MARKET TREND & ANALYSIS

THE CHINA STEEL SHOCK REVISITED:

SHIFTS IN THE SCRAP MARKET DYNAMICS AND THEIR RAMIFICATIONS

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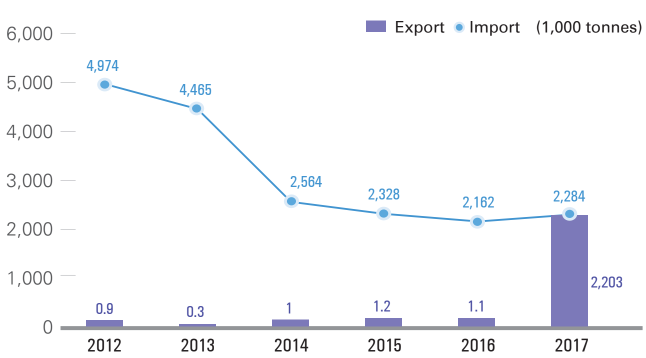
China exported 2.2 Mt of steel scrap in 2017, a remarkable surge compared to the meager 1,000 tonnes in 2016. This outpouring began unexpectedly in the second quarter of 2017 despite the government's de facto ban on the export of steel scrap. For the past 15 years, China's steel consumption as well as its accumulation demonstrated continued increase. The experts wonder if now is the high-time for the government to lift the ban. Let us look at the developments that occurred in the Chinese steel scrap market last year.

2017: The year that *ditiaogang* closed and the market responded

According to the China Association of Metalscrap Utilization (CAMU), the country's steel scrap consumption totaled 100.1 Mt in 2016. Steelmaking took 90.1 Mt, while forging and casting comprised of the rest. However, the recent closure of plants that produce *ditiaogang*, or low-quality steel made from scrap metal, has revealed numbers hidden beneath the official statistics. As it turned out, approximately 70 Mt had been consumed for the production of *ditiaogang*, which is made completely of steel scrap. *Ditiaogang* capacity in induction furnaces had not been included in official statistics and the steel scrap used for it was not calculated in production and consumption statistics. The entire *ditiaogang* market relied on such unrecorded transactions, creating an underground economy.

Figure 1. China's Steel Scrap Imports and Exports



Source: China Association of Metalscrap Utilization (CAMM)(January 2018)

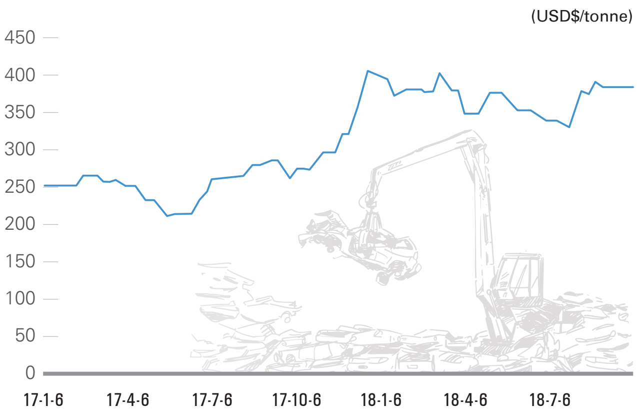
The Chinese government has pointed to *ditiaogang* as the main culprit behind overcapacity, environment pollution, industrial accidents, and tax evasion vis-à-vis illegal production and transactions. The closure of 140 Mt *ditaiogang* capacity (or annual production capacity of 65-70 Mt) during the first half of last year has created a seismic shift in the Chinese steel market.

China's crude steel production reached 832 Mt in 2017, an increase of 5.7% year-on-year, as law-abiding companies strengthened their production to a maximum capacity to respond to the dip in the country's steel production following the eradication of *ditiaogang*. *Ditiaogang* production, which had reached 65 Mt in 2016, plunged to 20 Mt in the first half of 2017 before ending completely. Reflecting this trend, China's actual crude steel production is considered to have declined by 20 Mt in 2017 and its export to have fallen by 17 Mt the same year. The price of steel has consequently increased in both Chinese domestic and regional steel markets.

With the closure of *ditiaogang* facilities, 70 Mt of scrap lost its source of demand and the overall price of steel scrap began to fall. Nearing the government mandated deadline of June 2017, the price plunged even further; thus, more and more steel scrap searched for a potential buyer overseas. China's steel scrap use in steelmaking is very low. For the past several years, the percentage utilization of steel scrap for blast furnaces remained at a mere 6-8%. Considering that a country's average steel scrap usage in steelmaking ranges from 18 to 22%, the current figures are quite dismal. Although electric arc furnaces (EAF) in other countries accept up to 100% scrap, the ones in China use only 40% and the remaining 60% is blast furnace liquid iron. However, with the decline in the price of scrap, China's integrated steel mills (ISMs) have raised the scrap ratio to reduce cost. The scrap charge ratio at EAFs also increased, and a number of EAF facilities began to re-operate.

Beginning the third quarter of 2017 with an upward trend, the price of steel scrap continued to surge with healthy signs: EAF production expanded, ISMs in northern China increased their scrap use to meet the environment target, and the overall demand for scrap rose to secure winter inventories. By the end of 2017, steel scrap prices were double the bottom they had reached in June. Throughout 2018, the price of scrap, pegged to the price of steel, have stayed relatively stable at a level $150-200 higher than that of last year. The previous year's trend of expanding steel scrap demand remains true this year as well.

Figure 2. China's Domestic Price for Medium Metal Scrap



Note: Shanghai price basis, including 17% VAT
Source: Mysteel

Steel scrap production in China expected to surge around 2025

The year 2017 saw two major trends in the Chinese steel scrap market: price fluctuation and export increase. Triggered by shifts in the crude steel production structure, such as the disappearance of *ditiaogang*, rise in the usage of scrap in steelmaking, and an increasing rate of EAF operation, the steel market in China is as volatile as ever. It is thus important to gauge whether this trend will be short-lived or if these changes signal the beginning of a long-term structural shift. If a long-term transition has already begun, how will China's steel scrap market change and what influence will this have on the global steel industry?

Let us look at the supply of scrap in China first. There are three ways to produce scrap: first, obsolete (i.e. post-consumer) scrap that is collected after steel-containing products reach the end of their lives; second, home (i.e. return) scrap that comes from waste generated during the steelmaking process; and third, prompt, or industrial scrap created during downstream manufacturing processes. The key here is obsolete scrap. The supply of obsolete scrap is calculated by estimating steel accumulation, generation of obsolete steel scrap, and the apparent recovery rate.

$$\text{Steel accumulation } (n) = \sum_{t=1}^{n} \text{Apparent finished steel consumption}^*(t) - \sum_{t=1}^{n} \text{Quantity of scrap recovered } (t)$$

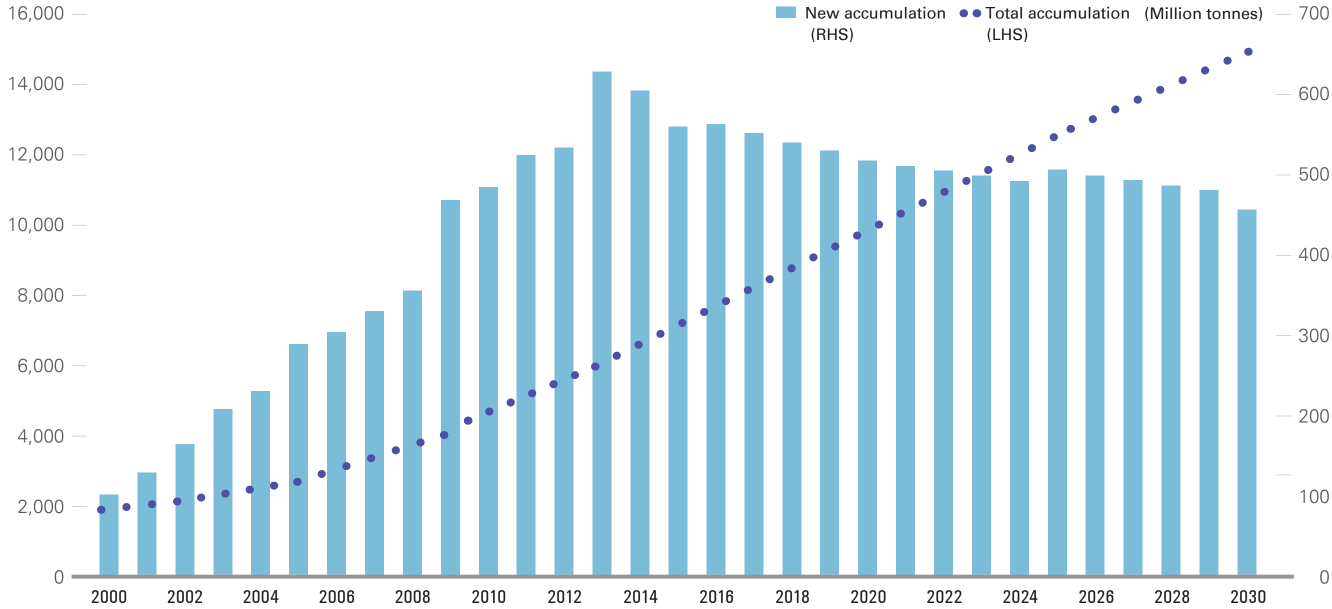
*Finished steel production + Finished steel import - Finished steel export + Indirect import - Indirect export

China's steel accumulation reached 7.3 billion tonnes in 2015, a significant amount compared to that in the US (4.64 billion tonnes), Japan (1.36 billion tonnes) or Korea (650 million tonnes).[1] Steel accumulation is calculated by subtracting the quantity of scrap recovered from apparent finished steel consumption. In 2017, the Chinese steel accumulation is believed to have reached 8.3 billion tonnes.[2] Although the growth rates of China's steel production and consump-

1 The China Iron and Steel Association (CISA), Japan Iron and Steel Recycling Research (JISRI), and Korea Iron and Steel Association (KOSA)

2 According to POSCO Research Institute's prediction for Chinese steel consumption using China's GDP and business activities in steel-consuming industries, it is expected to increase by a CAGR of 0.01% until 2020, but decline by a CAGR of 0.8% during 2020-2030. With this capacity and operation rate forecast, Chinese steel production is predicted to decline by a CAGR of 0.7% until 2020 and a CAGR of 0.9% by 2030 (POSRI, 2017.12). China's steel exports are projected to decline to 70 Mt by 2030, according to Chinese expert opinions.

Figure 3. China's Steel Accumulation Forecast



Source: Performance data based on CAMU and CISA; forecast by POSCO Pesearch Institute

tion are expected to slow in the future, the country's steel accumulation rate will continue to increase by 450-500 Mt annually until 2030. In this light, the research by POSCO Research Institute in 2017 estimated that China's steel accumulation will reach 10 billion tonnes in 2020, 12.6 billion tonnes in 2025, and 14.9 billion tonnes in 2030.

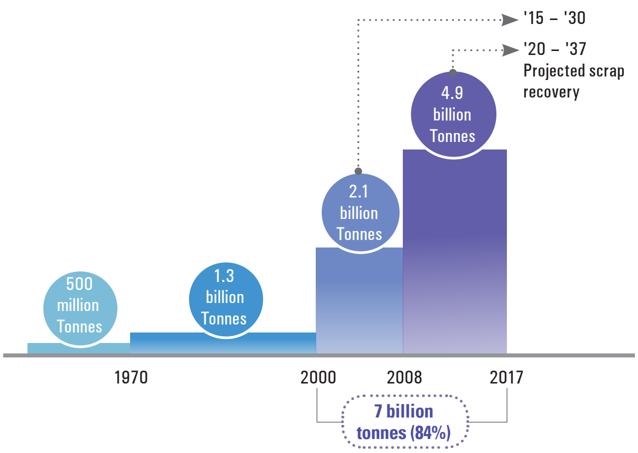
Obsolete scrap generated from steel accumulation is highly relevant to the lifecycle of steel-related products. Scrap is collected from steel products after the end of their lifecycle: 30 years for construction steel and 11-15 years for industrial (e.g. machinery and home appliances) steel.[3] Interestingly, 7 billion of 8.3 billion tonnes, in other words, 84% of total steel accumulation in China has occurred since 2000, the year the Chinese demand for steel began to climb rapidly. Applying the past figures on the lifecycle of steel-using products to the share of industry-wise steel consumption, we see that steel products consumed up to the early 2000s have been a major force behind post-2015 steel accumulation. This is why China's steel scrap imports, which stood at 5 Mt until 2012, have recently fallen to 2 Mt. On a similar note, we predict China's production of obsolete scrap to reach 300 Mt by 2025.

As the production of obsolete scrap continues to increase, the volume of scrap recovered and supplied is expected to rise from 70 Mt in 2017 to 100 Mt in 2020 and 200 Mt in 2030. The recovery rate and supply of obsolete steel scrap both shift in response to the price of scrap and the cost of recovery. The recovery rate in China still remains low at 0.85% (2017).[4] In China, numerous small private entities comprise the scrap metal processing industry. Be-

3 University of Science and Technology Beijing, 2015.

4 In 2015, US 0.85%, Japan 1.58%, Korea 1.68%, Taiwan 1.67% (Japan Iron and Steel Recycling Research, 2016)

Figure 4. China's Steel Accumulation & Scrap Recovery Projection



Source : POSCO Pesearch Institute (October 2017)

Table 1. Steel Production Yield Rate & Share of Steel Products

	China	Korea	Japan	US
Steel production loss rate (2015)	95%	93.2%	92%	93%
Production by steel type (2016)				
Long product	44%	30%	31%	27%
Flat product	56%	70%	69%	73%
Hot-rolled steel	75%	52%	38%	48%
Cold-rolled steel	25%	48%	62%	52%

Source: worldsteel, CISA, KOSA, etc.

cause transactions are made without proper records of the collection and early processing stages, it is difficult to assess the actual condition of the industry. The government has licensed law-abiding companies and offered them tax breaks since 2012, but many companies resist entering the lawful sphere because the benefits of engaging in unrecorded transactions are considerable.

However, in 2017 the steel scrap processing industry entered a new chapter with the restructuring of the *ditiaogang* market that had been sustained by small companies. Investments in scrap classification facilities and warehousing have continued to increase since the second half of 2017.

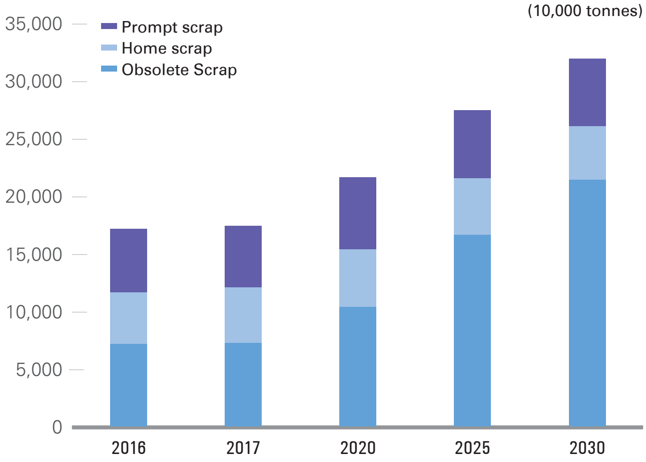
Government policies encouraging small enterprises to expand and receive qualification checks are considered to be implemented actively in the coming future. As recovery systems become more efficient and the costs decline, we expect both the recovery rate and the supply of obsolete steel scrap to increase even further.

Another issue is that the standards and criteria for steel scrap products vary by country. In other words, we do not yet have an international classification standard for steel scraps. Chinese steel companies have been developing their own raw material mixes and production structures that suit the kind of facility each employs. Since they create and operate their own standards based on experience, the task of predicting scrap prices by product or examining precisely the changes in volume are all too daunting. Therefore, in addition to the refurbishment of the recovery systems, we deem it necessary to create a single coherent method for product classification and accounting.

China's home scrap production rate is relatively low because it has high actual yield rate between crude and finished steel production due to the elevated share of long products in steel production. The more cold-rolled steel products are produced, the more scrap is generated. As China's steel products are expected become high value-added in the long run, the steel production yield rate is expected to decline and the home scrap production rate to increase. However, as crude steel production is projected to fall, we expect the volume of home scrap generation to stabilize at the 2017 level of 46 Mt by 2030.

Based on the weighted average of prompt scrap generation by steel-consuming industries and industry-wise steel consumption as of 2015, we estimate the rate of China's

Figure 5. China's Steel Scrap Supply by Type



	2016	2017	2020	2025	2030
Obsolete scrap	7,100	7,100	10,183	16,288	20,929
Home scrap	4,430	4,600	4,742	4,679	4,641
Prompt scrap	5,100	5,300	6,133	5,715	5,581
Total scrap supply	16,630	17,000	21,057	26,682	31,124

Source: POSCO Research Institute (December 2017)

prompt scrap generation to be 8.9%.[5] The scrap generation rate is high at around 20% for products with multiple parts and high formability (e.g. automobiles and electric machinery), but the rate remains low at 6.5% for other products like construction materials. Altogether, China produced 53 Mt of prompt scrap in 2017. Domestic steel consumption in China is anticipated to decline, but the share of high value-added, steel-consuming products like automobile parts will increase. In short, the sheer volume of prompt scrap generation will remain unchanged.

Combining all accounts, we expect the Chinese steel scrap supply to swell from 170 Mt in 2017 to 210 Mt in 2020 and 310 Mt in 2030. Production of home and prompt scrap will remain at their current levels of 100 Mt each, as the share of flat products increases while industrial production decreases. However, the production rate of obsolete scrap and its recovery rate are expected to surge to triple the current amount by 2030. As the share of obsolete scrap in the total supply of scrap is expected to rise from 30% in 2017 to 67% in 2030, China will have a supply structure similar to that of the US where obsolete scrap accounted for 72.2% of the total scrap supply in 2015.

Chinese steel scrap consumption and export forecast

How much will the Chinese demand for scrap rise and how much impact will this rise have on scrap exports? China's steel scrap consumption including *ditiaogang* is estimated to have been 165 Mt in 2017. China has low EAF production, which accounts for the lion's share of steel scrap consumption. In 2016, EAF represented only 5.2% of Chinese crude steel production (41.8 Mt of 880 Mt, excluding *ditiaogang*). China's EAF capacity is known to be around 120-130 Mt, meaning that the current operation rate remains at 35%. As of 2014, about 372 kg of scrap is loaded into an EAF per tonne of crude steel production in China, which is only a third of the average rate in Korea, Japan, and Taiwan. Because of the American steel industry's tendency to rely heavily on pellets, the US figure is 700-800

5 JISRI (2016)

Table 2. Steel Scrap Usage Per Tonne of Crude Steel Production

(kg/tonne)

		2008	2009	2010	2011	2012	2013	2014	2015
BOF	China	80	65	73	70	59	61	60	-
	Korea	130	97	135	147	159	196	123	-
	Taiwan	146	141	123	117	94	86	84	87
	Japan	158	145	158	136	115	122	122	106
	US	231	329	314	257	211	208	192	147
EAF	China	629	520	521	521	403	381	372	-
	Korea	1,014	1,107	1,009	934	995	965	1,104	-
	Taiwan	1,036	1,025	1,051	1,066	1,043	1,023	1,054	1,039
	Japan	1,041	1,038	1,043	1,047	1,048	1,050	1,032	1,036
	US	848	1,088	817	854	922	771	734	797
Total	China	149	109	119	116	90	83	79	-
	Korea	516	532	498	450	473	464	455	410
	Taiwan	585	569	563	582	533	494	488	446
	Japan	378	340	350	346	332	331	333	319
	US	589	798	622	617	631	549	531	555

Source: JISRI (September 2016)

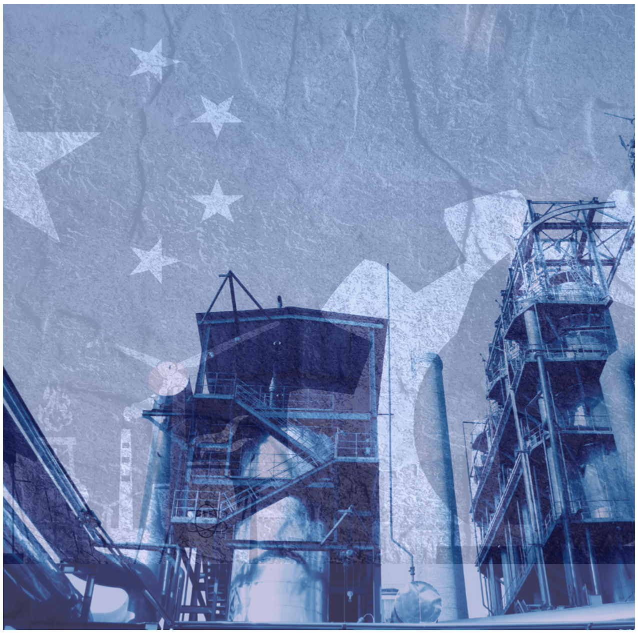
kg. The amount of scrap charge fed into a BOF per tonne of crude steel production in China was also the lowest, at 60 kg in 2014.

About 55% of China's EAFs are owned by ISMs such as Shagang Group, Wing Hing Steel Engineering, Chongqing Iron and Steel, and Nanjing Iron and Steel United (NISCO). The rate at which these companies infuse molten iron into EAFs fluctuate as the price of molten iron shifts. Until 2016, China experienced a unique situation in which more than 60% of pig iron is fed into EAFs and scrap usage remains below 40%.

After steel scrap prices plunged in 2017, however, this situation reversed. Since the middle of 2017, some steel mills have increased their scrap charge up to 60%, but the rate declined to 50% with the resurgence of scrap prices. Annual scrap charge per tonne of crude steel production is estimated to have increased from 300 Kg in 2016 to 410 kg in 2017. In addition to the rise in the EAF operation rate by steel mills, EAF manufacturers have also resumed operations, lifting the total EAF operation rate to above 50%. In 2017, China's EAF production grew to 74.75 Mt, or 9% of total crude steel production.[6] This is a whopping 25 Mt increase compared to the previous year. Of course, this figure is still low given that the average global share of EAF production was 28% in 2017.

If scrap prices remain at stable-to-lower levels as the supply increases and recovery systems improve, China could use 100% scrap in EAFs in the long term. Some steelmakers' scrap usage in BOFs has increased from their previous level of less than 10% to 15-20% in

6 worldsteel, 2018



2017. The figure will reach an average of 18% over the long term. The Chinese government plans to improve its electricity rate system and encourage EAF as new facilities replace shuttered obsolete facilities. In terms of the reduction of environmental pollution and recycling of resources, the advantage of EAF performs better in China. As blast furnaces (BFs) account for 43% of total capacity newly built after 2008, it will be difficult to replace all facilities with EAFs at once. However, 349 small BFs with less than a 1000 m³ volume will be closed in phases and it is highly likely that some of them will be replaced with EAFs. In this sense, EAF production will increase to 20% until 2030.

Chinese steelmakers' share of total metallic input will change flexibly with the direction of steel scrap prices. Assuming that EAF production and scrap's share of the total metallic input both rise, Chinese scrap consumption is expected to mark 165 Mt in 2017, 190 Mt by 2020, and 260 Mt by 2030. In this case, the scrap supply glut could reach 17 Mt in 2020 and 50 Mt of excess scrap supply will be added after 2025.

From the perspective of scrap demand, the supply glut will depend on how much EAF production increases under the Chinese government's environmental and facility restructuring policies. Furthermore, the government's resource recycling and steel scrap industry policies can influence the steel scrap supply. If supply increases with a stable price, EAF production and scrap usage will expand faster than expected and China will be able to absorb its supply glut domestically. This will occur only if the Chinese government recognizes steel scrap as an important resource and applies it to reduce its dependence on iron ore over the long term. China could mirror the US, where the share of obsolete scrap surpasses 70%, EAF accounts for 67% of total crude steel production, and small EAF manufacturers are scattered across the entire country.

Just like the US, China will likely convert into a major steel scrap exporter. The increase in the steel scrap supply will not be coincident with a change in the internal structure of the steel industry. In this situation, the pressure on the supply glut in China will accumulate and raise the possibility of the reduction or even the elimination of export duties. As of 2016, global steel scrap trade recorded 87 Mt. If China exports a marked portion of its estimated 50 Mt of excess scrap supply by 2025, it will have a significant impact on the global steel market.

By 2025, the shock from Chinese steel in the 2000s will be revisited with the impact of Chinese steel scrap. There are various anticipated results, including a decline in global iron ore demand and prices, the rise of the steel industry in India and the Middle East based on EAF, and a shift in advanced country-led global steel scrap trade. The time is coming when a steel giant that has grown by absorbing global resources must release what it has accommodated. For this reason, close attention should be paid to the Chinese government's macroeconomic and industrial policies, subsequent changes in its economic and steel industry structures, and shifts in production methods and technologies.