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Where is the Excess Capacity in the World Iron and Steel Industry? –A focus on East Asia and China–

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Where is the Excess Capacity in the World Iron and Steel Industry? –A focus on East Asia and China– *

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Abstract

The purpose of this study is to identify the location of excess capacity in the world iron and steel industry. Excess capacity is a production capacity that is inferior in competition, surviving due to factors other than competitive advantages, under the condition that world production capacity exceeds demand.

As a result of analysis, China was found to have the highest scale of excess capacity, while NAFTA (North American Free Trade Agreement) members, Europe, CIS (Commonwealth of Independent States) members, Japan, South Korea, and ASEAN (Association of Southeast Asian Nations) members were found to have a moderate scale of excess capacity. In China, Russia, Ukraine, Japan, and South Korea, excess capacity coexists with large-scale steel exports. However, excess capacity is considered to promote the exports of low value-added steel products only in China, Russia, and Ukraine. The iron and steel industry in China is not necessarily export-oriented, and its capacity utilization rate is not low compared with other regions. However, the production scale in China is outstanding among all economies. As a result, the scale of excess capacity and steel exports are the largest in the world. Moreover, low value-added products occupy a high share in the total iron and steel exports from China. In the cases of Russia and Ukraine, iron and steel industries are export-oriented. Furthermore, compared with China, low-value added products constitute a higher proportion in their export mix. However, the scale of excess capacity and exports are lower than China, in parallel with their production scale. In the cases of Japan and South Korea, iron and steel industries are export-oriented. However, the most exported products are high-grade flat products and high-grade host materials for business partners and subsidiaries abroad. In other words, the steel exports from Japan and South Korea are not commodity-based.

An increasing number of construction projects involving steelworks is in progress or being planned worldwide, especially in Asia. Thus, reduction of excess capacity would become difficult. Furthermore, as state-of-the-art technologies will be embodied in newly installed steelworks, the competition for survival in the iron and steel industry will intensify in the future.

Keywords: Iron and steel industry, Excess capacity, Steel trade, Global value chain

JEL classification: F14, L61

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I Preface

1 Purpose of this Paper

The purpose of this paper is to identify the location of excess capacity in the global iron and steel industry. For this purpose, the analysis is done in three geographical dimensions: world, region, and country. This paper focuses on the first two, the world and on the region of East Asia, specifically.[1] In addition, this paper proposes a theoretical aspect to grasp excess capacity. For a total investigation of excess capacity, the mechanism of emergence and continuance, economic and social effects, possibility and prospect of elimination should be investigated. This paper is the first step of such studies.

2 Survey of Previous Studies

Locational identification of excess capacity is a valid issue because it is an unexplained issue and few studies are available on the topic.

The first step is the definition of excess capacity. The OECD Steel Committee, which is engaged in this policy issue, considers excess capacity as the difference between production capacity and demand (OECD [2016]). In this committee's discussion, various member countries indicate the necessity to reduce excess capacity in China. However, reports by the committee do not specify the geographical distribution of excess capacity (Sekiguchi et al. [2016], Carvalho et al. [2015]).[2] This is not due to a lack of analytical capacity, but instead the result of political considerations to maintain the field of multilateral negotiations.

Brun [2016] shows the most detailed analysis of excess capacity of the iron and steel industry. This paper uses the term "overcapacity" to have the same meaning as excess capacity as used in OECD reports. According to Brun [2016], overcapacity is industrial capacity not utilized by production. This paper calculates the volume of excess capacity in the world and in each region by deducting production volume from existing production capacity. This definition can be supported, although the implication of this definition should be clarified.

The second issue is the promotional factor of excess capacity. Several policy reports indicate that market distortion due to governmental intervention triggers excess capacity and that the strongest contributor is actions by the Chinese government. Specifically speaking, governmental intervention

[1] In this paper, East Asia includes Japan, South and North Korea, Mainland China, Taiwan, Mongolia, and ASEAN economies.

[2] The OECD Steel Committee virtually treats only the worldwide situation of excess capacity. In a worldwide base, neglecting inventory fluctuation, demand equals production. Therefore, the OECD definition can agree that excess capacity is the difference between capacity and production.

in China includes state ownership involvement in corporate decision making, direct support by low-interest loans and grants, indirect support by low-priced sales of energy and land, administrative bailouts to stop shutdowns of low-performing factories, debt refinancing, and debt-equity swap, among other actions (Price, Weld, El-Sabaawi and Teslik [2016], Brun [2016], Steel Industry Coalition [2016]). Of course, the causal connection between governmental intervention and excess capacity is an important issue.

In the meantime, there is some range of variation about the importance of governmental intervention among promotional factors for excess capacity. In policy reports on trade issues published in importing countries, governmental intervention is a main target of criticism. Price et al. [2013], compiled for the American Iron and Steel Institute (AISI) and the Steel Manufacturers Association (SMA) and its new version, Price et al. [2016], are typical examples. Price et al. [2016] criticizes not only production promotion policies but also structural adjustment policies by the Chinese government as leading the investment into new facilities and the increase of total production capacity.

Brun [2016] is more analytical than the Price et al. [2016]. This paper indicates that there are two kinds of overcapacity. One is "cyclical overcapacity," caused by variability of demand that includes cyclical demand in one economy or uneven change among economies. The other is "structural overcapacity" caused by overinvestment due to non-price factors. Following Carvalho et al. [2015] published by the OECD Steel Committee, Brun [2016] considers non-price factors as overinvestment induced by governmental behavior, exit barriers, and investment barriers. This assumption seems to be balanced and inclusive.

In addition, the author places emphasis on the cyclical switch between overinvestment and investment shortage caused by the price factor, which is considered "cyclical overcapacity" by Brun [2016]. In the history of the iron and steel industry, latecomer economies have caught up with the frontrunners and overtook them. For steel producers, the burden of transportation cost is great because steel products are heavy and bulky. For this reason, the iron and steel industry in a developing economy usually orients for import-substitution at first. However, a latecomer has to install large-scale steelworks that embody state-of-the-art technologies to catch-up with the frontrunner, whether or not it receives governmental support (Abe and Suzuki eds. [1991], Sato [2016]). As Brun [2016] indicated, the iron and steel industry is capital intensive, and has a long investment time horizon. The investment for import-substitution induces the issue of keeping high capacity utilization in the face of market fluctuation. Therefore, the steel producer in a latecomer economy tends to try to export products in the second stage of development. In short, active construction of the iron and steel industry in developing economies tends to induce an excess capacity situation in the world. As a result of the competition to survive, steel production and

employment will increase in some areas, and decrease in other areas. Diffusion of new and alternative technologies induces the unevenness of this process (D'Costa [1999]). From the perspective of catch-up and restructuring, reduction of excess capacity is not a short-term, frictional adjustment in the market, but an ordinary form of international competition that persists as long as developing economies try to build an iron and steel industry for their industrialization. Excess capacity as a product of catch-up and restructuring is structured in the world economy in a different sense from Brun [2016]. One the one hand, as shown by Brun [2016] and trade issue reports, excess capacity is a product of market distortion. On the other, however, it is a product of ordinary international competition in the form of catch-up and restructuring. Governmental intervention should be placed in this dynamism. Moreover, in the restructuring process, we should pay attention to not only the process that overinvestment leads to excess capacity, but also the process that production capacity in some regions falls into excess capacity as a result of competition for survival.

The third issue is the relation between excess capacity and steel exports. Brun [2016] indicated that a firm with excess capacity has an incentive to export products with low prices to keep a steady rate of capacity utilization and recovery of fixed costs, quoting the past periods of excess capacity (Brun [2016] p. 21, 23). However, there is no sufficient theoretical base that excess capacity directly leads to an export drive. It is possible that excess capacity leads to lowering the capacity utilization. This can be identified by the combination between the existence of having excess capacity and no export. Moreover, export from an economy with excess capacity does not necessarily mean a dumping export drive to keep capacity utilization. It might be the export of a high-grade product or a specialized product that cannot be produced in the importing economy. Such a case can be identified based on the steady share of high-grade and specialized products in the exports. After deducting such cases, the regions and products in which excess capacity promotes low-priced exports will be specified.

The analytical perspectives of this paper are configured based on the three points mentioned above.

3 Analytical Perspectives and Research Methods

(1) Analytical Perspectives

The lesson absorbed from examination of previous studies is that specifying the location of excess capacity with competitive disadvantage is needed for the progress of research on excess capacity in the world iron and steel industry. This is the basic perspective of this paper.

In other words, excess capacity should be considered not only as a situation that capacity is larger than demand but also the specific capacities with competitive disadvantage. The total market situation in which capacity is larger than demand is a presumption of the existence of excess capacity. However, more specifically, excess capacity is the relatively inferior production capacity that would be overwhelmed under competition with advantages of cost, quality, delivery, and service. In other words, excess capacity is a production capacity preserved by factors other than competitive advantages. Governmental assistance is one of important non-competitive factors; but it is not the only factor. At the least, the high exit barrier that Brun [2016] acknowledged, the low entry barrier, the continuous entry behavior, and monopoly by market concentration should all be considered as possible factors.

The analytical unit of excess capacity should coincide with the scope of competition. In the current iron and steel industry, this is the world market. On that basis, in parallel with the degree of division by transportation costs and other trade barriers, excess capacity in each region and economy can be discussed. Only in the world economy, can excess capacity be considered as a difference between capacity and demand. This definition is misleading at the regional and national level. Under this definition, ordinary exports that reflect the market balance and competitive advantages are misidentified as a result of excess capacity.

In general, excess capacity can generate as a result of an increase in capacity induced by capital investment, or a result of shrinkage of demand. The former configuration fits the current situation in the world iron and steel industry because production capacity has increased enormously. This mechanism of excess capacity emergence as a result of capacity increase is modeled in Figure 1.

Assume that a steel market size is 80 units and that there are 100 units of production capacity. In Figure 1, the production facility is ranked from the top and down along with the level of productivity. In that case, the volume of excess capacity is 20. Therefore, 20 units of capacity from the bottom are excess capacity. Next, if we assume that 20 units of capacity were added by capital investment without a change in total market size, total production capacity becomes 120 units. Therefore, 40 units from the bottom are excess capacity.

Moreover, assume that the new investment adds a state-of-the-art facility with the highest productivity (“New” in Figure 1). This investment exacerbates the excess capacity situation. However, the added facility itself is not excess capacity because its productivity is higher than other facilities. Instead, 20 units of the worst capacity that could be operated before the investment will cease and fall into excess capacity (“Old2”in Figure 1).

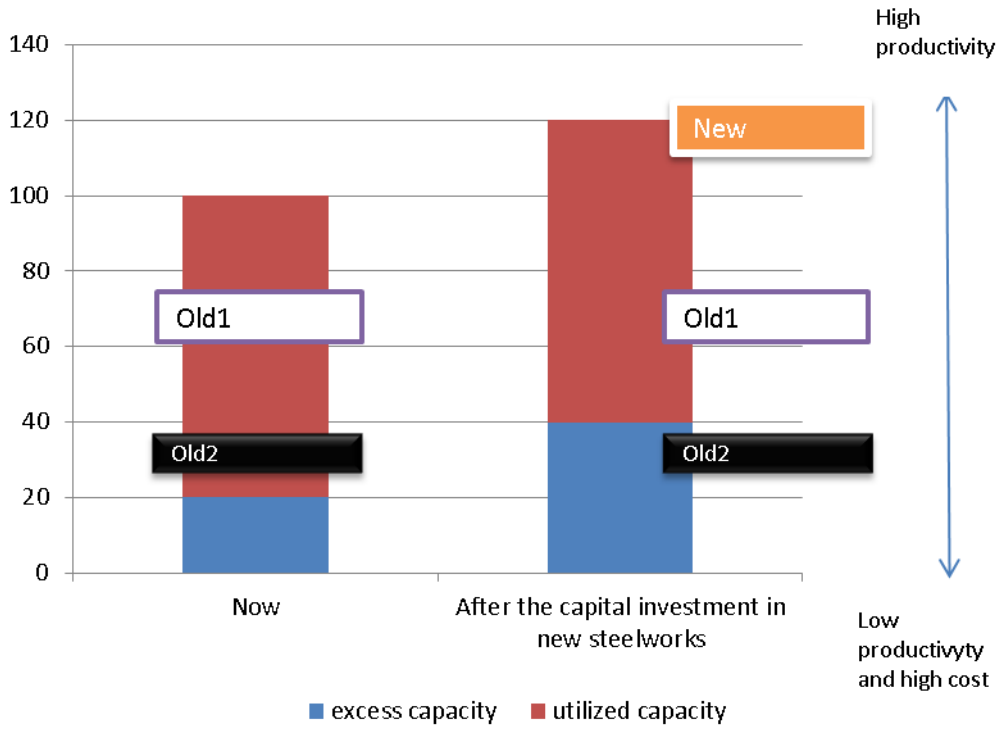

Figure 1. Competition Dynamics by Capital Investment under an Excess Capacity Situation

Source: Compiled by Author.

As this model shows, capital investment under an excess capacity situation not only increases the volume of excess capacity, but also triggers competition among enterprises for the status of operating capacity and the fall into excess capacity.

(2) Research Methods

It is difficult to measure productivity and cost for enterprises all over the world with the same criteria. Therefore, this paper considers unutilized production capacity as a simple indicator of excess capacity, assuming that effective competition does work in the world steel market. Though it is the same criteria as in Brun [2016], this paper has a steadier theoretical base as described earlier. Additionally, this study pays attention to two points.

The first is the ceiling of capacity utilization. Usually iron and steel works cannot reach 100% of utilization rate even in a boom period. Therefore, the volume of unutilized capacity does not necessarily equal excess capacity. Given that the highest record of utilization rate after the 2000s was 91% (Carvalho et al. [2015] p.8), effective production capacity is 91% of nominal production

capacity. The difference between effective capacity and production can be considered as effective excess capacity. However, nominal unutilized capacity is also useful as an easy-to-use indicator of the trend of excess capacity, because the volume of unutilized capacity (nominal excess capacity) changes in the same direction with effective excess capacity.

The second point is the relation between unutilized capacity and steel exports. Today, trade frictions are reported from various regions of the world. Under this situation, it is necessary to investigate whether excess capacity is simply stopping operation or deliberately operating to export low-priced products. For that purpose, we should notice when a region with large-scale unutilized capacity makes mass exports, especially in specific products. Additionally, we should know whether exported products are low value-added commodities or special valued products that are indispensable to customers. To solve these issues, it is necessary to utilize the results of qualitative case analysis on the nature of the production facility and the trade.

For statistical data, 2015 figures are used as much as possible. Production capacity data is quoted from the OECD database. If that is not possible, the official statistics of government and regional or national industry association are used. Regarding data on production, consumption, and trade, statistics of the World Steel Association (worldsteel) are preferentially used. For detailed trade data, however, we rely on the data prepared by the Japan Iron and Steel Federation from customs statistics of each economy.

(3) Structure of this Paper

Section II gradually identifies the location of excess capacity based on the analyses of supply-demand balance and steel exports. Section III continues those analyzes with a focus on the East Asia region, especially Japan, China, and South Korea. Section IV contains the conclusion and the prospect for subsequent research.

II The Change of Supply-Demand Relation and Excess Capacity in the World Iron and Steel Industry

1 Products, Processes, and Production system of the Iron and Steel Industry

This sub-section explains the products, processes, and enterprise types of the iron and steel industry for non-specialists of that industry. Figure 2 displays them graphically.

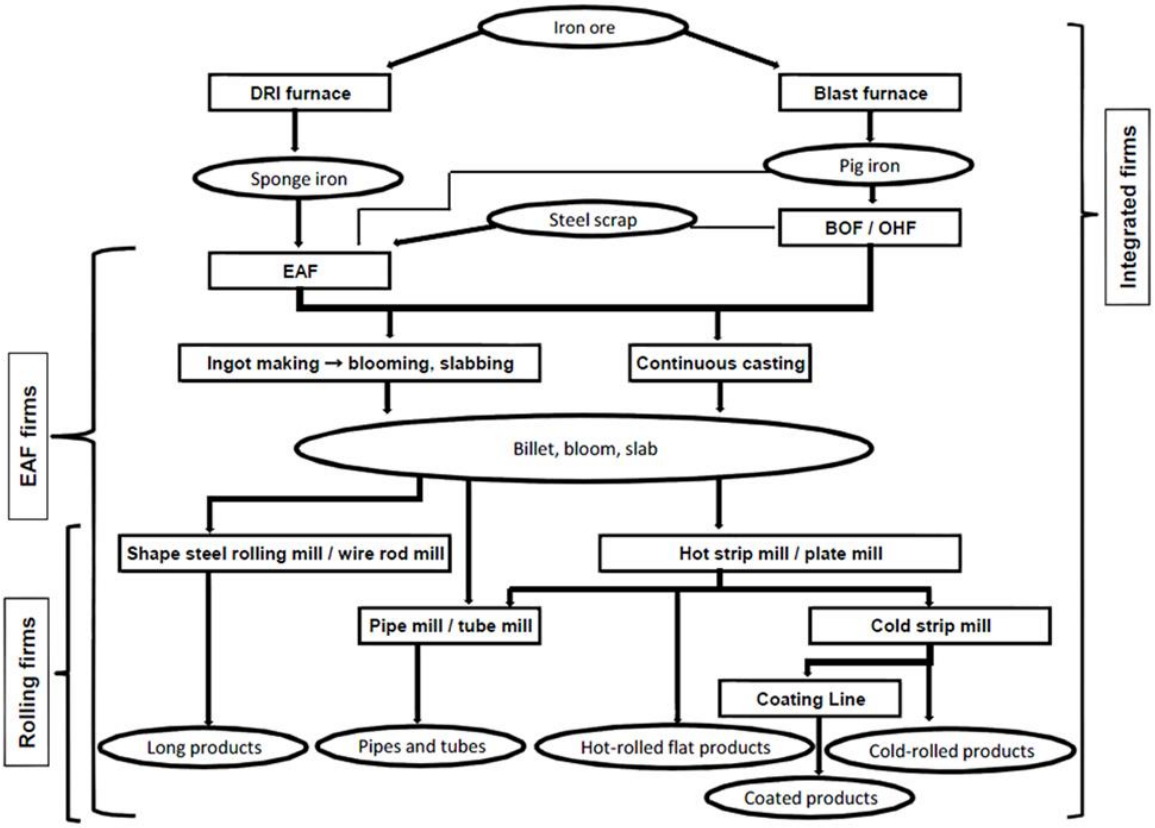

Figure 2. Production Processes, Products, and Types of Enterprises in the Iron and Steel Industry
Note: Rectangles indicate major production facilities, while the ovals depict inputs and/or outputs
Source: Sato [2009], p.7.

(1) Features of Steel Products

The iron and steel industry produces various steel products from iron ore and/or steel scrap as major materials. Steel products are classified into main categories according to form. The major category is long products, flat products, and pipe products. Another classification is by ingredient such as alloy steel and non-alloy steel, ordinary steel and specialty steel. Apart from steel products, cold pig iron and semi-products are traded.

In the middle category level, the long products category contains rail and accessories, bars, wire rods, and shapes. There are some high-grade varieties in long products, like machinery structural steel, special screws, and high-tensile wire rods for steel cords. Quantitatively, however, these products have only a minor share. Most long products are construction steel that contains concrete bars, wire rods, and small shapes. They can be produced with proven technology by small and

medium enterprises. In general, long products are considered low value-added products. Flat products contain plates, hot rolled sheet products, cold rolled sheet products, and surface treated sheet products. Compared to long products, higher share of flat products are used for manufacturing that have a high requirement of quality. Plates for shipbuilding, high-tensile hot rolled sheets for car body structures, and surface treated sheets for car body panel are examples of high-grade flat products. Moreover, the production process of flat products is long and multistage. For that reason, flat products are considered high value-added in general. Pipe products contain welded and forged pipes, and seamless pipes. The grade range is very wide in pipe products. An example of low-grade pipe is pipe for scaffolding. Pipes for resources development are examples of high-grade products.

(2) Features of the Production Processes of Iron and Steel

The production of iron and steel contains multistage processes. The ironmaking process converts iron ore into pig iron with a blast furnace (BF) or other types of reducing furnace. The steelmaking process refines pig iron and/or scrap into crude steel with a basic oxygen furnace (BOF) or electric arc furnace (EAF), and continuously casts the melted crude steel into semi products. The rolling process rolls semi products into various forms of steel products. The tubing process (similar to the rolling process) makes various pipes by forging, welding, or boring the steel. The process of surface treating coats or/and paints materials on the surface of steel products. Rolling, tubing, and surface treating are multistage processes. In each process, some outputs become final products and others go on to a next process. In the case of flat products, a typical sequence is steelmaking, hot rolling, cold rolling, and surface treating. In the case of seamless pipe, the typical processes are steelmaking followed by tubing. For welded or forged pipe, the sequence is steelmaking, hot rolling, and tubing.

Because ironmaking and steelmaking are chemical processes, the major production facility is mechanized apparatus like ovens and furnaces. For apparatus, economies of scale work strongly, and the major direction of technological progress is an expansion of size. Rolling and tubing change the shape of a solid host material. In surface treating, host material is already formed. For such downstream processes, technological progress is not necessarily sizing up. On the one hand, more room is needed for rolling machines to widen a strip and reinforce the rolling power. On the other hand, more compact machines with the same power can be available and desirable. Moreover, technology can take other directions, like speeding up a process or combining processes.

More specifically, most flat and pipe products share hot rolling as a first rolling process. After the hot rolling, the processes deliquesce. Therefore, economies of scale do work in a hot strip mill.

Its major direction of progress is size expansion. In cold rolling, surface treating, and tubing processes, smaller scale machines can work.

(3) Typology of steel enterprises based on production system

In the iron and steel industry, two major production systems are observed: integrated production with BF and semi-integrated production with EAF (mini mill). An integrated steel mill is an enterprise that adopts an integrated production system to integrate ironmaking, steelmaking, and rolling processes vertically in the same enterprise. This system needs economies of scale, especially in the ironmaking and steelmaking processes, and fits mass production. According to the empirical rule, the minimum optimum scale of newly constructed integrated steelworks is 3 million tons of annual production in crude steel. As we shall discuss later, most mega steel companies in the world are integrated enterprises. On another front, integrated system enables the production of high-grade steel products with carefully refining. For example, most outer panels of cars are produced by integrated production systems.

A mini mill is a steel enterprise that adopts a semi-integrated production system with EAF and makes crude steel from steel scrap. The major products of mini mills are long products for construction, although some mills are expanding their product mix to flat products. Moreover, some mini mills are producing specialty steel. On the one hand, a mini mill is suited for multi-products and small lot production because the minimum optimum scale of newly constructed min mill is only 500 thousand tons per annum for ordinary steel and smaller than that for specialty steel. On the other, there is a ceiling on quality upgrading for mini mills because of the harmful tramp elements in scrap. Under these conditions, there are two types of mini mills. One is a mini mill for volume production of ordinary construction steel and other is mini mill for multi products with small batch production of specialty steel. Each of them has a smaller production scale than an integrated mill. But some mini mill enterprises are big business, holding many semi-integrated works.

Apart from integrated and mini mills, there are some varieties of enterprises in downstream processes, such as hot rolling enterprises, cold rolling enterprises, and surface treating enterprises. Some of them are partially integrated like one enterprise that does cold rolling and surface treating. There is a room for growth in those companies because the steel production processes extensively branch downstream.

The share of crude steel production by converter approximately represents the production share of integrated enterprises. In 2015, the share was 74.2% in the world, 77.1% in Japan, 69.6% in South Korea, 93.9% in China (worldsteel [2016a] p.18). In East Asia, integrated enterprises are major producers.

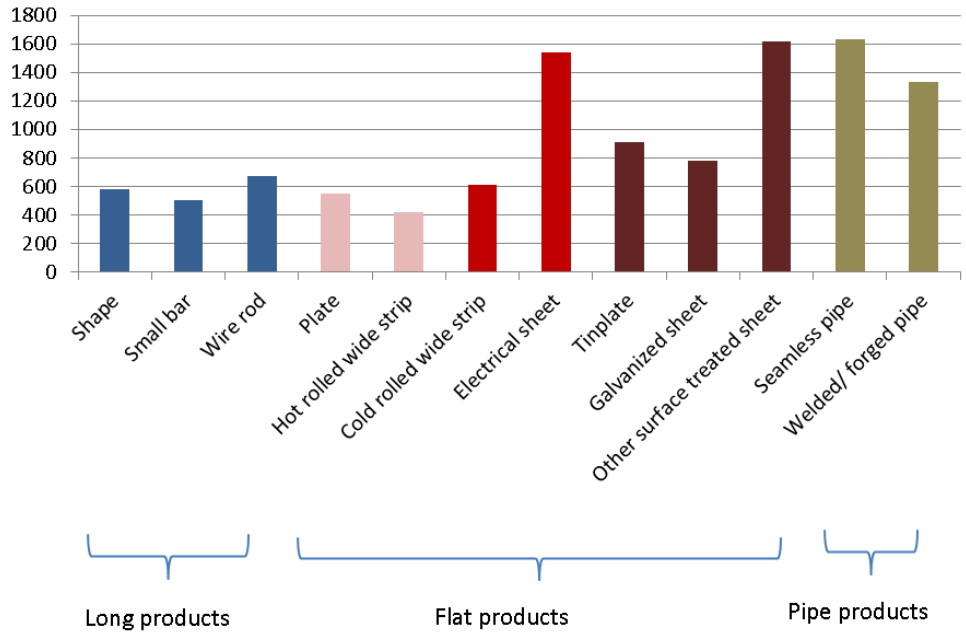

Figure 3. Unit Export Prices of Ordinary Steel Products in Japan in 2015

Unit: US Dollar per ton.

Note: Item coding is based on small category. Color coding is based on middle category.

Source: Author compiled it from JISF [2016] pp.142-143.

(4) Value-Added of Steel Products

Figure 3 shows the unit prices of exported ordinary steel products from Japan to reveal the relations of value-added of steel products and multistage production processes. At a glance, it is clear that flat and pipe products are higher value-added than long products, after considering long products from Japan concentrates in relatively high grades. Moreover, value is added in each step of the production process. For example, cold wide strip is produced by rolling hot wide strip. An electrical sheet is produced by special treating of a cold rolled sheet. Tinplate, galvanized sheets and other surface treated sheets are produced by surface treating cold wide strips (in some cases, hot wide strips). Welded and forged pipes are produced by welding/forging plates or hot rolled sheets (in some cases, cold rolled sheets). In Figure 3, it is clear that value is added after all of those processes.

2 Excess Capacity and Corporate Performance

The global production capacity of steel is surveyed by OECD on a continuous basis. According to this survey, total crude steel production capacity reached 2.374 billion tons in 2015, compared to

1.046 billion tons in 2000. In the same period, crude steel production increased to 1.62 billion tons from 849 million tons, according to a survey by worldsteel. In Figure 4, data of capacity are superimposed on crude steel production records. The growth of production capacity was larger than that of production records. As a result, capacity utilization decreased from 81.1% to 68.3%. Unutilized capacity (nominal excess capacity) increased from 197 million tons to 751 million tons. Effective excess capacity that was estimated by subtracting steel production from effective production capacity was 131.3 million tons in 2000. After that, it contracted temporarily, but increased again after the world financial crisis, again exceeding 100 million tons in 2008, and reaching 537.35 million tons in 2015.

The growth of excess capacity was a direct result of greater capacity expansion. Most expansion was done in non-OECD economies. According to the data from OECD, the increment of capacity from 2000 to 2013 was 1.165 billion tons in non-OECD economies, compared to 62 million tons in OECD economies.[3] Though harmonized statistics are not available, the increment of crude steel

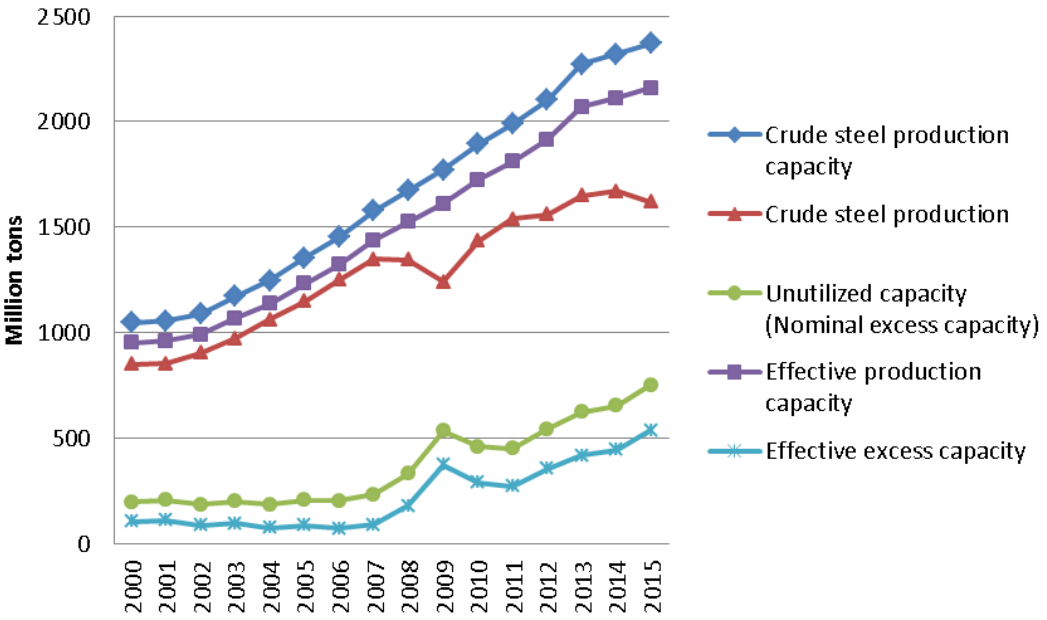

Figure 4. World Crude Steel Production Capacity, Production, and Excess Capacity

Source: Author compiled with data from OECD, World Crude Steelmaking, December 2015, worldsteel [2016a].

[3] OECD, World Crude Steelmaking Capacity, December 2015 (http://www.oecd.org/sti/ind/1.1Worldcrudesteelmakingcapacity.xlsx), retrieved in August 4, 2016.

production capacity in China was 957 million tons in the same period.[4] Even considering possible error, 70–80% of the increment of capacity was attributable to China. If China had been only investor in production capacity, 200 million tons or more excess capacity would have occurred in 2013. Based on that calculation, the rapid expansion of production capacity in China was a major cause of the growth of excess capacity in the world.

However, this does not mean that all of the existing excess capacities are in China. If expansion in China was based on competitive advantages, it debased some capacities in other economies and/or old facilities in China into excess capacity. If added capacities in China had no competitive advantages, excess capacity inside China was accumulated. This is an important issue.

Massive excess capacity promoted the lowering of steel prices. According to World Steel Dynamics (WSD), which supplies business data for the world steel industry, recent prices of hot coil (hot wide strip in coil), represented by FOB price in the United States and factory gate prices in Western Europe and China, peaked in the summer of 2008 and dropped sharply after that, recovered for several years, fell again after 2011, and dropped at a higher rate in 2015. The factory gate price in China was 259 dollars, and the FOB price in the United States was 478 dollars in October 2015, which were about half of the prices in 2011 (WSD [2015] p.198).

The plunge in the price of steel after 2011 was partially the result of the price decline for iron ore and bituminous coal. The spread between the price of hot coil in China and the cost of producers in China showed positive in most months until the end of 2013.[5] In 2014, as the falling speed of costs was higher than that of price, the spread expanded until it was 60 dollars per ton. However, the effect of the falling product prices exceeded the effect of falling material prices in 2015. The spread fell negative after February 2015 and bottomed at −60 dollars per ton (WSD [2015] p.200).

In 2015, the performance of steel enterprises dropped in many economies. Table 1 shows the return on sales of the world's top fourteen companies with 20 million or more in production in 2014 and 2015. Almost every company except Tata Steel and Hyundai Steel ran in the red or reported declines in profits.

[4] China Iron and Steel Association (CISA) [2001] p.212, CISA [2014] p.107.
[5] Operation cost of medium sized Chinese steel producer plus 8% of value added tax and 20 dollars of transportation cost until port.

Table 1. Financial Performance of the Major Iron and Steel Enterprises in the World, 2014-2015

Rank	Enterprise	Crude steel production (mill. tons)	Economy	State-owned (+)	Net profit to sales		Note about net profit
					2014	2015	
1	Arcelor Mittal	98.09	Luxembourg and others		−1.4%	−12.5%	Consolidated. All regions
2	Nippon Steel & Sumitomo Metal	49.30	Japan		3.8%	-	Consolidated in fiscal year
3	Hebei Iron and Steel Group	47.09	China	+	0.7%	0.8%	Hebei Iron and Steel Co. Ltd.
4	Baosteel Group	43.35	China	+	3.1%	1.8%	Baoshan Iron and Steel Co. Ltd.
5	POSCO	41.43	South Korea		0.9%	−0.2%	Consolidated
6	Jiangsu Shagang Group	35.33	China		0.3%	−1.1%	Jiangsu Shagang Co. Ltd.
7	Ansteel Group	34.35	China	+	1.3%	−2.1%	Angang Steel Co. Ltd.
8	Wuhan Iron and Steel (Group)	33.05	China	+	1.2%	−2.0%	Wuhan Iron and Steel Co. Ltd.
9	JFE Steel	31.41	Japan		3.6%	-	Consolidated net profit of JFE Holdings in fiscal year
10	Shougang Group	30.78	China	+	0.3%	−4.1%	Beijing Shougang Co. Ltd.
11	Tata Steel	26.20	India		15.4%	13.1%	Non-consolidated in fiscal year
12	Shandong Iron & Steel Group	23.34	China	+	−2.7%	−2.4%	Shandong Iron and Steel Co. Ltd.
13	Nucor	21.41	USA		3.4%	2.2%	
14	Hyundai Steel	20.58	South Korea		4.7%	8.4%	Non-consolidated

Source: Author compiled from worldsteel [2015b], materials from JISF, and financial data of various companies.

3 Supply-Demand Relations and World Trade

(1) Inter-Regional Balance of Supply and Demand

Table 2 shows the inter-regional balance of supply and demand of steel in 2006 and 2015. It is clear that Asia is very strong in the world iron and steel industry. Asia has a 68.7% share of crude

steel production and a 64.2% share in apparent steel consumption.[6] East Asia's share is especially large, with 63.0% in production and 57.9% in consumption. The production shares of the 28 countries of the EU (EU28), North and Central America, and the CIS, the major steel producing areas in the 19th and 20th centuries, were 10.3%, 6.8%, and 6.3% respectively. Moreover, they show a declining trend.

Table 3 is an abstract of supply-demand balances. It shows the significant change of the balances and the varieties of the direction and scale in the balances in the last nine years.

In Asia, including the large-scale producing economies of Japan, China, South Korea, and India, the surplus increased from 19.427 million tons to 74.355 million tons. Both production and consumption increased, while the former exceeded the latter. The surplus in this region is the largest of all regions. These features of Asia are dominated by East Asia as a result of the growth of production and consumption after 2006; while in South Asia, the situation changed from balanced to a shortage.

Table 2. Supply and Demand of Steel in the World (1)

	Crude steel production		Share of production		Crude steel consumption		Share of consumption		Self-sufficiency ratio	
	2006	2015	2006	2015	2006	2015	2006	2015	2006	2015
Asia	675,226	1,112,872	54.0%	68.7%	655,799	1,038,517	52.6%	64.2%	103.0%	107.2%
East Asia	624,706	1,020,824	50.0%	63.0%	602,048	936,840	48.3%	57.9%	103.8%	109.0%
South Asia	50,520	92,048	4.0%	5.7%	53,751	101,677	4.3%	6.3%	94.0%	90.5%
North and Central America	131,421	110,945	10.5%	6.8%	182,952	156,550	14.7%	9.7%	71.8%	70.9%
South America	45,269	43,899	3.6%	2.7%	39,303	46,860	3.2%	2.9%	115.2%	93.7%
EU28	207,386	166,115	16.6%	10.3%	208,289	167,491	16.7%	10.4%	99.6%	99.2%
Other Europe	28,124	36,178	2.2%	2.2%	29,776	43,024	2.4%	2.7%	94.5%	84.1%
CIS	119,908	101,552	9.6%	6.3%	57,069	56,716	4.6%	3.5%	210.1%	179.1%
Oceania	8,691	5,717	0.7%	0.4%	8,730	8,173	0.7%	0.5%	99.6%	69.9%
Africa	18,695	13,701	1.5%	0.8%	23,954	42,033	1.9%	2.6%	78.0%	32.6%
Middle East	15,376	29,429	1.2%	1.8%	40,194	57,448	3.2%	3.6%	38.3%	51.2%
World Total	1,250,098	1,620,408	100.0%	100.0%	1,246,067	1,616,813	100.0%	100.0%	100.0%	100.0%

Unit: Thousand tons.

Note: "World Total" does not necessarily show a total of each column due to rounding off.

Source: Author compiled from worldsteel [2016a].

[6] Apparent consumption is calculated by production plus import minus export. It is the most major indicator of consumption. Fluctuation of inventory and indirect trade are neglected. Apparent consumption is calculated after converting exports and imports recorded as weights of various steel products into crude steel by a certain coefficient.

Table 3. Supply and Demand of Steel in the World (2)

	Balance (thousand tons)		Chang of production and consumption			Shortage or surplus
	2005	2014	Production		Consumption	
Asia	19,427	74,355	Increase	>	Increase	Surplus→Surplus
East Asia	22,658	83,984	Increase	>	Increase	Surplus→Surplus
South Asia	−3,231	−9,629	Increase	<	Increase	Balance→Shortage
North and Central America	−51,531	−45,605	Decrease	<	Decrease	Shortage→Shortage
South America	5,966	−2,961	Flat		Increase	Surplus→Balance
EU28	−903	−1,376	Decrease		Decrease	Balance→Balance
Other Europe	−1,652	−6,846	Increase	<	Increase	Balance→Shortage
CIS	62,839	44,836	Decrease	=	Flat	Surplus→Surplus
Oceania	−39	−2,456	Flat		Flat	Balance→Balance
Africa	−5,259	−28,332	Flat		Increase	Shortage→Shortage
Middle East	−24,818	−28,019	Increase	<	Increase	Shortage→Shortage
World Total	4,031	3,595	Increase	=	Increase	

Note: In this table, surplus is equal to extra-regional export. Shortage is equal to extra-regional import.

Source: Author compiled from worldsteel [2016a].

In North and Central America, the shortage decreased from 51.5 million tons to 45.6 million tons. However, as of 2015, the shortfall was the largest among all regions. South America switched from a surplus of 6.0 million tons to a shortage of 3.0 million tons. Production was flat, but consumption increased. In the EU 28, the supply and demand was balanced in both 2006 and 2015 and both production and consumption declined. The CIS had the largest surplus of 62.8 million tons in 2006, but it decreased to 44.8 million tons in 2015. Production declined and consumption increased. However, it still generated a large surplus behind Asia. Both Africa and the Middle East showed a shortage of over 20 million tons. Consumption increased in Africa with flat production, while in the Middle East, the increase in consumption exceeded the increase in production. Both regions can be considered emerging steel markets.

Table 4 compares the production capacity of crude steel with production to analyze the operation status of facilities. This table is compiled from data in 2014 because the data in 2015 are not available. It is noteworthy that 67.0% of the world's production capacity and 63.7% of the world's unutilized capacity are concentrated in Asia. Asia is the center of the world iron and steel industry both in production and consumption, capacity to operate, and unutilized capacity. Outside of Asia, the European OECD members, members of NAFTA and the CIS have a large unutilized capacity; though combined, they are less than half of Asia.

Table 4. Crude Steel Production Capacity and its Operating Condition by Region in 2014

	Crude steel production capacity	Share of capacity	Crude steel production	Capacity utilization rate	Unutilized capacity	Share of unutilized capacity	Apparent consumption of crude steel
OECD Europe	281.0	12.1%	201.5	71.7%	79.5	12.2%	191.9
non-OECD Europe	8.3	0.4%	6.2	74.7%	2.1	0.3%	9.6
CIS	146.7	6.3%	106.1	72.3%	40.6	6.2%	63.0
NAFTA	160.4	6.9%	119.9	74.8%	40.5	6.2%	165.2
Latin America	69.6	3.0%	46.3	66.5%	23.3	3.6%	55.0
Africa	33.9	1.5%	15.0	44.3%	18.9	2.9%	39.9
Middle East	58.1	2.5%	30.0	51.6%	28.1	4.3%	56.5
Asia	1,554.6	67.0%	1,139.7	73.3%	414.9	63.7%	1,073.4
Oceania	9.1	0.4%	5.5	60.1%	3.6	0.6%	8.4
Total	2,321.6	100.0%	1,670.1	71.9%	651.5	100.0%	1,662.9

Unit: Million tons.

Source: Author compiled from OECD, World Crude Steelmaking Capacity (http://www.oecd.org/sti/ind/1.1Worldcrudesteelmakingcapacity.xlsx), updated December 2015, worldsteel [2015a].

However, the next thing to note is that the absolute size of the unutilized capacity does not match the low utilization rate. The utilization rate in Asia is 73.3%, which is higher than the world average. However, due to the concentration of production capacity, it is the largest source of excess capacity.

(2) Steel Trade in the World

Table 5 shows the supply-demand relationship from the perspective of world steel trade. Looking at this, we can see that intra-regional trade both in Europe and Asia account for a large proportion of the world steel trade. The former has reached 122.9 million tons; the latter has reached 129.5 million tons, and when they are combined, the share in world trade accounts for 52.9%. The intra-regional trade of NAFTA economies also exceeds 10 million tons each, although it is much smaller than Europe and Asia.

The major exporters in extra-regional trade are Asia, Europe, and the CIS, while the major importers are NAFTA members, Europe, the Middle East, and Africa. Among the net exporting regions, the net export ratio in Asia is only 6.2% of production, but the net export volume is the largest at 69.5 million tons. On the other hand, the net export ratio of the CIS is 38.6%, higher than

Table 5. World Steel Trade Matrix in 2015

Import side / Export side	Europe	CIS	NAFTA	Other America	Africa	Middle East	Asia	Oceania	Export total	Of which extra-regional export	Of which extra-regional net export	Extra-regional net export to crude steel production
Europe	122.9	1.7	9.8	2.5	10.5	6.7	4.6	0.2	158.9	36.0	−10.9	
CIS	23.3	8.7	3.1	0.6	6.8	4.7	4.4	0	51.6	42.9	39.2	38.6%
NAFTA	0.4	0	17.4	1.3	0.2	0.1	0.5	0	19.9	2.5	−35.6	
Other America	3	0	6.4	2.9	0.4	0.2	1.8	0	14.7	11.8	−3.7	
Africa and Middle East	1.5	0	0.6	0	1.6	0	0.8	0.1	4.6	3.0	−55.9	
Asia	18.6	2	17.8	11.1	11.9	17.3	129.5	3.2	211.4	81.9	69.5	6.2%
Oceania	0.1	0	0.4	0	0	0.1	0.3	0.3	1.2	0.9	−2.6	
Import total	169.8	12.4	55.5	18.4	31.4	29.1	141.9	3.8	462.3			
Of which extra-regional import	46.9	3.7	38.1	15.5	29.8	29.1	12.4	3.5				
Of which extra- regional net import	10.9	−39.2	35.6	3.7		55.9	−69.5	2.6				
Extra-regional net import to apparent consumption of finished steel	5.6%		26.6%	8.1%		61.1%		36.0%				

Unit: Million tons.

Note: Exports and imports contain finished and semi-finished products.

Source: Author compiled from worldsteel [2016a] [2016b].

that of Asia. Of the net importers, NAFTA members' dependence on net external imports is 26.6%, compared to Africa plus the Middle East at 61.1%. Excluding intra-regional trade, net exports exceeding 10 million tons in individual inter-regional trade are from Europe to Middle East/Africa, from the CIS to Europe, from Asia to Europe, NAFTA members, and the Middle East/Africa. In other words, the major flows of steel trade consist of intra-regional trades in Europe and Asia, flows to neighboring areas with historical relationships, and flows from Asia to various regions. When all the flows are summed, Asia and the CIS are net export regions, while NAFTA countries, the Middle East and Africa are net importers.

4 Conclusion of this Section

Based on the analysis so far, the conclusion of this section is as follows.

The utilization rate of crude steel production facilities of the world iron and steel industry is 68.3%, the lowest level since 2000. There is nominal excess capacity of about 751 million tons and effective excess capacity of 537 million tons. The excess capacity exacerbates the supply-demand relationship and has led to a worldwide fall in the prices of steel products and the profitability of steel companies.

Asia is the center of world in steel production and consumption. However, high pace of expansion in production capacity has led to a concentration of half of the unutilized world capacity. Asia’s net export ratio to the outside is merely 6.2% of production but the quantity of net exports is huge at 69.5 million tons. Therefore, we cannot help deeming Asia the biggest epicenter of the problem of export owing to excess capacity. However, the facts need to be investigated at the regional level.

Unutilized capacity also exists in Europe, NAFTA economies, and the CIS, but their properties are considered to be different. The NAFTA region is a net import region with an import dependence ratio of 26.6%, and the production capacity in this area has fallen to excess capacity as a result of losses in competition with imported goods. On the other hand, the CIS is a net export area whose net export ratio reaches 38.6%; it is inevitable to estimate the production behavior, which is extremely dependent on export due to excess capacity. In Europe, both exports and imports are extensive, and the nature of excess capacity is considered to have both aspects.

III Supply-Demand Relation and Export Structure of the Iron and Steel Industry in East Asia

1 Supply-Demand Relations and the Location of Unutilized Capacity in East Asia

East Asia is the center of production, consumption, and excess capacity of the world iron and steel industry, with China sitting at the center. Figure 5 and Figure 6 show crude steel consumption and production in East Asia. In 2015, 75.2% of crude steel consumption and 78.8% of crude steel production in East Asia were occupied by one country, China. It is clear that most of steel industry growth since 2000 in East Asia was due to expansion in China. All East Asian economies except China were affected by the global financial crisis, but diversity can be seen in the trend after the crisis. As of 2015, production in South Korea, Taiwan, ASEAN economies, and consumption in ASEAN countries exceeded the levels before the financial crisis.

Table 6 shows the situation of facility operation and supply-demand relations. It is understood that 81.0% of the crude steel production capacity concentrates in China. The utilization rate exceeds 80% in South Korea and Taiwan, 79.8% in Japan, 71.1% in China, and less than 50% in Indonesia, Viet Nam, and Malaysia. The largest unutilized capacity of 326.2 million tons is observed in China, followed by Japan with 26.6 million tons, and South Korea with 11.7 million tons. Total unutilized capacity of the ASEAN economies also reaches 29.5 million tons.

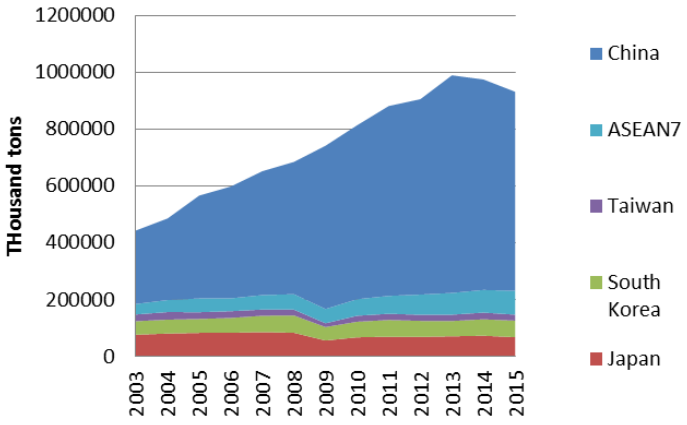

Figure 5. Crude Steel Consumption in East Asia

Note: ASEAN7 includes Indonesia, Malaysia, Thailand, Philippines, Singapore, Viet Nam, and Myanmar.

Source: Author with data compiled from worldsteel [2016a].

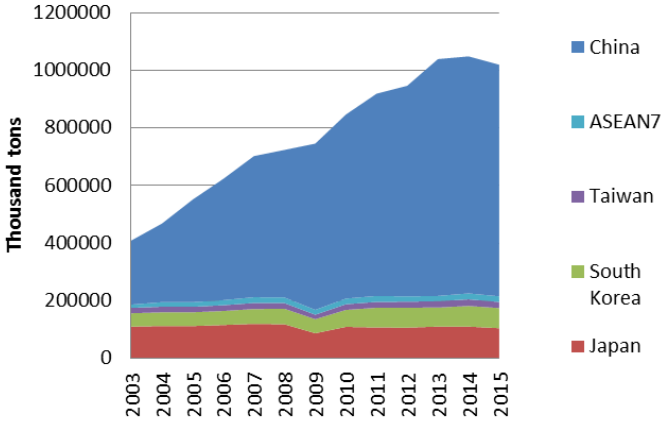

Figure 6. Crude Steel Production in East Asia

Source: Author compiled with data from worldsteel [2016a].

Table 6. Crude Steel Production Capacity, its Operating Condition, and Export by Economy in East Asia in 2015

	Crude steel production capacity	Share of capacity	Crude steel production	Capacity utilization rate	Unutilized capacity	Apparent consumption of crude steel	Net export (crude steel equivalent)	Net export (crude steel equivalent) to production
China	1,130.0	80.0%	803.8	71.1%	326.2	700.4	103.5	12.9%
Japan	131.7	9.3%	105.1	79.8%	26.6	67.8	37.3	35.5%
South Korea	81.4	5.8%	69.7	85.6%	11.7	58.1	11.5	16.6%
Taiwan	19.8	1.4%	21.4	108.0%	-	21.1	0.3	1.6%
Thailand	10.1	0.7%	3.7	36.9%	6.3	19.5	−15.7	
Indonesia	12.6	0.9%	4.9	38.5%	7.8	13.7	−8.8	
Viet Nam	12.0	0.8%	5.6	47.1%	6.4	21.2	−15.6	
Malaysia	12.1	0.9%	3.8	31.2%	8.3	11.6	−7.8	
Philippines	1.4	0.1%	1.0	70.1%	0.4	10.2	−9.2	
Singapore	0.8	0.1%	0.5	66.8%	0.2	5.1	−4.6	

Unit: Million tons.

Note: Crude steel production capacity of Singapore is 2014 data.

Source: Crude steel production capacity is from MIIT (China) [2016] for China, Research and Statistics Department, Minister's Secretariat, METI (Japan) [2016] for Japan, SEAISI [2015] for Singapore, SEAISI [2016] for other economies. Crude steel production and consumption are from worldsteel [2016a].

In China, the net export ratio is only 12.9%, but the net exports in physical terms of crude steel is huge, 103.5 million tons, which is overwhelmingly the largest in the world. In contrast, the net exports of Japan and Korea are 37.3 million tons and 11.5 million tons respectively, which are quite large exports from a single economy. Moreover, the net export ratio is 35.5% in Japan and 16.6% in South Korea, respectively, both higher than China. Although the Chinese iron and steel industry is not extremely export-oriented, it is an overwhelming largest net exporter due to its huge production scale. Although the industries in Japan and South Korea are more export-oriented, they are much smaller net exporters compared with China.

Meanwhile, the net import ratio on domestic consumption exceeds 60% in all ASEAN economies, which shows that self-sufficiency has not been achieved in this region.

Therefore, most of the excess capacity in the East Asian steel industry centers in China. However, in Japan, South Korea and even in the ASEAN economies, it exists to a significant extent compared with the production capacity of each economy. A link between excess capacity and large-scale exports may exist in China, Japan, and South Korea. For verification of the links, we must add an analysis on the nature of the exports of each economy.

2 Iron and Steel Exports from Japan, China and South Korea

This sub-section analyzes the iron and steel exports of Japan, China and South Korea from three perspectives: destination, product, and unit price. After that, a comprehensive assessment will be carried out. Unless otherwise stated, the data of quantities and prices of iron and steel exports of the three countries are cited from materials prepared by the Japan Iron and Steel Federation with the original source as customs statistics from each economy.

(1) Steel Exports from Japan

Total iron and steel exports from Japan in 2015 was 41.642 million tons.[7] Regarding exports by destination, exports to Asian economies accounted for 76.0% with South Korea (15.9%), China (12.9%), and Thailand (12.5%) as the main destinations. Meanwhile, no region other than Asia reached 10%.

Exports by product are shown in Figure 7. The share of export items based on the major classification was 11.6% for ingots and semi-finished products, 12.8% for long products, 68.7% for flat products, 4.1% for pipes, and 2.8% for others. The high ratio of flat steel indicates the specialization into high-grade products. However, there are two unusual things observed. First,

[7] "Export of steel products" contains semi-finished products and final steel products. "Total iron and steel exports" contains not only "steel products" but iron products, ferroalloys, cast iron pipes, and secondary steel products.

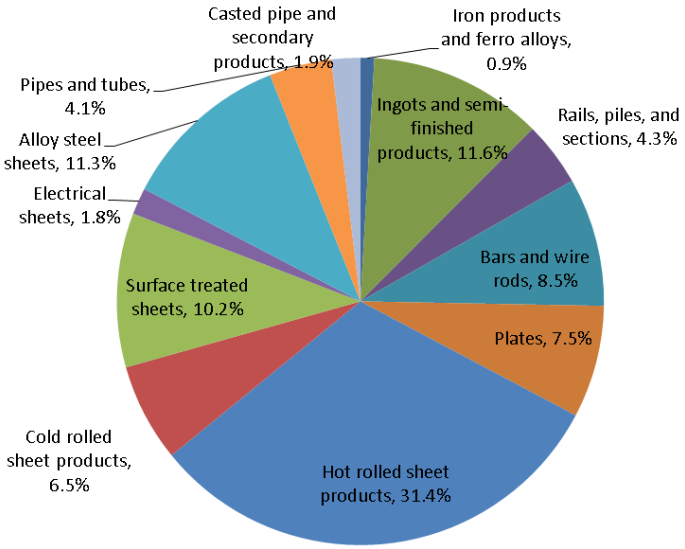

Figure 7. Steel Exports from Japan by Product in 2015

Unit: Thousand tons

Sources: Author created from the data in JISF [2016] p.170. Original source is customs statistics.

although Japan is considered to specialize in production of high-grade steel products (Kawabata [2012], Sato [2009]), it exports some steel ingots and semi-products with lower added value than final steel products. Second, in flat products, the ratio of hot rolled sheets and strips with relatively low value-added is as high as 31.4% in the middle classification. This unique export structure is based on exporting high-grade host materials to subsidiaries and affiliated companies in various economies, which will be described in detail in a later sub-section.

(2) Iron and Steel Exports from China

In 2015, iron and steel exports from China were 116.413 million tons. Regarding exports by destination, the share of export to Asian economies was 57.0%, lower than Japan. The export destinations are dispersed in various regions of the world. Only South Korea (11.9%) as a destination exceeds 10%. In Asia, the share of Vietnam (8.8%) was relatively high. Among other regions, the subtotals of Europe (12.1%) exceeded 10%. Also, the characteristic that is different from Japan and South Korea is Africa's relatively high share at 8.4%.

Exports by product are shown in Figure 8. The share of export items based on the major classification was almost zero for ingots and semi products, 43.0% for long products, 41.6% for flat

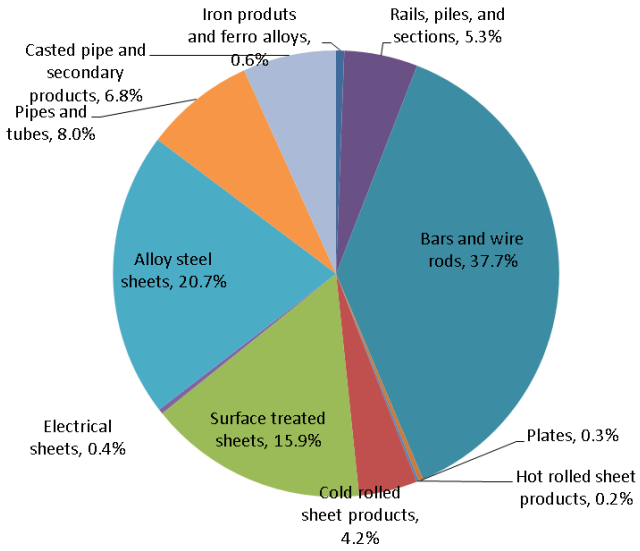

Figure 8 Steel Exports from China by Product in 2015

Unit: Thousand tons.

Source: Author compiled from the data in JISF [2016] p.170-171. Original source is customs statistics.

products, 8.0% for pipes, and 7.3% for others. A high ratio of long products was an important feature. Most of these were commodity-grade construction steel like small sections, bars and wire rods which can be manufactured without technological difficulty, not high valued long products like rails and H sections. In addition, some of the bars were actually billets, with a lower value-added than bars. Also, some of alloy steel sheets were functionally equal to non-alloy hot rolled sheets. [8] Because a refund of value-added tax can be received if an export item is an alloy steel, export companies in China had declared to customs billets as alloyed bars and declared hot rolled sheets as alloy steel sheets by adding a small amount of boron. The Chinese government acknowledged this as a problem and raised the export tax on boron added steel bars from January 2015. However, during this time, exports of "alloyed steel" with chromium increased. As described above, steel exports from China are more centralized to low value-added products like billets, bars and wire rods, and hot rolled sheets than they appear in statistics.

[8] "UPDATE 1-Sparking friction, China steel exports reinforced by rebate," *Reuters*, Oct. 29, 2014 (http://www.reuters.com/article/china-steel-idUSL4N0SO2DO20141029, retrieved on July 24, 2016), "Gaming the system: China steel exporters look for tax advantage," *Reuters*, Dec. 9, 2015 (http://www.reuters.com/article/us-china-steel-exports-idUSKBN0TS2ST20151209, retrieved on July 24, 2016). About the billet exports in detail see Hayashi [2015].

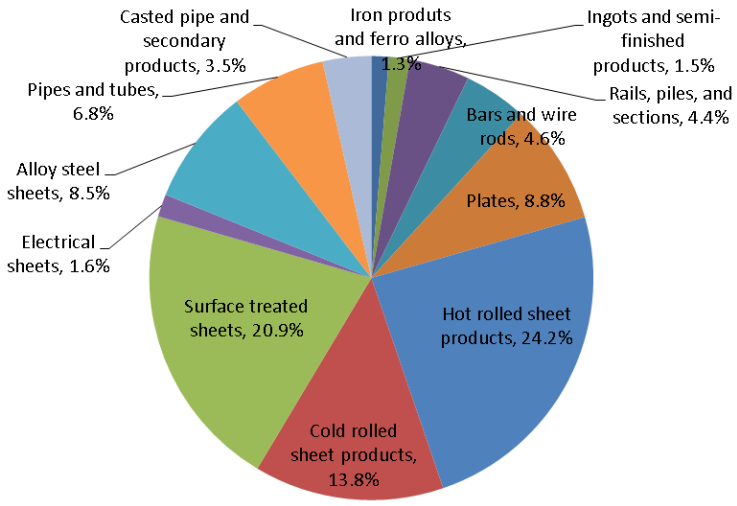

Figure 9. Steel Exports from South Korea by Product in 2015

Unit: Thousand tons.

Sources: Author created from data in JISF [2016] p.170. Original source is customs statistics.

(3) Iron and Steel Exports from South Korea

In 2015, the total iron and steel exports from South Korea were 31.852 million tons. Regarding exports by destination, the ratio for the Asian economies was 57.3%, which was close to that of China. The largest export destination was the United States (12.8%), followed by China (12.2%). The total of the four ASEAN major export destinations was 17.8%. The feature that is not observed in Japan and China is the large share of exports going to the US.

Exports by product are shown in Figure 9. The share of export items based on the major classification was 1.5% for ingots and semi-finished products, 9.0% for long products, 77.9% for flat products, 6.8% for pipes and tubes, and 4.8% for others. The ratio of flat products was higher than Japan and China. Among flat products, hot rolled sheets and strips were extremely high at 24.2%, followed by surface treated sheets at 20.9%. Thus, steel exports from Korea rely on relatively high value-added products, such as flat products. As we will see in the next sub-section, exports of steel sheets contain considerably high-grade host material.

(4) Comparison of Export Unit Price by Products

Figure 10 shows the comparison of export unit prices for Japan, China and South Korea by steel product. Products whose share is less than 10% in both the export quantity and the export value of each economy are blurred in the graph, assuming that the influence of such products on the export

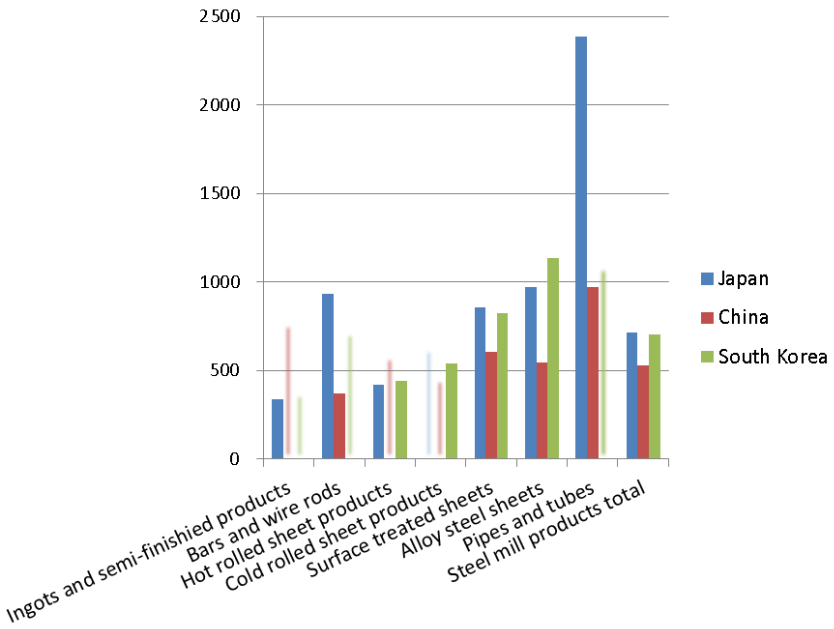

Figure 10. Comparison among unit prices of exported steel products from Japan, China, and South Korea

Unit: Dollar per ton.

Sources: Author created from a spreadsheet compiled by JISF. Original source is customs statistics.

structure is negligible. The items without blurring are the core of exports and the target of this analysis.

Regarding total steel mill products, the exporter with the highest price is Japan, followed by South Korea, and then China. In most product categories, Japan or South Korea shows the highest price. The price of pipes and tubes from Japan is extremely high. This indicates the steady status of Japan in the high-grade pipe segments.

In all export items that are comparable with other economies, China records the lowest unit price. This indicates that China is exporting low value-added, commodity-grade products on the basis of low price. It also suggests that billets are contained in "bars and wire rods" and ordinary steel sheets are mixed in with "alloy steel sheets."

(5) Export of Host Materials in the Global Value Chain

The remaining mystery is Japan's large exportation of semi-products and hot rolled sheets, which appear at first glance, to be low value-added. In order to ascertain the actual condition, we conduct a cross analysis of major exports by destination and by product. Table 7 shows the items exported

Table 7. Export of Steel Mill Products from Japan, China, and South Korea by Destination and Products in 2015

Import side / Export side	China	Japan	South Korea	Taiwan	Indonesia	Thailand	Viet Nam	India	Middle East Total	Central and South America total	United States	EU28	Africa
China			Bars2890, Wire rods1126, CRS501, Galvanized944, Other surface1668, Alloy sheets4335	Alloy sheets777	Bars2986, Wire rods595	Bars1506, Wire rods1276	Sections 537, Bars1568, Wire rods1335, Galvanized 788, Alloy sheets4928	Bars560, Wire rods876, Other surface683, Alloy sheets1675	Bars2101, Wire rods1411, Other surface732, Alloy sheets2377, Seamless 1192, WFP524	Bars1623, Wire rods1295, CRS778, Galvanized1163, Other surface854, Alloy sheets1625, WFP821	Galvanized 521	Bars1208, CRS877, Galvanized 1681, Other surface653, Alloy sheets2753	Bars2981, Wire rods1185, CRS523, Galvanized539, Other surface744, Alloy sheets1003, WFP611
Japan	Plates869, HRS871, CRS567, Galvanized637, Alloy sheets1077		Semi products1598, HRS2192	Semi products 1558	HRS556	HRS1665, CRS606, Galvanized 676, Alloy sheets910	HRS1034	HRS1248	HRS792	HRS1360	Bars and wire rods666		HRS1044
South Korea	CRS1001, Galvanized1094	HRS898, CRS601, Galvanized 518					HRS890	HRS1409, CRS654		CRS594	HRS1149, WFP1059	Galvanized 594	

Abbreviations: HRS = Hot rolled sheets and strips, CRS = Cold rolled sheets and strips, Galvanized = Galvanized sheets, Other surface = Other surface treated sheets, Seamless = Seamless pipes, WFP = Welded and forged pipes

Unit: Thousand tons.

Source: Author compiled from JISF materials. Original source is customs statistics in various economies.

by more than 500 thousand tons in 2015 to specified destinations.

From this table, some of the previously revealed features can be seen again. That is, exports of steel products from China extend to a wide range of regions, while most exports from Japan head to Asian economies.

However, what should be emphasized here is that some items reflect a long-term relationship between Japan and South Korea and their export destinations. Continuous transactions are undertaken between parent companies and subsidiaries or affiliates based on international inter-process division of labor.[9] The corresponding items in Table 7 are underlined. Table 8 shows the corresponding concrete inter-process transactions. In these transactions, the export destination companies are continuously purchasing host materials from parent companies in Japan or South Korea in order to ensure a stable supply of high-grade products that cannot be made from locally supplied materials. In Thailand, high-grade steel sheets for automobiles are an example that was analyzed in previous studies (Kawabata [2005] pp. 160–163, Kawabata [2008] pp. 276–279). Continuous transactions exist even for items that are not underlined in Table 7 because of the small amount of trade (Kawabata [2012] p.31, Figure 2). However, these subsidiaries or affiliated companies are not exclusively importing the total amount of necessary host materials from parent companies. While they purchase high quality host materials from the parent companies, they do use various suppliers according to the level of requirements.[10]

Such continuous export represents the optimization of the global value chain (GVC).[11] It has a different character from the low price export that is promoted by excess capacity.

(6) Comparison with Exports from Russia and Ukraine

For reference, we also mention Russia and Ukraine, where excess capacity may be linked to exports along with East Asia. Figure 11 and Figure 12 show iron and steel exports by product in both economies. In 2015, the total iron and steel exports from Russia were 38.181 million tons, and Ukrainian steel exports were 20.802 million tons. The characteristics of the export items of Russia and Ukraine that differ from the three Asian economies are the high share of pig iron (19.8% in Russia, 10.5% in Ukraine) and ingots and semi-products (40.1% in Russia, 37.8% in Ukraine). Unlike Japan, this does not represent exports of high-grade host materials to partners.

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[9] On the international inter-process division of labor between the Japanese companies and partners, see also Kawabata [2012] pp.30-31.

[10] On the procurement of host materials by BNA in China, see Kawabata [2012] p. 35. On the procurement of host materials by TCRSS and SUS in Thailand, see Kawabata [2008] 276-279.

[11] On the recent development of GVC approach, see Gereffi [2013].

Table 8. Continuous Transactions between Integrated Iron and Steel Enterprises in Japan/ South Korea and Downstream Enterprises in Destination Economies

Exporting Economy	Destination	Products	Next process	Exporting enterprise → Importing enterprise
Japan	China	Hot coil	Cold rolling	NSSMC→BNA
				JFE→GJSS
	China	Cold coil （Tin Mill Black Plate）	Surface treating (Tinplating)	NSSMC→PATIN
				JFE → Fujian Sino-Japan Metal
				JFE → Hainan Haiwoo Tinplate Industry
	South Korea	Semi-product (Slab)	Hot rolling for plate	JFE→Dongkuk Steel Mill
	Taiwan	Semi-product (Slab)	Hot rolling	NSSMC → Chung Hung Steel
	Thailand	Hot coil	Cold rolling	NSSMC→SUS
				JFE→TCRSS
	Thailand	Hot coil	Tubing for structural pipe	NSSMC→SNP, TSP
	Thailand	Cold coil (Tin Mill Black Plate)	Surface treating (Tinplating)	NSSMC→STP
				JFE→TTP
	Thailand	Cold coil	Surface treating (Galvanizing)	NSSMC→NSGT
				JFE→JSGT
	Thailand	Cold coil	Surface treating (Electro Galvanizing)	JFE→TCS
	Viet Nam	Hot coil	Cold rolling	NSSMC→CSVC
	India	Hot coil	Cold rolling	JFE→JSW Steel
	UAE	Hot coil	Cold rolling	NSSMC→AGIS
South Korea	Viet Nam	Hot coil	Cold rolling	POSCO→POSCO Vietnam
	India	Hot coil	Cold rolling	POSCO → POSCO Maharashtra Steel
	India	Cold coil	Annealing and surface treating for electrical steel	POSCO→POSCO ESI

Abbreviation: NSSMC: Nippon Steel & Sumitomo Metal, BNA: Baosteel-NSC Automotive Steel Sheets, GJSS: Guangzhou JFE Steel Sheet, PATIN: Guangzhou Pacific Tinplate, SUS: Siam United Steel, TCRSS: Thai Cold Rolled Steel Sheet, SNP: Siam Nippon Steel Pipe, TSP: Thai Steel Pipe Industry, STP: Siam Tinplate, TTP: Thai Tinplate Manufacturing, NSGT: Nippon Steel Galvanizing (Thailand), JSGT: JFE Steel Galvanizing (Thailand), TCS: Thai Coated Steel Sheet, CSVC: China Steel Sumikin Vietnam, AGIS: Al Ghurair Iron & Steel.

Source: Disclosed materials of various enterprises, *Japan Metal Daily*, Interviews by author.

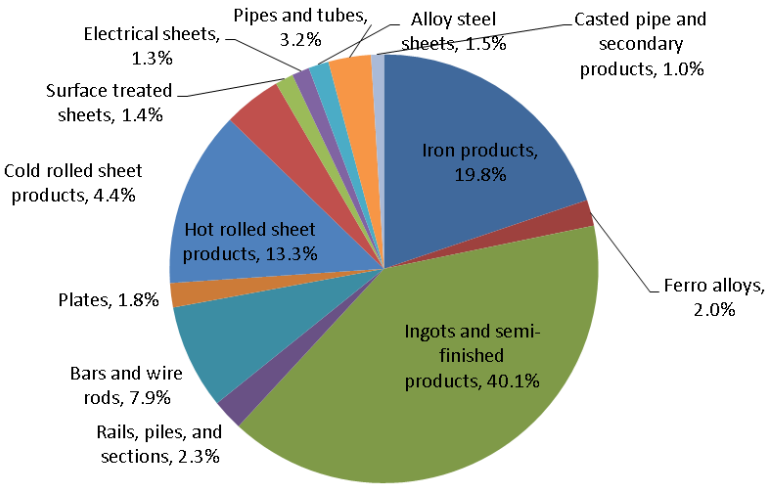

Figure 11 Steel Exports from Russia by Product in 2015

Unit: Thousand tons.

Sources: Author created it from a spreadsheet compiled by JISF. Original source is customs statistics.

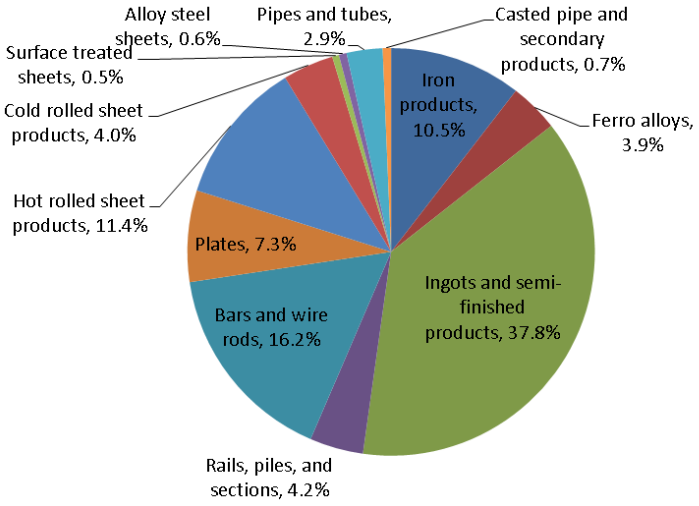

Figure 12 Steel Exports from Ukraine by Product in 2015

Unit: Thousand tons.

Sources: Author created from a spreadsheet compiled by JISF. Original source is customs statistics.

The iron and steel industry of both economies were privatized after the collapse of the Soviet Union and facility modernization has not yet progressed sufficiently. This is indicated by technical

indicators. In 2015, the use ratio of open furnace, which is the steel refining technology used in previous eras, fell to 0.4% worldwide and zero in Japan, China, and South Korea, while showing a 2.4% use ratio in Russia and 22.6% in Ukraine. [12] In addition, the proportion of semi-finished products produced by the continuous casting method with short manufacturing time and high-energy efficiency reached 96.2% worldwide, compared to 81.8% in Russia and 48.9% in Ukraine. The rest of the steel in both economies was manufactured by the old-fashioned ingot-making method. Therefore, in Russia and Ukraine, excess capacity is generated because of the competitive disadvantage in final steel products. Factories in these countries export pig iron and semi-finished products at low prices due to the availability of raw materials because of their location close to an iron mine and/or coalfield and due to the ability to pay low level wages. [13] This feature is particularly striking in Ukraine (Hattori [2015]). The export structures of both economies are biased toward products with lower value-added, even when compared to China.

3 Additional Capital Investment

According to an OECD survey, further capital investment is proceeding in various parts of the world, even under excess capacity. Assuming that the equipment under construction at the time of the investigation by the OECD is completed (low level case), the production capacity of 2017 will increase by 4.3% from 2014 to 2.42 billion tons. Moreover, if all the equipment under planning is completed (high level case), it will be 2.77 billion tons.[14] The global steel demand forecast (final steel products) by worldsteel in 2017 will be 1.51 billion tons. Because this will be smaller than 2014,[15] it is expected that the excess capacity will become even more serious.

Looking at the regional distribution of capacity increase in the low level case, Asia accounts for 70% of the increase. India shows the greatest increase, followed by China. When looking at the rate of increase, the Middle East is remarkable at 31.2%, followed by India at 28.5%.[16] India and the Middle East are emerging in capital investment competition, while large-scale construction projects in China and ASEAN are also proceeding.

Table 9 lists the major construction plans of the integrated steelworks in East Asia. In China,

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[12] Numbers of open furnace and continuous casting ratio in this paragraph are from worldsteel [2016a] pp.5-6, 17-18.

[13] Fortescue [2009] said the Russian steel industry relied on exports based on low-cost production factors as mentioned here in the 1990s, but thereafter it switched to capital investment and product specialization for domestic market. However, based on the export structure, it has not yet completely withdrawn from "survival mode" of the 1990s.

[14] Author calculated from Sekiguchi et al. [2016] p.10, 12.

[15] worldsteel, Worldsteel Short Rage Outlook 2016-2017, worldsteel, Press Release, October 11, 2016 (https://www.worldsteel.org/media-centre/Press-releases/2016/worldsteel-Short-Range-Outlook-2016---2017.html) (Retrieved on January 14, 2017).

[16] Author calculated from Sekiguchi et al. [2016] p.10, 12.

Table 9 Construction Plans of Large-Scale Integrated Iron and Steel Works in East Asia

Economy	Location	Major Owner	Base economy of major owner	Crude steel production capacity per annum (mill. tons)	Capital investment (bill. USD)	Current status and schedule
China	Caofeidian Industrial Zone, Tangshan City, Hebei Province	Shougang Jingtang United Iron & Steel (Shougang Group)	China	20	N.A.	1st stage (9.7 million tons) in operation
China	Rizhao City, Shandong Province	Shandong Iron and Steel Group Ri Zhao Co.	China	8.5	9.15	Under construction. Scheduled for completion in mid−2017
China	Zhanjiang City, Guangdong Province	China Baowu Steel Group	China	8.93	6.8	1st and 2nd blast furnaces have started operation until July in 2016
China	Fangchenggang City, Guangxi Zhuang Autonomous Region	Former Wuhan Iron and Steel (Group)	China	9.2	10.12	Under construction. Reconsidered after the integration with Baogang Group
Indonesia	Cilegon, Banten	Krakatau POSCO (JV between Krakatau Steel and POSCO)	Indonesia・South Korea	6	6 (1st stage)	1st stage is in operation (3 million tons)
Viet Nam	Vung Ang Economic Zone, Ky Long Ward, Ky Anh Town, Ha Tin Province	Formosa Ha Tinh Steel (Formosa Plastic Group)	Taiwan	20	10.5	1st stage (7.07 million tons) was completed, but is not in operation because of water pollution problem.
Viet Nam	Ca Na Industrial Park, Ninh Thuan Province	Hoa Sen Group	Viet Nam	16	10.6 (5 stages)	Ministry of Industry and Trade gave permission in August 2016.
Viet Nam	Dung Quat Economic Zone, Quang Ngai Province	Hoa Phat Group	Viet Nam	4	3	Prime Minister approved the construction plan.

Source: Author compiled based on news and company websites.

under a policy for excess capacity reduction, new steel mills will be constructed in exchange for reducing the existing production capacity. However, it is unclear whether this replacement policy will succeed. In Indonesia and Vietnam, construction has been substituting huge steel imports because there was no large-scaled integrated company in both economies. Despite the reexamination of some plans, it is expected that additional capabilities will be installed in near future.

It is important to note that these steel works are equipped with state-of-the-art technology and capable of larger production scales, except for the plans of Hoa Phat Group and Hoa Sen Group in Vietnam, whose details are unknown. Therefore, when these new steelworks begin operation, they could be competitive in productivity and production cost. In that case, steelworks with relatively poor productivity and high cost will fall into excess capacity.

4 Conclusion of this Section

From the analysis of this section, we conclude the following.

The majority of excess capacity in the East Asian steel industry exists in China. However, even in Japan, South Korea and the ASEAN countries, it exists to a significant extent as compared with production capacity scale. Because further capital investment is being made in China and the ASEAN region, it is not easy to reduce excess capacity.

Although the Chinese steel industry does not have a high net export ratio to production, it is an overwhelming largest net exporter due to its large production scale. Quantitatively, the export scale of Japan and Korea is much smaller than that of China, but their net export ratio to production is higher. Qualitatively, both Japan and South Korea are more export-oriented than China. Meanwhile, the ASEAN countries are net importers.

Steel exports in Japan and South Korea are specialized in high value-added steel products such as flat products, while they supply quality host materials through continuous transactions to overseas subsidiaries or affiliates. A considerable part of the exports from both economies forms the global value chains and are not exports to maintain a utilization rate under the pressure of excess capacity.

Meanwhile, China's steel exports contain a high share of low value-added products, such as billets, bars and wired rods, and hot rolled sheets, which are not necessarily revealed in public statistics. Those low value-added products are exported to various regions in the world. Compared to Japan and South Korea, it is possible that exports from China are promoted by a motivation to keep capacity utilization under the excess capacity.

In Russia and Ukraine, the export volume is much smaller than that of China, but the items exported are more biased toward low value-added products, like pig iron and semi-finished products, even compared with China. Their quantitative influence is smaller than China, but qualitatively, exports from Russia and Ukraine are commodity-based and extremely influenced by excess capacity.

IV Concluding Remarks and Forward Agenda

1 Conclusion

This paper defined excess capacity as production capacity that is inferior in competition, surviving due to factors other than competitive advantages, under the condition that world production capacity exceeds demand. Moreover, the location of excess capacity in the world iron and steel industry has been pursued. As a result, it is clear that the largest excess capacity has existed in East Asia, especially in China. At the same time, significant excess capacity was also observed in Europe, NAFTA economies, the CIS, Japan, South Korea and the ASEAN member economies, with much smaller volume compared to China. In China, Russia, Ukraine, Japan and South Korea, the coexistence of excess capacity and massive net exports were observed. Among those economies, the excess capacity in China, Russia and Ukraine were linked to low value-added commodity exports.

The Chinese iron and steel industry is not necessarily export-oriented qualitatively, and the capacity utilization rate is not particularly low compared to other areas. However, export items are biased toward low value-added products. Additionally, because the industrial scale is prominent and large, the scale of China’s excess capacity and export are overwhelmingly the largest in the world.

The iron and steel industries in Russia and Ukraine are more export-oriented qualitatively and export items also depend on lower value-added items than in China. However, because the industrial scale is smaller than China, the scale of overcapacity and export are smaller than China.

Although the iron and steel industry in Japan and South Korea are export-oriented, most export items are not commodities, but high-grade flat products and high-grade host materials for subsidiaries and affiliated partners.

As capital investment continues in the world and East Asia, excess capacity is unlikely to fade out easily. Since state-of-the-art technologies will be embodied in newly-constructed steelworks, survival competition will become even more intense in both domestic and overseas competition.

2 Forward Agenda

In order to make the analysis of this paper more convincing, the location of excess capacity and the relationship between excess capacity and exports must be clarified more concretely by an analysis of industrial organization in each economy. It is especially necessary to do this for China.

There are several problems concerning excess capacity in China; the relationship between international trade friction and excess capacity is an especially urgent topic. Within this topic, the main issue is the influence of government assistances and subsidies. It is necessary to clarify whether excess capacity is caused by government assistances and subsidies, by non-governmental factors such as intense entry and high withdrawal barriers, or both. Because many of the large steel companies in China have been state-owned enterprises, we need to examine whether government assistance and subsidies go mainly to state-owned enterprises. Clarifying the location of excess capacity by company type, company size, and product type will be a clue to this problem. This analysis will reveal what types of products are exported with the burden of excess capacity, and what types of companies own such excess capacity: large enterprises or small to medium enterprises, state-owned enterprises or private companies. This is the next agenda.

References

Abe, Etsuo and Yoshitaka Suzuki eds. [1991]. *Changing Patterns of International Rivalry: Some Lessons from the Steel Industry*, Tokyo: University of Tokyo Press.

Brun, Lukas [2016]. *Overcapacity in Steel: China's Role in a Global Problem*, Durham, NC: Center on Globalization, Governance & Competitiveness, Duke University.

China Iron and Steel Institute [various years]. *China Iron and Steel Statistics* (Chinese).

D'Costa, Anthony P. [1999]. *The Global Restructuring of the Steel Industry: Innovations, Institutions and Industrial Change*, London, UK, New York, NY: Routledge.

De Carvalho, Anthony, Naoki Sekiguchi and Filipe Silva [2015]. Excess Capacity in the Global Steel Industry and the Implications of New Investment Projects, *OECD Science, Technology and Industry Policy Papers*, No. 18.

Fortescue, Stephen [2009]. The Russian Steel Industry, 1990-2009. *Eurasian Geography and Economics*, 50(3), pp. 252-274.

Gereffi, Gary [2013]. Global Value Chains in a Post-Washington Consensus World, *Review of International Political Economy*, 21(9), pp. 9-37.

Hattori, Michitaka [2015]. A Comparison of the Steel Industries of Russia and Ukraine, *Japanese Journal of Comparative Economics*, 52(2), Japanese Association for Comparative Economic Studies, pp.21-32 (Japanese).

Hayashi, Seiichi [2015]. The Emergence of New Constraints on Export and Price, *Research Report*, 30, Steel Recycling Research Co. Ltd., pp.1-8 (Japanese).

Japan Iron and Steel Federation (JISF) [2016]. *Directory of Iron and Steel Statistics in 2016*, JISF (Japanese).

Kawabata, Nozomu [2005]. *Structure and Dynamism of the Iron and Steel Industry in East Asia*, Kyoto: Minerva Publishing (Japanese).

Kawabata, Nozomu [2008]. "*The Thai Steel Industry: Domestic Hot Rolling Companies under the Hierarchical Division of Labor*," in Hajime Sato ed., *The Steel Industry in Asia: Development and Restructuring*, Chiba: Institute of Developing Economies, pp.251‐296(Japanese).

Kawabata, Nozomu [2012]. A Comparative Analysis of Integrated Iron and Steel Companies in East Asia, *The Keizai Gaku, Annual Report of the Economic Society*, 73(1/2), Tohoku University Economic Society, October, pp.23-42.

Ministry of Industry and Information Technology (MIIT), China [2016]. *Blueprint for the Adjustment and Upgrading for Iron and Steel Industry (2016-2020)*.

OECD [2016]. Background Note No. 2 Capacity Developments in the World Steel Industry, presented at *HIGH LEVEL MEETING Excess Capacity and Structural Adjustment in the Steel Sector*, 18 April 2016, Brussels.

Price, Alan H., Christopher, B. Weld and Laure El- Sabaawi［2013］. *Government Intervention and Overcapacity: Causes and Consequences for the Global Steel Industry*, Washington, DC: Wiley Rein LLP.

Price, Alan H., Christopher, B. Weld, Laure El- Sabaawi and Adam M. Teslik [2016] *Unsustainable: Government Intervention and Overcapacity in the Global Steel Industry*, Washington, DC: Wiley Rein LLP.

Research and Statistics Department, Minister's Secretariat, Ministry of Economy and Trade (METI), Japan [2016]. *Yearbook of Current Production Statistics, Iron and Steel, Non-Ferrous Metals, and Fabricated Metals*, 2015 edition.

Sato, Hajime [2009]. The Iron and Steel Industry in Asia: Development and Restructuring, *IDE Discussion Paper,* 210, pp. 1-35.

Sato, Hajime [2016]. "Advantages of Backwardness and Linkage Effects: The Steel Industry in Asia," in Yukihito Sato and Hajime Sato eds., *Varieties and Alternatives of Catching-up: Asian Development in the Context of the 21st Century*, NY: Palgrave Macmillan.

Sekiguchi, Naoki, Hokuto Otsuka, Anthony de Carvalho, and Filipe Silva [2016]. *Capacity Developments in the World Steel Industry*, Paris: OECD.

South East Asia Iron and Steel Institute (SEAISI) [2015] [2016]. *Steel Statistical Yearbook*.

Steel Industry Coalition [2016], *Report on Market Research into the Peoples Republic of China Steel Industry*, Steel Industry Coalition (American Iron & Steel Institute [AISI], Steel Manufacturers Association [SMA], Specialty Steel Industry of North America [SSINA], The Committee on Pipe and Tube Imports [CPTI], and American Institute of Steel Construction [AISC]).

World Steel Association (worldsteel) [2016a]. *Steel Statistical Yearbook*.

World Steel Association [2016b]. *World Steel in Figures*.

World Steel Dynamics (WSD) [2015], *Steel Strategist #41: Profitability Sinkhole*, Englewood Cliffs, NJ: World Steel Dynamics Inc.