations, multilateral organizations, government statements, press releases of companies, and third-party reports purchased by Haitong. The information from different sources is cross-checked whenever possible.

For the quantitative forecast, a vector autoregressive model is used. More details will be provided in the corresponding section of this report. All estimations and forecasts are performed in Matlab R2018a.

Introduction

Basic Facts and Terminologies of Steelmaking

Raw Materials

Iron Ore

Iron ore are the minerals that are rich in Fe, which is the main composition element of iron and steel. Heating iron ore and extracting the element in an economically feasible way is the starting point of the ironmaking and steelmaking industry. Due to the chemical characteristics of Fe, under natural circumstance, iron ore normally exists in the form of iron oxides, mostly as hematite and magnetite.

Coking Coal and Coke

Coking coal is a genre of bituminous coal that is low in ash content and sulfur. The grades of coking coal are determined by the percentage of ash content in the coal. Coke is a hard, deep grey solid material, which can be derived from coking coal by keeping heating coking coal at over 1,000 ℃ when oxygen is absent. Main use of coke is to reduce impurities from iron ore.

Scrap

Scrap is the recyclable part of discarded iron or steel-made objects. Scrap can be reused in the steelmaking process as a substitute for iron ore. Though steel-made products are highly recyclable, since the only source of scrap are the products that have been out of use, and iron and steel being durable, scrap, for now, is still unable to replace iron as the main material in the iron and steel industry.

Direct Reduced Iron (DRI)

DRI, as implied by its name, is the iron that is produced by reducing impurities from iron ore directly. The chemical process is finished by heating iron ore between 800 to 1200 ℃ with the appearance of the reducing gas, which is mainly hydrogen and carbon monoxide.

Steelmaking Process

Steelmaking refers to the industrial process that uses iron ore and coke to produce steel and further steel parts which are in various shapes, depending on the use of the products. The factories where the process is carried out are usually referred to as steel mills. There are normally, a maximum of four processes necessary for steelmaking, which can be finished step by step in a single mill, namely ironmaking, steelmaking, continuous casting, and rolling.

Ironmaking

Iron is the primary material for steel making. Under industrial circumstance, the chemical reaction that extracts iron out of iron ore happens in large blast furnaces, where coke is used to heat the furnace to melt the iron ore. During the reaction, coke releases carbon monoxide when burning, which then combines with and removes the oxygen away from the melted iron. The product that comes out of the blast furnace is called pig iron, which is richer in carbon and sulfur compared to steel.

Steelmaking

Modern steel mills basically follow at least one of two major technological approaches: blast oxygen furnace (BOF), or electric arc furnace (EAF). The former method requires pig-iron and scrap as inputs, while the latter uses scrap or DRI. By the end of 2016 around ¼ of the global crude steel output was generated by EAF.

In the BOF process, hot melted iron from the blast furnace is led into the BOF, along with scrap, which is an optional material in the BOF method. A high-pressure oxygen stream is injected into the hot metal, resulting in impurities transformed into gases or slag, which can then be easily removed.

In the EAF process, the main raw materials are scrap and DRI, though economically the use pig iron is also possible. The raw materials are charged into the EAF and are melted as the furnace temperature is brought up by the heat generated from the electric arc. After the metal is melted and reaches the stage of a flat bath, an oxygen jet infuses the oxygen to the melt to transform the impurities into slag.

The end-product from both approached is crude steel, which will be ready to be transformed into semi-finished steel.

Continuous Casting

The continuous casting process is where the liquid steel is formed and cooled down into solid steel objects. The hot liquid steel is poured into molds and passed through casting machines and becomes an intermediate product when it comes out of the machines. At the end of this stage, the steel can take various shape, depending on which kind of end-product it is about to be made into.

Rolling

In the rolling process, steel can be shaped into different structures to satisfy the end users. Depending on the temperature when the steel is rolled, rolled products can be divided into hot-rolled products and cold-rolled products. Different rolled products have different characteristics and uses.

Markets Related to the Steel Industry Supply Chain

Multiple sectors are related to the whole supply chain of the steelmaking industry.

Starting with the raw materials, iron ore and coking coal are among the major frequently traded commodities. Spot and future markets are active all year round and a large volume of these materials are transported a long way globally from the mines to the mills.

The iron, either pig iron or DRI are typically not traded directly, though there are markets for them if it is economical to do so. Usually, ironmaking is integrated in the production process in large steel mills. Thus, the iron, instead of entering markets, goes directly to the steelmaking furnaces.

Similarly, crude steel and semi-finished steel products are generally not exposed to outside markets but enter the casting and rolling process in the mill.

The steel objects that come out of the mill serve the most important industries of modern civilization. The main demand for steel products originates from industrial needs, e.g. infrastructure, construction, and transportation, to daily used white goods.

Shandong Iron & Steel Group Co., Ltd ("SISG")

Shandong Iron & Steel Group Co., Ltd ("SISG") is a gigantic state-owned enterprise ("SOE") in China. Measured by crude steel production, in 2016, SISG ranked 11th globally and 6th domestically, standing among the sector leaders with an output of 23.02 million metric tonnes (mt). By the end of 2017, SISG ranked 57th of the top 500 manufacturing enterprises in China and 150th of Fortune's top 500 enterprises in China. SISG ended Q1 2018 with total assets of 45.04 billion USD, operating revenue and net income of 5.05 billion USD and 540 million USD, respectively.

As a fully-equipped steel producer, SISG provides various types of steel products, including but not limited to plate, coils, bars, rods, rails, and structural shapes, offered by multiple subsidiaries, Jinan Iron and Steel Group Corporation, Laiwu Iron & Steel Group, and SD Steel Rizhao Co., Ltd. Besides the core steel making business, SISG also has presence in mining, materials, finance, and real estate.

Public Subsidiaries

Shandong Iron and Steel Co., Ltd ("Shandong Steel")

Shandong Steel is the primary steel producer controlled by SISG, which owns 50.09% of Shandong Steel through the control over Jinan Iron and Steel Group Corporation, Laiwu Iron & Steel Group. By the end of Q1 2018, Shandong Steel had total assets of 9.14 billion USD, with operating revenue and net income reaching 1.86 billion USD and 98.93 million USD, respectively. The output of crude steel of Shandong Steel was 7.2 mt in 2017.

Similar to SISG, the core business of Shandong Steel sticks to the supply chain of the

steel industry, with its presence from iron ore to a variety of steel products.

Shandong Jinling Mining Co., Ltd ("Jinling Mining")

Jinling Mining is the main subsidiary of SISG in the mining sector. Jinling Mining produces ores of iron, copper, and other metal. By the end of Q1 2018, total assets of Jinling Mining reached 420 million USD, while its operating revenue and net income climbed to 38.77 million USD and 1.58 million USD, respectively. SISG owns 58.41% of Jinling Mining.

What is noticeable is that, since Jinling Mining has ended 2016 and 2017 with negative net profit, its listing in the exchange will be terminated if it finishes 2018 with another net loss.

M&A History

SISG was set up in 2008, following the merger of Jinan Iron and Steel Group Corporation and Laiwu Iron & Steel Group. The merger was a significant reform to the SOEs in the steel industry, promoted by the State Government. Back then, Jinan Iron and Steel Group Corporation, which has a majority stake in Jinan Iron and Steel Company, the listed steel company, and Laiwu Iron & Steel Group, which has a majority stake in Laiwu Steel Corporation, the listed iron and steel producer, have merged to form SISG. The merger had been discussed since 2006. By the end of 2007, the last year before the merger, the two companies had crude steel output of 23.8 mt in total. By the time the merger finished, SISG had 14.23 million USD of registered capital and 12.10 billion USD of total assets. After the merger, Laiwu Iron & Steel Group ceased to be listed publicly. The two companies are currently the majority shareholder of Shandong Steel. The merger was followed by a series of acquisitions and consolidation transactions, restructuring the assets of the two companies and SISG.

On 4th January 2011, Jinan Iron and Steel Company acquired assets from its parent company, Jinan Iron and Steel Group Corporation, and Laiwu Iron & Steel Group for 570.48 million USD. The assets acquired from Jinan Iron and Steel Group Corporation include Jinan Xinying Coal Chemical Processing Co., Ltd, which engaged in coal chemical industry, and Jinan Baode Gas Company Limited, which engaged in chemical gas production. The assets acquired from Laiwu Iron & Steel Group include Laiwu Tianyuan Gas Company Limited, the industrial gas producer, Laiwu Iron & Steel Group Electronics Company Limited, the electronics components manufacturer, 83.33% stake in Shandong Laiwu Iron & Steel International Trade Company Limited, the company that offers international trade services, and the operating assets and debts under the Energy, Automation, and Transportation Departments of Laiwu Iron & Steel Group. To close the transaction, 962,191,700 new shares were issued at an issuance price of USD 0.62 per share. The total consideration was 570.48 million USD. Jinan Iron and Steel Group Corporation received 337,397,100 shares, valued at 209.58 million USD, and Laiwu Iron & Steel Group received 624,794,600 shares, valued at 360.9 million USD. The new shares purchased by Jinan Iron and Steel Group Corporation had a lockup period of 36 months before they could be traded on the Shanghai Stock Exchange.

On 28th February 2012, Shandong Steel officially merged with Laiwu Steel Corporation. The transaction was conducted by share exchanging. The exchange ratio was 2.43 Shandong Steel shares per Laiwu Steel Corporation share. Laiwu Steel Corporation was valued at USD 1.33 per share, and 1.23 billion USD for total equity capital, using the

exchange rate of CNY 6.54707 per USD on 12 Apr 2011. The offer represented a 15% premium, approximately. Back then, SISG ultimately held 74.65% and 69.23% in Laiwu Steel Corporation and Shandong Steel, respectively.

On 27th February 2013, Shandong Steel acquired transformer substation and water plant assets from Laiwu Iron & Steel Group for a total cash consideration of 81.76 million USD. The acquisition completed the operation chain which in turn improved profitability.

On 31st December 2013, SISG International Trade Co Ltd, a subsidiary of SISG, acquired 80% stake in Jinan Steel International Trade Co Ltd and 100% stake in Shandong Laiwu Iron & Steel International Trade Co., Ltd from Shandong Steel via auction, with a cash consideration of 14.4 million USD and 81.17 million USD, respectively. The acquisition is in line with the strategy of SISG to revitalize its assets, optimize capital structure and improve profitability.

On 28th February 2017, SISG acquired fixed assets and construction in process of the Jinan branch and 100% of Jinan Baode Gas from Shandong Steel. The total cash consideration was 2.31 billion USD.

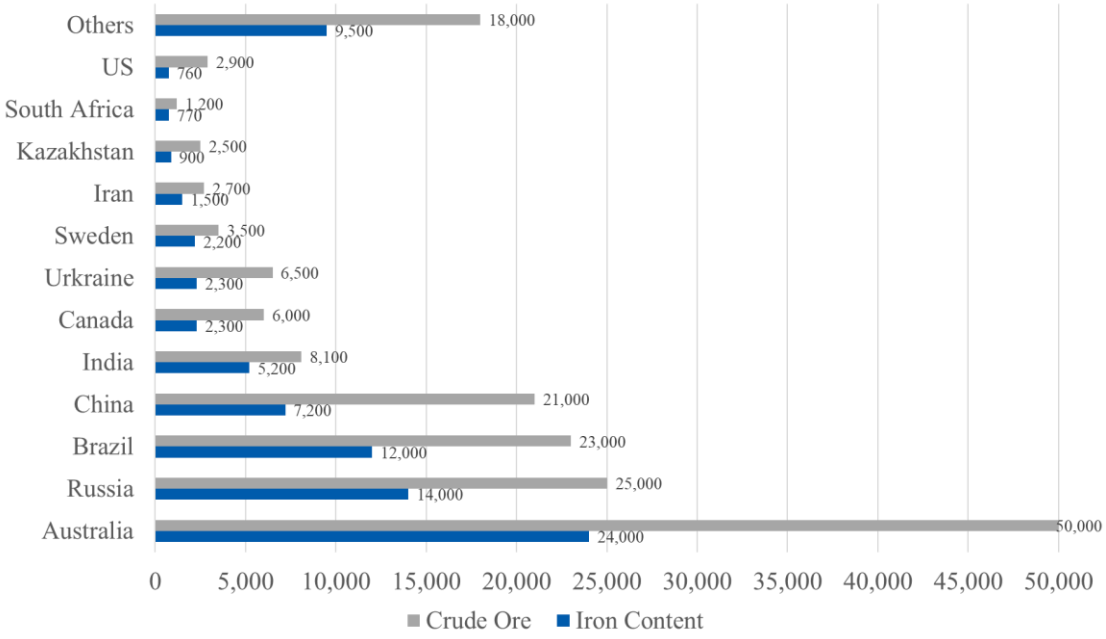
Overview of the Global Steel Industry

Raw Materials Markets

Iron Ore

Australia, Russia, Brazil, China, and India are the top 5 countries of iron ore reserves. Since domestic iron ore is advantageous in the sense of transportation cost, steel producers would usually consider purchasing iron ore from local suppliers. Thus, iron ore export does not necessarily positively relate to iron ore production.

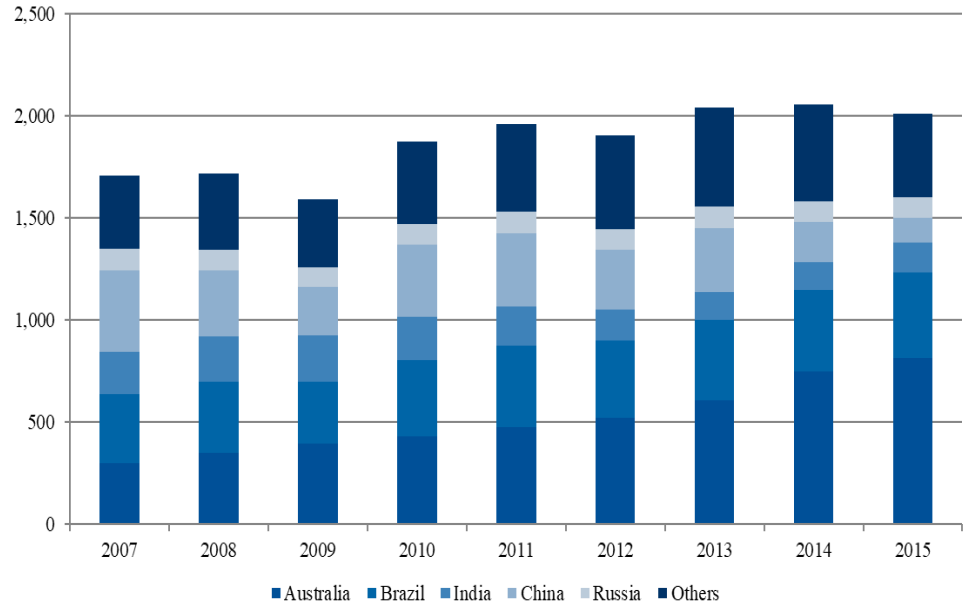
Global Iron Ore Reserves (mt)



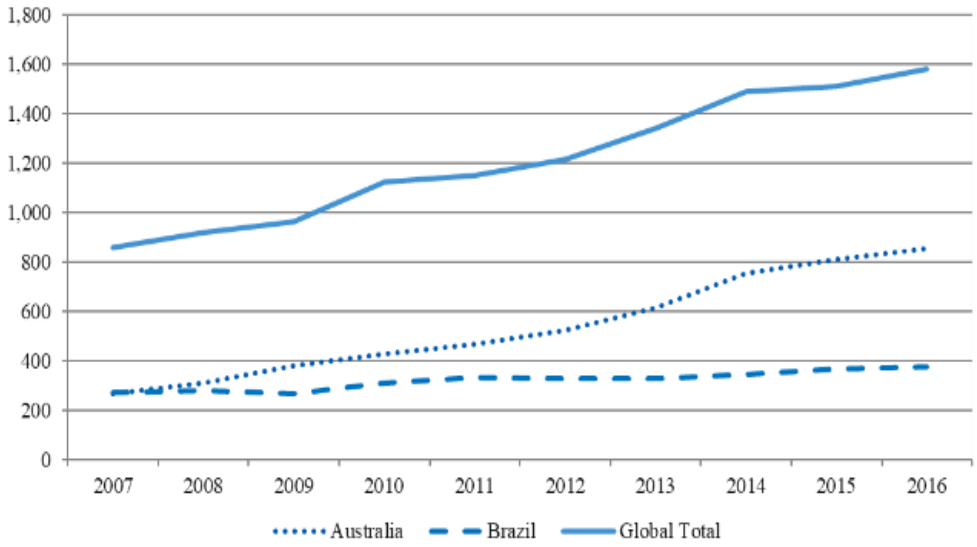
Source: statista

Production in Australia and Brazil in total exceeded 60% of the global volume, while the low domestic consumption of iron ore reasonably makes the two countries the largest exporters in the world.

Global Iron Ore Production (mt)



Global Iron Ore Exports (mt)



Source: WSA

Australia, Brazil, and India are expected to drive future production growth, while miners in China will be forced to cut output due to low grade of ores and high cost of extraction.

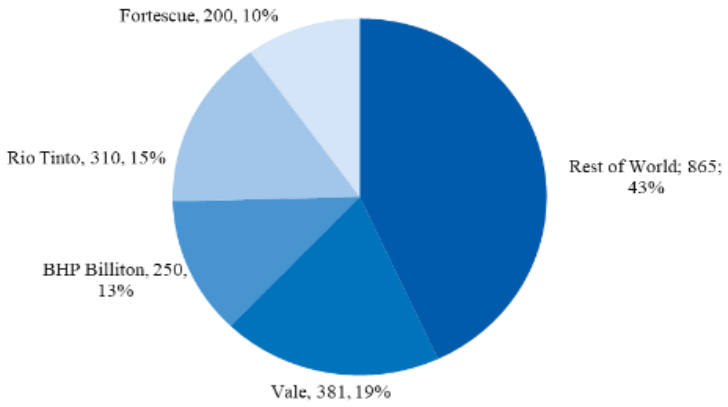
In Australia, iron ore miners whose costs are higher than those of the peers would have to exit the market. Major producers are currently focusing on cost-cutting. In Brazil, on the other hand, miners are already benefiting from low operating cost and sound project pipeline. Hence, Brazil is expected to be the main driver of robust iron ore output growth in the coming years. Along with Brazil, India provides another boost of growth of global iron ore production. In the 2016 Union Budget of India, export taxes for iron

ore below 58% iron content were removed. Meanwhile, India's Mines & Minerals Development & Regulation Act has authorized the reopening of mines in Goa, where iron ore mining was banned by the Supreme Court earlier.

Miners in China have to fight for their own survival, while their peers in Brazil and India are busy with expanding projects, basically because of the high operating cost and declining of ore grades. Having difficulty in cutting costs would squeeze the profit margin thinner unless the price of iron ore rises significantly, which is not likely to happen, given the current market structures. Also, as the government is working to improve air quality, steel mills tend to choose higher-grade ores to make sure the environmental regulations are not breached. Since the government is trying to shift economic growth away from heavily polluted industries, and construction and automotive industry in China show no signal of a new wave of booming, there's no fundamental for rapid growth of the steel industry in the coming years, making it more difficult for iron miners, some of which would eventually be forced to quit the sector, while strengthening China's position as the leading import of iron ore.

In 2015, the 4 largest iron ore mining companies, Vale, BHP Billiton, Rio Tinto, and Fortescue, produced over 50% of the global output. Vale, the largest iron ore miner by production, made over 80% of Brazil's output. Aided by further mining projects, the company would be a key driver of iron ore production growth both in Brazil and all over the world. Though junior miners in Australia were exiting the market, the majority of miners are expected to keep Australia as a global leading producer, as their focus on intense cost-cutting efforts has started to pay off. As the grade of iron ore produced in China is decreasing, small miners will be forced out of the market. While Indian companies, who are benefiting from domestic policies and reopened mines, would seize the chance to grow.

Iron Ore Production Shares 2015 (mt)



KPIs of Top 4 Iron Ore Mining Companies

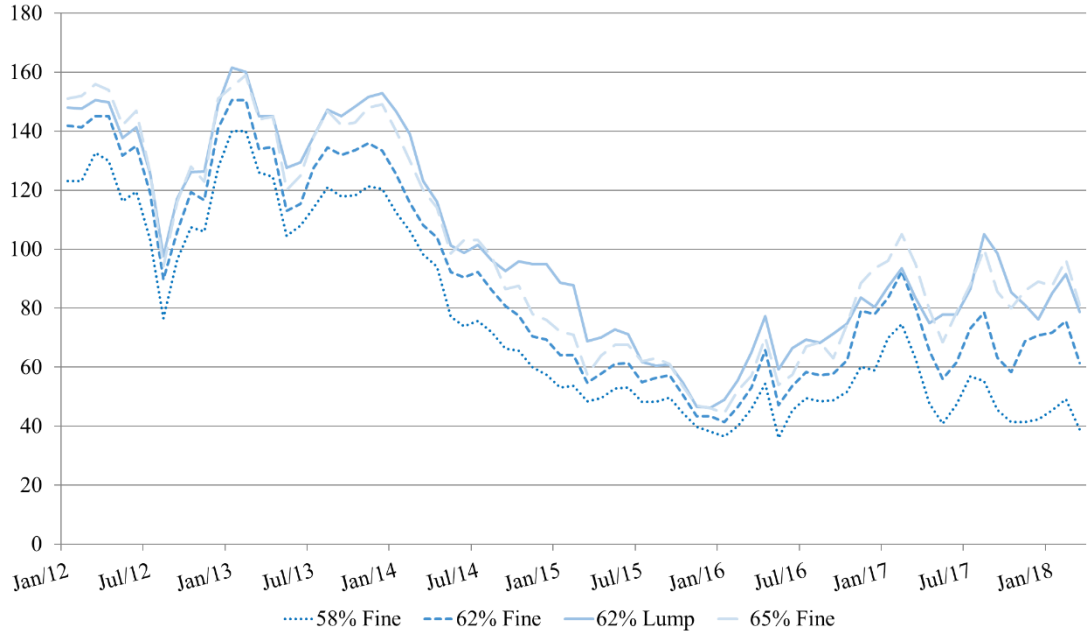
End of FY 2016	Market Cap ($ Billion)	EBITDA/Production ($/Tonne)	Cash Cost ($/Tonne)	Capex ($ Million)
Vale	38.48	27.08	12.02	5,006
BHP Billiton	91.51	75.71	15.00	5,220
Rio Tinto	71.21	37.26	14.30	3,012
Fortescue	13.05	21.47	N/A	729

Source: Bloomberg, BMI

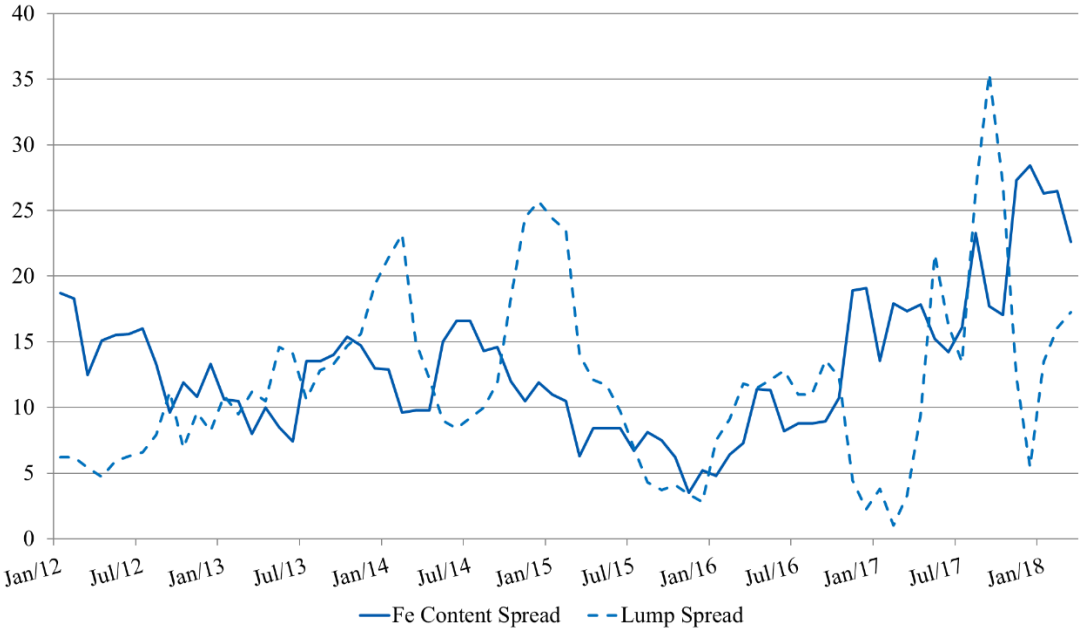
Supported by the robust performance of steel price in the winter of 2017, iron ore price rebounded strongly at the end of November 2017, which contrasted with the market expectation that the price of iron ore would continue to drop because of the concern over the winter production cut in China being about to significantly decrease the global iron ore demand.

While lump spread keeps fluctuating since in China sintering is facing strict regulation, according to which production would be halted when air condition worse, Fe content spread (between 62% and 58%) shows an obvious upward sloping trend, which is in line with Chinese steelmakers' growing appetite for higher-quality ores.

Iron Ore Price Trends (USD/Tonne)



Iron Ore Price Spreads (USD/Tonne)



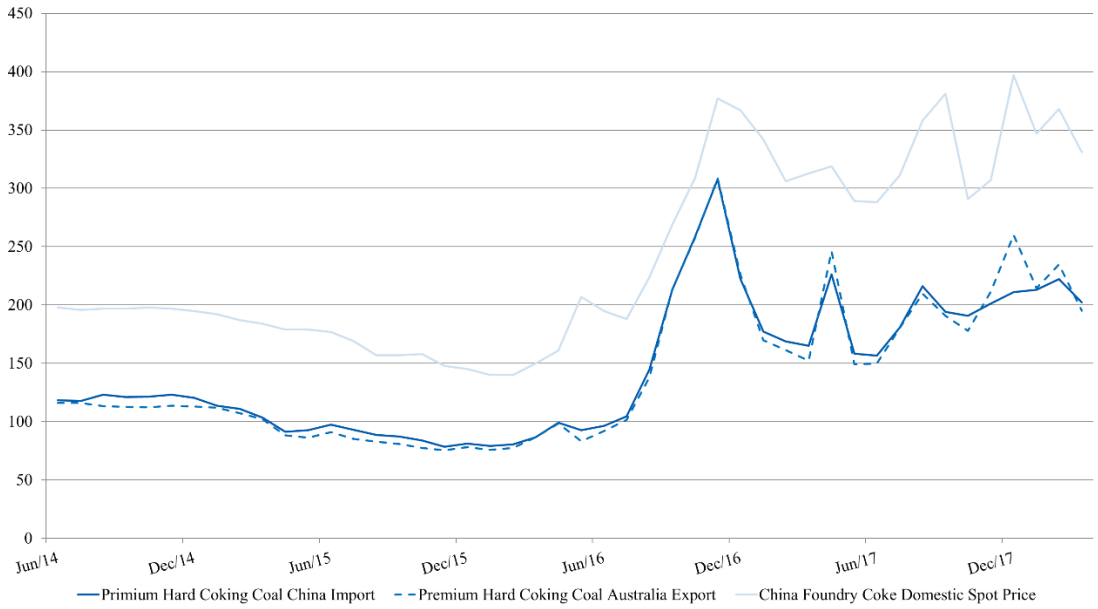
Source: Bloomberg

Coking Coal and Coke

The winter production restriction in northern China, where the coking process is extended to reduce pollutants, will shrink coking coal supply by 30%, contributing to the concern on supply, and leading to the increase in coke price since November 2017.

Simultaneously, coking coal price is also affected by concerns over possible supply disruptions as in November, Australia, which accounted for 61.6% of seaborne coking coal supply in 2016, enters wet season, which would normally end in March of the next year. Coking coal price would be exposed to increased volatility during this period.

Coking Coal and Coke Price Trends (USD/Tonne)



Source: Bloomberg

Scrap

Scrap is a substitute material for iron ore in steel making, resulting in notable substitution effects, which indicates that for a given crude steel production, input of iron ore and scrap cannot increase at the same time. By the end of 2016, since the EAF method only accounts for around 25% of global steel output, the use of scrap in steelmaking is still far less popular than that of iron ore.

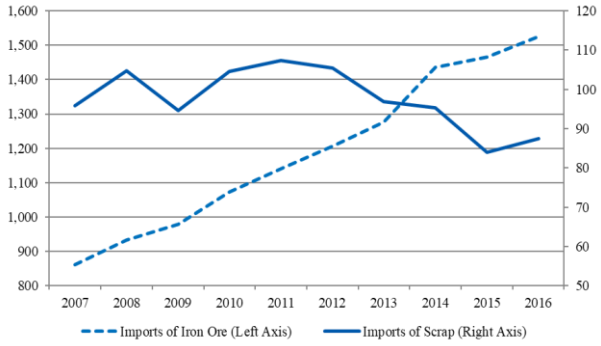
Most steel products remain in use for decades before they can be recycled. Therefore, there is not enough scrap to meet the growing demand for steel using the EAF steelmaking method alone. As a result, the scrap market is mainly driven by supply.

Developed countries, where steel products have been extensively used, are the major exporters in the market. In 2016, the United States, Japan, Germany, the United Kingdom, and France took up around 50% of global exports.

The appetite of importers, on the other hand, is driven by both the crude steel production and the use of EAF, where scrap is used as a major material in steelmaking. In 2016, boosted by a crude steel output of 33.16 mt (8th rank globally) while 65.9% of which was produced by EAF, Turkey was far ahead of other scrap consumers with an import of 17.72 mt, equivalent to 20.24% of the global total amount.

Total Exports and Imports of Scrap (Mt)

Imports of Iron Ore and Scrap (mt)



Source: WSA

Steel Market

Overview

China

Following the current trend, GDP growth of China is expected to slow down gradually. As the government keeps focusing on shifting the economic growth drivers toward consumption, investment is unlikely to experience a further rapid increase. Steel demand in 2018 is expected to stay flat, since no obvious structural change that can boost steel demand are observed, given the fact that construction, which was booming, has entered a much milder stage.

Developed countries

The steel demand in the US remains robust due to relatively strong economic fundamentals, compared to years ago. The manufacturing sector is being supported by a low dollar and increasing investment. The construction sector, meanwhile, is benefiting from rising housing prices and a steady non-residential sector.

The EU economy has developed a strong momentum with broadening recovery across member countries. Steel demand will be supported by a recovery in non-residential construction and manufacturing activities.

Steel demand in Japan has been benefitting from an improving investment sentiment and government stimulus, but future growth is still limited by economic fundamentals that are not favorable enough.

Though consumer sentiment has improved, thanks to high consumer debts, and the underperformance of the construction and the shipbuilding sector, South Korea is hardly able to see a robust growth of steel demand in the near future.

Developing countries Outside China

Steel demand in emerging and developing economies (excl. China) is expected to increase rapidly in the coming years.

The mild recovery in Russia and Brazil is expected to continue. Recovery in Russia will be supported by the increase in credit, easing monetary policy and improving consumer and business confidence. In early 2017, Brazil started getting out of recession, but uncertainty remains. In other Latin American countries, recovery has already been initiated and growth in the region could accelerate if reforms are implemented, but the

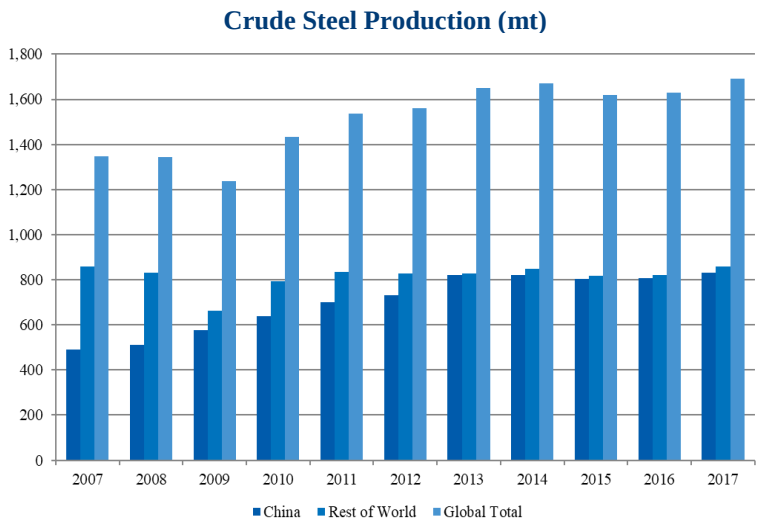
unstable political environment would generate uncertainty.

Turkish steel demand was impressive in 2017, supported by a series of government movement. The strong growth is expected to continue over the next years.

The Indian economy is stabilizing from the impact of currency reform and steel demand is expected to accelerate gradually, mainly driven by public investment. However, domestically, private sectors have not been strong enough to push demand to a higher level.

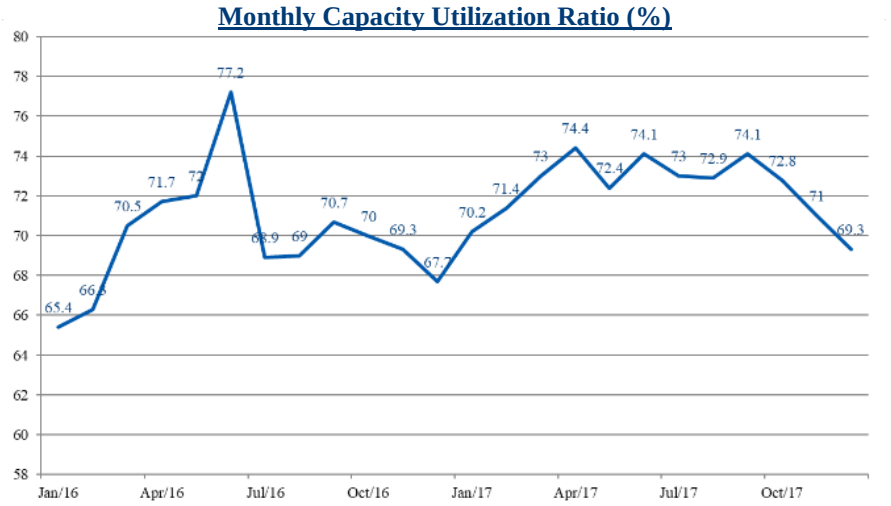
Steel demand in ASEAN-5 countries was disappointing in 2017 due to the slow construction activity and destocking. However, steel demand is expected to regain the growth momentum backed by infrastructure investment.

Supply



Source: WSA

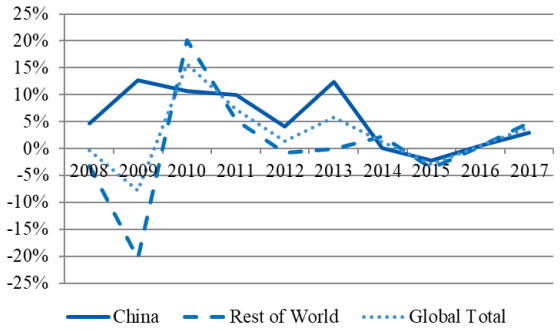
While global production growth remained muted in 2016 due to producers facing difficulties in maintaining profitability, the global crude steel output surged by 3.88% in 2017. Crude steel production in Asia was 1,162.5 mt in 2017, an increase of 3.36% compared to 2016. The EU produced 168.7 mt of crude steel, an increase of 4.12% compared to 2016. Crude steel production in North America was 116.0 mt, 4.86% higher than in 2016. The crude steel capacity utilization ratio in December 2017 was 69.3%, 1.6 percent higher than in December 2016.



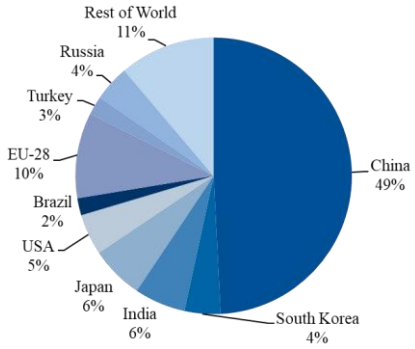
Source: WSA

Crude steel production growth varies between countries and regions, while the global growth recovers. China's crude steel production in 2017 reached 831.7 mt, up by 2.9% compared with 2016. China's share of world crude steel production decreased from 49.65% in 2016 to 49.2% in 2017. Strong growth continued in India, crude steel output reaching 101.4 mt, up by 6.2% compared with 2016. South Korea reversed the negative growth trend which started in 2015, achieving a 3.7% growth in 2017, with crude steel production of 71.1 mt. Japan's crude steel production remained stable in 2017, ending the year with an output of 104.7 mt. The US produced 81.6 mt of crude steel, up by 4.0% in 2016. Russia produced 71.3 mt of crude steel in 2017, up by 0.7% compared with 2016.

Crude Steel Production Growth



Shares of Crude Steel Production 2017



Source: WSA

In 2016, Chinese steel companies took up 5 spots out of the 10 largest steel companies that were ranked by crude steel production. The global leader, Arcelor Mittal, is far ahead of any other competitors, with the production of around 1.5 times as much as that of the second largest company in the world, China Baowu Group, and over 2 times as much as the third rank winner, HBIS Group, another giant enterprise in China. NSSMC Group and POSCO, the leading ones in Japan and South Korea, respectively, also made it into the global Top 5. As a major participant in the booming steel industry in India, Tata Steel has also earned its own seat in the Top 10.

Top 10 Companies Outside China by Crude Steel Output	Overall Rank 2016	Production 2016 (Mt)	Country (Headquarter)	End of FY 2017 ($ million)				
				Market Cap	Sales	Net Income	Profit Margin	Capex
Arcelor Mittal	1	95.45	Luxembourg	33,018	68,679	4,568	6.65%	2,819
NSSMC Group	4	46.16	Japan	24,404	42,856	1,211	2.83%	2,978
POSCO	5	41.56	South Korea	27,061	53,670	2,469	4.60%	2,024
JFE Steel	8	30.29	Japan	14,769	30,610	628	2.05%	2,094
Tata Steel Group	10	24.49	India	11,140	17,405	-633	-3.63%	1,151
Nucor Corporation	12	21.95	US	20,213	20,252	1,319	6.51%	449
Hyundai Steel	13	20.09	South Korea	7,300	16,959	634	3.74%	1,063
thyssenkrupp	15	17.24	Germany	18,123	45,790	-717	-1.57%	1,511
NLMK	16	16.64	Russia	15,295	10,065	1,450	14.41%	592
Gerdau	18	15.95	Brazil	6,062	11,567	-113	-0.97%	274

Source: WSA

Forecasting the Global Crude Steel Production

In forecasting the global crude steel production, a vector autoregression (VAR) model is used, which is able to capture linear interdependencies among multiple time series. Being different from univariate models, VAR models accept more than one variable.

Variable Selection

A total of four variables are used in the estimation and forecasting process, including the monthly growth rates of the global crude steel production (GCSPr), the monthly growth rates of the iron ore production in China (IOPr), the monthly returns of S&P 500 index (SP500r), and a variable (D) that can take values of integers from 1 to 12 and is supposed to account for seasonality.

As an autoregression process, the previous values of the output variable, the monthly growth rate of the global crude steel production, are a must. The selection of the other three variables is based on the considerations below:

- Domestic iron ore production in China supports most of the local steel production, which is equivalent to nearly half of the global crude steel production, making it a reasonable choice in predicting the future evolution of the global crude steel production.
- Since the steelmaking industry is significantly affected by the macroeconomic cycle, a variable that can reflect the global economy is essential in the forecast. Given the broad sectors and geography that S&P 500 index covers, the index is a reliable proxy for the global macroeconomy.
- As showed in the Figure I below, there is an obvious seasonal pattern in the monthly growth rate of the global crude steel production. To account for it in the model, the fourth variable needs to be introduced into the model accordingly.

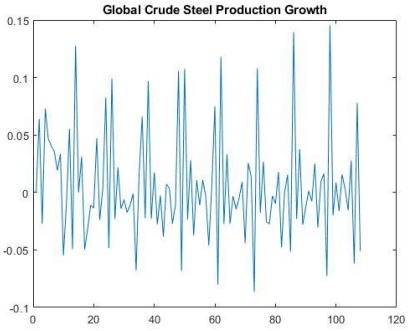


Figure I

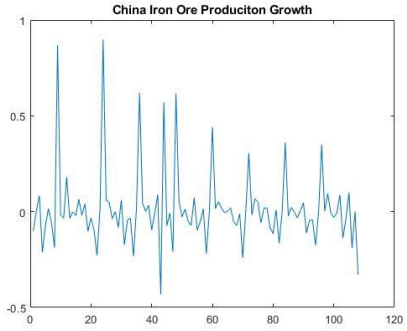


Figure II

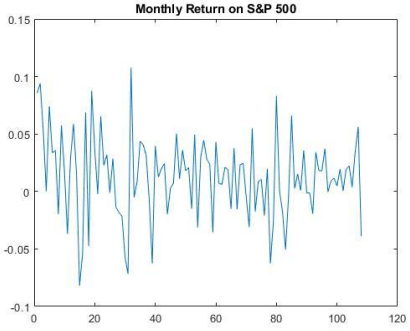


Figure III

Data Description

The raw data contains levels of the global crude steel production, and iron ore production in China, as well as close prices of S&P 500 index at the last trading day of each month. The horizon of the raw data set is from January 2009 to January 2018, a total of 109 observations.

To be used in the model estimation and forecasting, the data in levels is converted into simple periodic returns (i.e. $r_{t-1,\ t} = y_t / y_{t-1} - 1$). Thus, after the conversion, 108 observations are available.

The variable which is supposed to account for the seasonality, would equal to an integer from 1 to 12, where 1 indicates the growth rate between the level in January and the level in February, and 12 indicates the growth rate between the level in December and the level in the next January.

Model Setup

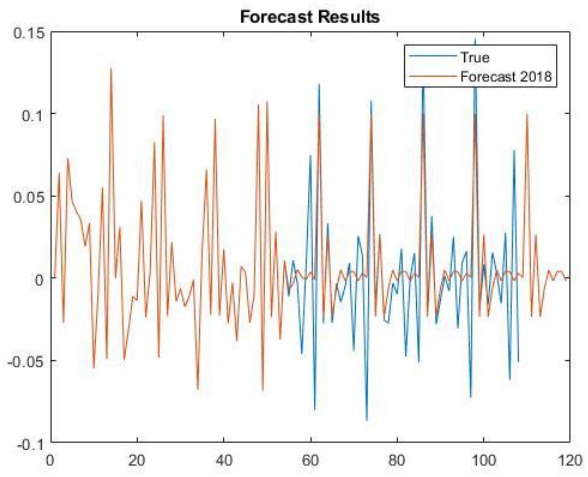
Besides selecting the variables and trimming the data, the VAR model can only be set up if the order of the model is determined. Decision for the most appropriate order was based on the following considerations:

- The order of the model cannot exceed 6, otherwise there will not be no enough data for simulation.
- An order around 3 is likely to be acceptable, given the fact that the information on nationwide or worldwide production is usually made public with a one-month lag. E.g. the global output in January would only be published in February. Hence, considering the time that producers need to make changes to their production plans, and the actual time that it takes to shut down or restart furnaces, the production in the current month should approximately reflect the effect of the production level three months ago.
- Since the quality of forecasts made by different VAR models can be judged, metrics that measure the forecast quality will provide sound evidence when choosing the most appropriate order.

Using Mean Squared Error (MSE) as the metric for forecast quality, a 3rd order VAR model is considered as the most suitable one in predicting the global crude steel production.

Estimation Method and Forecast Result

In estimating the model, the whole sample is separated into two equal-length subsamples (54 observations in each). The first subsample is used for the initial estimate of the model, and for producing a one-period forecast, which would then be added to the first subsample for estimating a new model. This process is repeated until 11 out-of-sample forecast are acquired, which is the forecast for the global crude steel production in 2018. The second subsample, as well as the forecast, is used to computing the MSE of the forecast period.



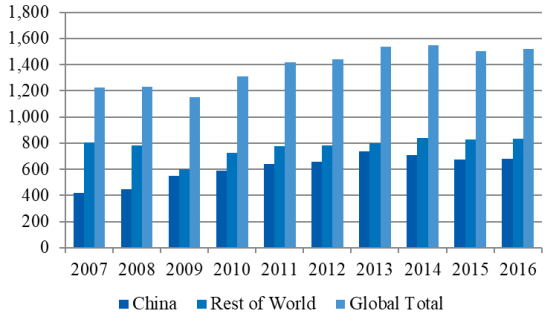
According to the model, the global crude steel production will grow for 2.56% in 2018.

Demand

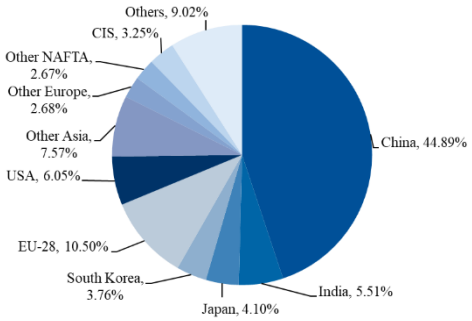
Global steel consumption, measured by apparent steel use of finished products equivalent, increased by 1.03% in 2016. The growth is expected to speed up in 2017, due to the recovery of the global business cycle and improved construction activities in most countries.

China remains the key driving force of global consumption, followed by the United States and India. As the construction sector in China is expected to slow down due to less spending, demand growth for steel in China is also about to decelerate, resulting in slower growth of global consumption of steel, given the significant share that China takes in the global market. Outside China, developing countries, such as India and Vietnam will make a notable contribution in boosting global consumption. Major developed consumers, such as the US, Japan, and South Korea, on the contrary, will likely see a flat growth trend in coming years.

ASU – Finished Products Equivalent



ASU – Finished Products Equivalent 2016



Source: WSA

Global Trades

Overview

Measured by semi-finished and finished steel products, the top 10 exporters took up over 70% of the total export volume of the world. China consumes most of its production domestically, while it tops the net export volume at the same time. The expected driver of future growth of the industry, India, exported and imported 10.3 and 9.9 mt in 2016, respectively. The largest steel consumer outside China, the US,

Top 10 Exporters 2016	Total Export (mt)	% of Crude Steel Production
China	108.1	13.37%
Japan	40.5	38.65%
Russia	31.2	44.06%
South Korea	30.6	44.62%
EU-28	29.9	18.45%
Germany	25.1	59.65%
Ukraine	18.2	75.15%
Italy	17.9	76.58%
Belgium	16.7	217.25%
Turkey	15.3	46.14%

Top 10 Importers 2016	Total Import (mt)	% of Finished Products Consumption
EU-28	40.4	25.36%
United States	30.9	33.66%
Germany	25.5	62.96%
South Korea	23.3	40.82%
Italy	19.6	81.36%
Vietnam	19.5	87.33%
Thailand	17.6	91.61%
Turkey	17	49.89%
France	14.6	99.18%
China	13.6	2.00%

Top 10 Net Exporters 2016	Net Export (mt)	% of Crude Steel Production
China	94.5	11.69%
Japan	34.5	32.93%
Russia	26.9	37.99%
Ukraine	17.1	70.61%
Brazil	11.5	36.77%
South Korea	7.3	10.65%
Taiwan, China	4.4	20.23%
Belgium	3.7	48.13%
Austria	3	40.33%
Slovakia	2.1	43.68%

Top 10 Net Importers 2016	Net Import (mt)	% of Finished Products Consumption
United States	21.7	23.64%
Vietnam	17	76.14%
Thailand	16.1	83.80%
Indonesia	11	86.80%
EU-28	10.5	6.59%
Egypt	8.3	71.04%
Mexico	8.1	31.90%
Saudi Arabia	6.2	50.82%
Algeria	5.4	94.94%
Poland	4.7	35.68%

Source: WSA

suffered from years of decline in the steel industry, and is now the largest net importer in the market. Southeast Asian economies, such as Vietnam, Thailand, and Indonesia, showed strong dependency on import. This resulted from both ongoing construction and the scarcity of domestic steel production. Similar pattern could be observed in North African countries.

Trade Barrier

Trade barriers are rising between recipient countries and exporters, mainly China.

In June 2015, to support domestic producers suffering from low price competition and thin profit margins, India has imposed anti-dumping duties of USD 309/tonne on hot-rolled stainless flat steel imported from China.

In June 2016, the EU announced that it imposed an additional tariff on steel bar products, which are mainly used in construction, imported from China, raising tariffs from 9.2% to 13%.

In March 2016, the US announced that it imposed preliminary import duties of 266% on steel imported from China.

In August 2016, the European Commission imposed a five-year import duty of 19.7% to 22.1% on cold rolled steel products from China. These products are primarily used in the construction and automotive sector.

On January 30th, 2017, President Trump reiterated the "America first" procurement strategy to boost US steel production.

In March 2018, the US imposed an 25% tariff on imported steel products, though the exact date when the tariff will come into force is still pending.

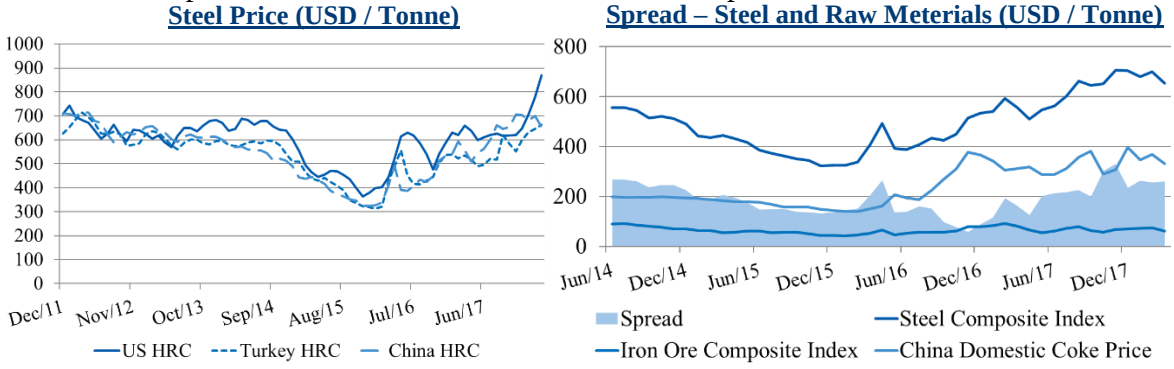
Price Trends

Recently, Northern China is under strict regulation due to air pollution concerns in the winter, leading to the decrease in global supply, and accordingly, the upward trend in steel prices.

As global oversupply of steel is expected to ease, and the global business cycle is about to revive, steel prices will stabilize along with the weakness of the raw material markets.

Since China would still be expected to lead the steel suppliers by export, steel price in each market is hardly able to deviate much from the export price of China´s product.

However, increasingly significant protectionism and trade barriers, if they exist, would widen the spread between domestic and international prices.



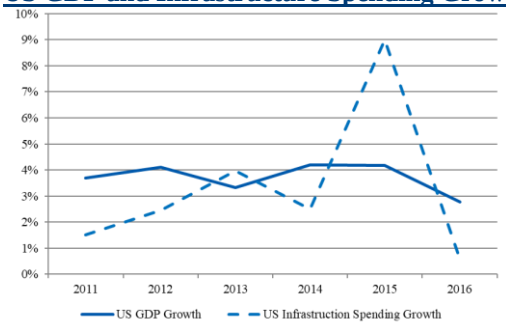
Source: Bloomberg, World Bank

United States

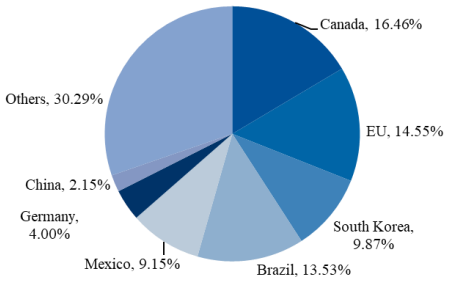
Steel production in the US will see limited growth, due to the ongoing competition from cheap imports and elevated operating costs. The steel demand in US is expected to remain robust in coming years, resulting from the reviving business cycle.

While the US will remain the dominant steel producer in the Americas, relatively higher operating costs will weigh on firms competing with cheap imports. Though several anti-dumping and tariff-raising acts have been signed by President Trump, the President, who received plenty of support from the Rust Belt, is likely to enact further manners to revive the US steel industry, targeting not only China, which took up less than 3% of total steel import in the US, but possibly also other exporters.

US GDP and Infrastructure Spending Growth



US Steel Imports 2017



Source: Bloomberg, World Bank

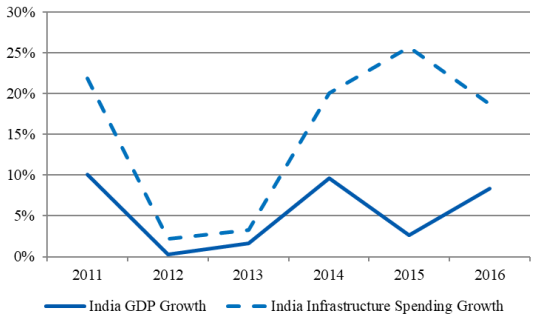
India

Due to the continuous growth of infrastructure, automobile, and construction, India will become the main growth driver for global steel demand in the future.

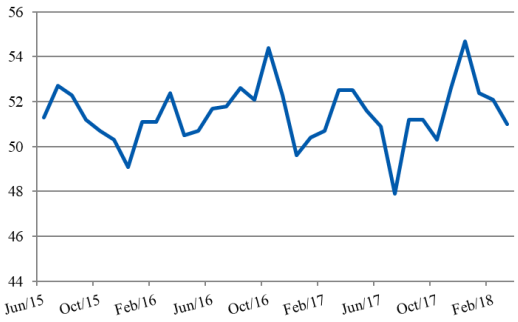
The Indian government is working hard to increase steel production capacity, including upgrading existing steel mills and building new steel mills in state-owned enterprises.

Major Indian companies contributing to the growth of steel production include the Steel Authority of India Limited and Tata Steel, the latter is trying to shift from primary steel products to higher-end steel products by increasing sales revenue from the automotive business.

India GDP and Infrastructure Spending Growth



India Manufacturing PMI (%)



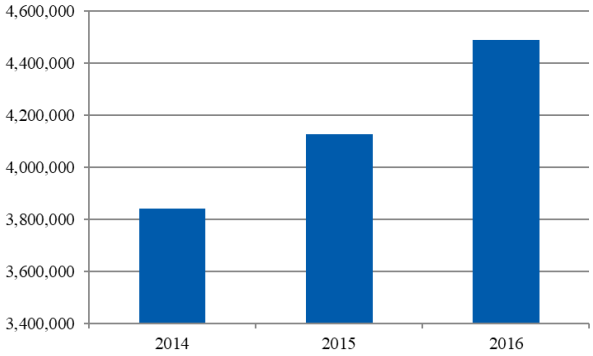
Source: Bloomberg, World Bank

In 2014, infrastructure accounted for 20% of India’s steel consumption. Between 2012 and 2017, India’s infrastructure investment totals more than USD 1 trillion.

The continued rapid growth of India’s population will greatly boost the demand for housing and white goods, providing steel companies with opportunities for further expansion.

With the support of the automotive industry, which accounts for 12% of India's national steel demand, steel consumption will continue to grow. For instance, in July 2016, in the automotive sector, new vehicle sales by major makers in India grew by 13.6% y-o-y, growing to 311,538 sales, up from 274,163 in July 2015.

India Vehicle Production (Units)



Source: Bloomberg

The low labor costs and increasing supplier channels in India's auto manufacturing industry are beneficial to automakers. Since September 2014, the total amount of investment in the announced automobile manufacturing projects has exceeded USD 4.8 billion, indicating the potential of India as a future automobile manufacturing and export center.

Major Issues SISG Facing

Systematic Trends in the Industry

No Fundamental Basis for Rapid Growth of the Global Steel Industry

Following the post-crisis rebounce that ended in 2014, steel has been suffering for 2 years due to global economic downturns. Though the industry has shown some signs of reviving in 2017, namely the relatively high growth of steel supply and demand, it is too early to be over optimistic about the industry. Because the growth of the global steel industry in 2017 is mainly driven by the recovery of the global economic cycle.

By looking at the grand picture of the whole supply chain of the steel industry, it is obvious that either the iron ore or the steel market is still struggling with supply surplus. Although major producers are working on bringing the supply-demand balance back to the market, it will take years to achieve this goal. Thus, on the supply side, steel producers need to look for ways to work through the low profit margin.

On the other hand, on the demand side, determined by the fact that downstream industries of steel, such as infrastructure, and construction, would grow more rapidly in developing countries rather than in developed economies, developing regions are playing the most vital role in driving the steel industry forward. However, the main supportive force of the global steel industry, China, is going through a reforming period, which will significantly negatively affect the growth of the industry. Another potential leader of the developing economies in the industry, India, though growth so far is favorable, its economy fundamental is less stable than other key players in the market, which is only possible to be amended through years of development. Similar weakness of the macroeconomy is not rare in developing economies, some of which are subject to political turmoil and less effective public authorities, that are standing in the way of robust economic growth.

Thus, despite of the recovery of the global business cycle, SISG, along with the whole steel industry will still be facing a difficult time.

China's Role in Global Steel Industry is Changing

As the most important player in the global steel industry, China takes around 50% shares in both global steel production and consumption.

Since 2002, steel production and consumption have increased by 3.4 times and 2.4 times, respectively. The rest of the world, over the same horizon, showed only 14% and 30% increase in production and consumption. In other words, China has contributed to 86% of global steel production growth and 70% of global steel consumption.

Similar pattern exists in the global trade landscape. The steel export of China increased by over 15 times from 2002 to 2017, while the rest of the world ended the period with a 17% growth on steel export, which means that China accounted for 65% of the increase in global steel export.

The dominance of China in the iron ore market seems even more impressive. Among the total increase in global iron ore import, over 90% resulted from China's increasing steelmaking capacity, more than 94% of which are BOF mills.

Now, China's steel industry is standing right at a crossroad, where multiple reforms and trends are shaping the future of the industry, bringing opportunities and risks to all the participants in the market.

Technology Divergence: BOF or EAF

EAF is not something new in China, as the technology has been applied to industrial production in China since 1990s. However, since the BOF technology is relatively mature, due to the mere fact that back then in China, supply of power and scrap was tighter than that of iron ore and coal, which are abundant in China. Most of the newly set up capacity since China's steel production started booming followed the BOF approach.

Nowadays, scrap supply has been increasing for years, mainly due to the increasing volume of steel products reaching the end of their economic life. Also, the tight supply of power has been relieved because of the advancement of the energy industry. Taking the environment benefit that comes along with switching from BOF to EAF into account, China now has more favorable conditions for the development of EAF facilities. Though from a global point of view, EAF for now only accounts for 6% of China's steel output, far behind the global average level of 25%, and the environmental advantage of EAF is recognized by both the Chinese government and the public, steel producers in China still need to assess the economic value of replacing BOF with EAF, while keeping a close look at the pollution limit set by the regulators. In the long-term, new technology that could use both iron ore and scrap as input would offer a better choice for steel producers.

Structral Reform

The structral reform in China's steel industry aims at cutting overcapacities and capacities that run at low efficiency. According to the initial plan of the reform, by 2020, crude steel production capacity would be limited to below 1,000 mt per year, and the capacity utilization rate should reach 80%, up from the 70% in 2015. Except for cutting the overcapacity, the reform requests steel producers to reduce the leverage of business,

as many of the low-efficiency capacities were supported only by government subsidies and bank loans. Under the framework of the reform, Chinese steel producers are no longer able to survive by expanding production and live on thin profit margins. Thus, steelmakers are under pressure of improve production efficiency and eliminate overcapacity internally.

Company Specific Factors

Performance

SISG has been suffering from the disappointing performance of its subsidiary, Shandong Steel, for years. According to related regulation in China, public listed companies that reported net loss for two consecutive years will have to add "ST (Special Treatment)" to their tickers in the exchange, alerting investors of the risk of the stocks, which would negatively affect the funding of the companies. For several times, to help Shandong Steel out of potential loss, SISG has purchased assets from Shandong Steel, which would then receive considerable amount to reverse the net loss.

On 15th October 2015, SISG acquired certain assets and liabilities at a premium of over 20% from Shandong Steel, which then ended FY 2015 with a net profit of 120 million USD, successfully avoided the Special Treatment. Similarly, on 24th December 2016, SISG again acquired the assets and liabilities of Jinan Baode Gas from Shandong Steel, saving it from a year of net loss. However, what is notable is that in this transaction, SISG offered a cash consideration at a slightly discount. Given that SISG itself was also struggling with making a profit back then, it is reasonable to conclude that SISG might not be able to save its underperforming subsidiaries again, as the global industry environment is not favorable enough for SISG to thrive.

Investments

In March 2012, SISG invested 1.5 billion USD in 25% stake in Tonoklili Iron Ore Mine in Sierra Leone. It was estimated that the reserve of the mine was 12.8 billion tonnes, second largest in Africa. However, due to the average Fe content was just around 30%, the mine was not advantageous compared with iron ore mines in China. In 2014, the operating cost of Tonoklili Mine increased significantly, while global iron ore price took a deep dive, Africa Mineral, which owned 75% stake in Tonoklili Mine, defaulted on its 167 million USD loan and shut all mining activities at Tonoklili Mine. Being concerned about the liquidation of Tonoklili Project, SISG had no choice but to invest another 700 million USD to purchase the stake that Africa Mineral held in Tonoklili Mine. If taking the 2.48 billion USD which is necessary for the 2nd phase of the Tonoklili Project, SISG will bear enormous stress of cash flow.

Strategy

After a series of restructuring of assets and liabilities, SISG's next major focus is the construction of Rizhao Steel Production Base, which will be fully finished by October 2018. Upon its finishing construction, the base will have a crude steel production capacity of 8.5 mt. The Rizhao Base is a signiture of SISG's new location strategy. Historically, steel mills in Shandong Province concentrate in inland areas, making the transportation cost of raw material and end products too high for the producers to bear. The setting up of the new base in Rizhao, a coastal city with advanced port facilities, is supposed to lower the material cost and making it possible for SISG to offer more competitive prices to clients.

Also, relocating the core business base to a coastal city is in line with SISG's export strategy of increasing exports to 10% of total production, most of which will target South Korea and Japan markets. The goal is not easy to achieve though. Even though China takes up over half of total steel products imports of South Korea, it is noticed that the import volume of South Korea has been decreasing since 2016. In 2017, China's export to South Korea was up by around 18% when measured by value, but down by 20% measured by volume, indicating that the competition in the market is still fierce for exporters. The Japan market, on the other hand, has remained muted for years, and China has never been holding a large share in steel import of Japan. The contribution that SISG's export strategy could make to the overall performance of the company is still vague.

Trends in M&A Activities

Suffering from the global business cycle over the past few years, which is not favorable enough, steel producers hardly initiated large-scale cross-border acquisitions. What can be observed, on the other hand, is the frequent appearance of domestic transactions that aim to the consolidation and integration of local supply chain or sub-segment. This pattern is obvious in China's steel industry, as it is encouraged by the government to improve the efficiency and reduce the leverage of the whole industry.

With the closing of these transactions, the bidder, which is usually a steel product manufacturer with notable productivity, would either increase its total output or improve the diversity of its product, or in some cases, gain control of raw material resources.

The target assets, which are normally smaller iron or steel mills, would be able to improve capacity and efficiency with new investment made with the injected capital from the bidder.

From 2016 to 2018, among the 45 transactions that Chinese steel producers got involved in, only 2 of them are cross-border transactions. Considering the cost of capital and time for cross-border deals, SISG should seek consolidation chances domestically, as under the current circumstances of the global steel industry, it is not likely for an ideal target to appear.

Example Case: Hesteel Acquired Serbian Steel Mill

Target: Zelezara Smederevo d.o.o

Deal value: EUR 46 million

Deal detail:

The target is a Serbia-based company that produces steel, hot, and cold rolled products, and tin plates. Government of the Republic of Serbia had acquired the company from US Steel Corporation in 2012.

After finishing the transaction, Hebei Iron & Steel Co., Ltd ("Hesteel") will invest approximately EUR 300 million in the target to upgrade the Steel Mill capacities and to construct a new plant, which will increase total capacity of the mill to 2.1 million tons, with no layoffs made. The acquisition will enable the target to operate on full scale, and to further grow and expand its business.

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Appendix

AR-Stationary 4-Dimensional VAR(3) Model

Effective Sample Size: 115
Number of Estimated Parameters: 52
LogLikelihood: 399.525
AIC: -695.05
BIC: -552.314

	Value	StandardError	TStatistic	PValue
Constant(1)	-0.0093284	0.0066083	-1.4116	0.15806
Constant(2)	-0.32723	0.052043	-6.2876	3.2233e-10
Constant(3)	-0.0061856	0.0080314	-0.77018	0.4412
Constant(4)	3.5497	0.84811	4.1854	2.8463e-05
AR{1}(1,1)	-0.21693	0.095281	-2.2767	0.022804
AR{1}(2,1)	-0.16501	0.75038	-0.2199	0.82595
AR{1}(3,1)	0.27351	0.1158	2.3619	0.01818
AR{1}(4,1)	-44.755	12.228	-3.6599	0.0002523
AR{1}(1,2)	-0.065935	0.012627	-5.2217	1.7725e-07
AR{1}(2,2)	-0.40219	0.099443	-4.0444	5.2462e-05
AR{1}(3,2)	-0.03354	0.015346	-2.1855	0.028849
AR{1}(4,2)	-4.4683	1.6206	-2.7573	0.0058286
AR{1}(1,3)	0.12758	0.062943	2.0269	0.042669
AR{1}(2,3)	-0.3157	0.4957	-0.63687	0.52421
AR{1}(3,3)	-0.14353	0.076499	-1.8763	0.060617
AR{1}(4,3)	4.4438	8.0782	0.5501	0.58225
AR{1}(1,4)	-0.0082692	0.00072126	-11.465	1.978e-30
AR{1}(2,4)	0.023746	0.0056802	4.1805	2.9082e-05
AR{1}(3,4)	-0.001671	0.00087659	-1.9063	0.056614
AR{1}(4,4)	0.61215	0.092566	6.6131	3.7635e-11
AR{2}(1,1)	0.16515	0.067835	2.4346	0.014908
AR{2}(2,1)	1.6537	0.53423	3.0954	0.0019653
AR{2}(3,1)	-0.17287	0.082444	-2.0969	0.036006
AR{2}(4,1)	-14.058	8.706	-1.6148	0.10636
AR{2}(1,2)	-0.059005	0.014471	-4.0775	4.5523e-05
AR{2}(2,2)	-0.34238	0.11396	-3.0043	0.0026622
AR{2}(3,2)	-0.017539	0.017587	-0.99724	0.31865
AR{2}(4,2)	-3.4807	1.8572	-1.8742	0.060909
AR{2}(1,3)	0.31415	0.055416	5.669	1.436e-08
AR{2}(2,3)	-0.11529	0.43642	-0.26417	0.79165
AR{2}(3,3)	-0.016587	0.06735	-0.24628	0.80547
AR{2}(4,3)	7.3767	7.1121	1.0372	0.29964
AR{2}(1,4)	0.010316	0.0012685	8.1326	4.2029e-16
AR{2}(2,4)	0.0046518	0.0099899	0.46566	0.64146
AR{2}(3,4)	0.012219	0.0015417	7.9259	2.2647e-15
AR{2}(4,4)	-0.32943	0.1628	-2.0235	0.043018
AR{3}(1,1)	0.073203	0.06067	1.2066	0.22759
AR{3}(2,1)	1.3116	0.4778	2.7452	0.0060477
AR{3}(3,1)	0.089325	0.073735	1.2114	0.22573
AR{3}(4,1)	10.641	7.7863	1.3667	0.17174
AR{3}(1,2)	0.017228	0.013213	1.3038	0.19229
AR{3}(2,2)	-0.12986	0.10406	-1.248	0.21205
AR{3}(3,2)	0.018142	0.016059	1.1297	0.2586

AR{3}(4,2)	-2.2233	1.6958	-1.3111	0.18983
AR{3}(1,3)	0.2115	0.055095	3.8389	0.00012358
AR{3}(2,3)	-0.35642	0.43389	-0.82144	0.4114
AR{3}(3,3)	0.096333	0.06696	1.4387	0.15024
AR{3}(4,3)	7.6577	7.0709	1.083	0.27881
AR{3}(1,4)	-0.00013338	0.0013894	-0.095998	0.92352
AR{3}(2,4)	0.030994	0.010942	2.8325	0.0046187
AR{3}(3,4)	-0.0076329	0.0016886	-4.5202	6.1794e-06
AR{3}(4,4)	0.24893	0.17832	1.396	0.16272

Innovations Covariance Matrix:

0.0003	0.0014	-0.0000	0.0036
0.0014	0.0201	-0.0003	-0.0000
-0.0000	-0.0003	0.0005	-0.0020
0.0036	-0.0000	-0.0020	5.3422

Innovations Correlation Matrix:

1.0000	0.5546	-0.1018	0.0854
0.5546	1.0000	-0.0944	-0.0000
-0.1018	-0.0944	1.0000	-0.0399
0.0854	-0.0000	-0.0399	1.0000

The MSE of the estimated model is 0.0011 .
The global crude steel production will grow for 2.5635 percent in 2018.
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