

The Korean Steel Industry in Retrospect : Lessons for Developing Countries

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The rise of Korea from the ashes of war

At the end of the Second World War in 1945, South Korea had secured its independence, but five years later, the Korean War broke out. A GDP per capita at a nominal value hovered around USD 67 in 1953 when the Korean War ended. It remained one of the world's poorest countries. However, the South Korean economy grew exponentially following the government-led economic development initiatives launched in the early 1960s. Today, Korea has joined the ranks of advanced countries, becoming the world's seventh-largest exporter, 12th largest economy in terms of GDP, and 30th largest in terms of GDP per capita as of 2016. Together with this economic expansion, the Korean steel industry has grown robustly. It today enjoys a lofty global standing just like the overall Korean economy. In the 1960s the Korean steel industry was starting from nothing: it lacked technology, resources, and expertise. However, as shown

in Table 1, by the mid-1990s it had become the world's sixth-largest steel producing country and has maintained this status ever since.

What was the key to this success? The experience of the Korean steel industry offers useful lessons for emerging economies pursuing economic development. Therefore, it would be meaningful to analyze the factors that drove the Korean steel industry to success.

Many emerging economies are seeking to achieve the self-sufficient development of their steel industries since steel, dubbed "the staple of industry," is the fundamental industry that underpins other basic industries, such as the automotive, home appliance, shipbuilding, machinery, and construction sectors. By doing so, it contributes to the improvement of competitiveness across industries, and eventually to national economic growth. In addition, with high forward-backward linkage effects, as can be seen in Table 2, the steel industry can bring about positive ripple effects in an entire economy, including in investment, employment, and growth.

Table 1. Development of the Korean Steel Industry

	1970	1975	1980	1985	1990	1995	2000	2005	2010	2016
Crude steel production (Mt)	0.5	2.5	8.6	13.5	23.1	36.8	43.1	47.8	58.9	68.6
Share of global production (%)	0.1	0.4	1.2	1.9	3.0	4.9	5.1	4.2	4.1	4.2
World ranking	34	29	13	10	7	6	6	5	6	6
Apparent crude steel use per capita (kg)	51	84	141	234	501	827	851	1,015	1,101	1,171

Source: "Steel Statistical Yearbook" worldsteel (2016)

Table 2. Forward-Backward Linkage Effect in the Korean Industry

	Primary metal	Chemical	Machinery and equipment	Construction	Transport equipment	Precision industry
Impact coefficient (Backward linkage effect)	1.282	1.106	1.220	1.177	1.278	1.092
Sensitivity coefficient (Forward linkage effect)	1.988	1.945	0.915	0.601	0.931	0.641

Source: Numbers are based on 2014, Source: Bank of Korea (BOK)

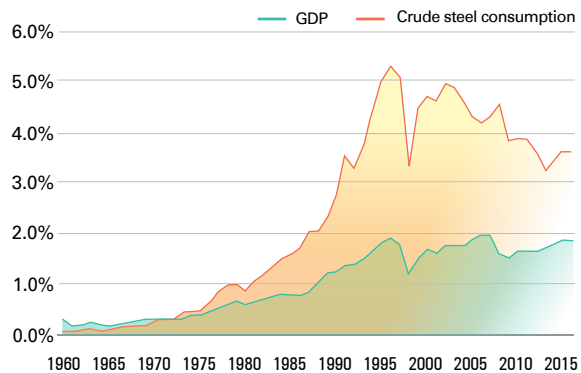
However, despite these advantages, it is not easy for latecomers to successfully nurture a local steel industry. The field requires massive investments, advanced technologies, and operational know-how, which requires a long time to accumulate before first movers can be overtaken.

Retrospective view on the development of the Korean steel industry

To identify what made the Korean steel industry successful, it is reasonable to examine the history of its development. The pertinent patterns differ before

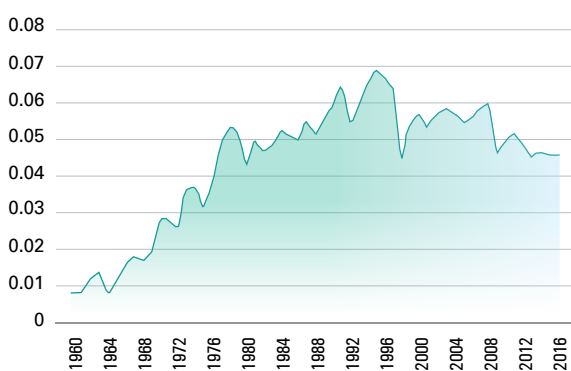
and after the financial crisis of 1998. Looking at the proportions of Korea's GDP and steel production versus global GDP and global steel production in Figure 1, the figures shift notably around the financial crisis of 1998. The Korean economy and steel industry entered a period of full-blown boom times in the late 1980s and Korea's GDP and steel production continued to grow until 1997. However, everything changed after

Figure 1. Share of Korea in Global GDP and Steel Consumption



Source: IMF, worldsteel

Figure 2. Korea's Steel Intensity of GDP

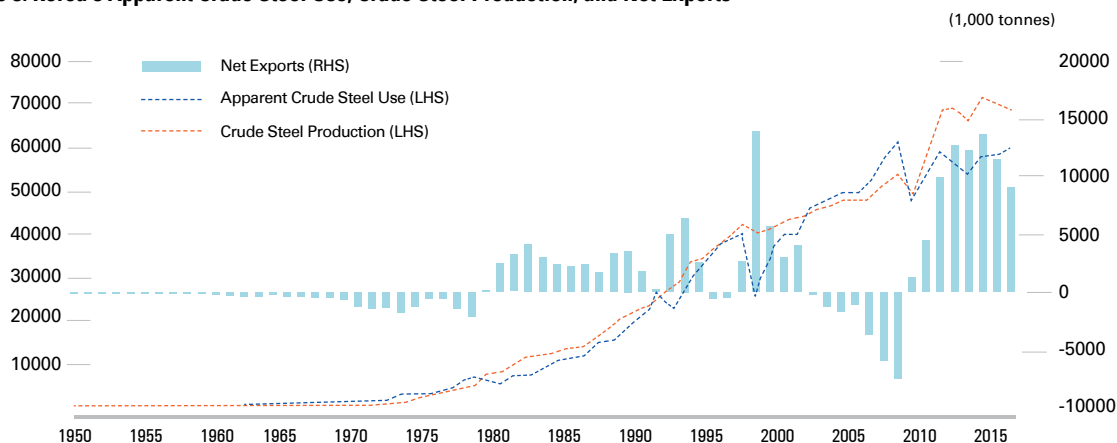


Source: BOK, worldsteel

Note: Steel intensity = Crude steel consumption (kg) / Nominal GDP(KRW)



Figure 3. Korea's Apparent Crude Steel Use, Crude Steel Production, and Net Exports



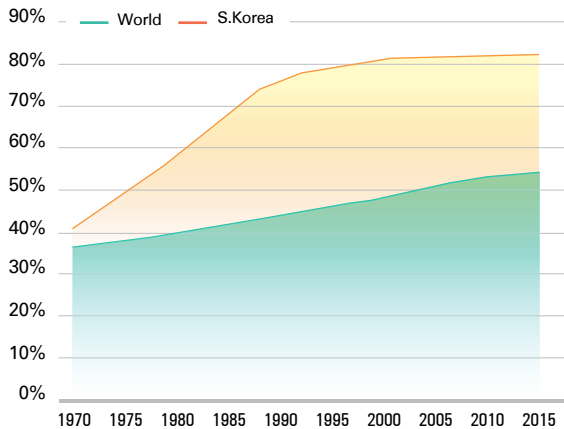
Source: worldsteel

the financial crisis: Korea's proportion within global GDP peaked first in 1996 and then crested again in 2007. In contrast, Korea's global share of steel consumption peaked in 1996, but declined afterwards despite some periods of reglobal GDP peaked first in 1996 and then crested again in 2007. In contrast, Korea's international share of steel consumption peaked in 1996, but declined afterwards despite some periods of recovery. This mismatch is attributed to the fact that the Korean economy, heavily dependent on IT-driven growth after the financial crisis, had maintained its share of GDP consistent, but Korea's share in global consumption has been falling faster than that of GDP due to declining steel intensity of GDP. Figure 2 shows that Korea's steel intensity of GDP peaked in 1995 and began to decline afterwards.

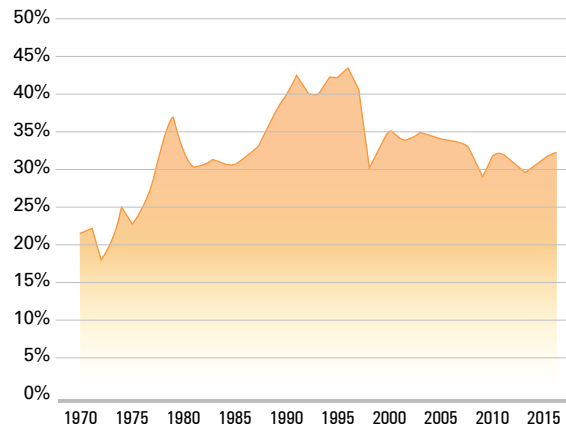
Figure 3 shows Korea's apparent crude steel use and crude steel production trends from 1950 to 2016. The growth rates of apparent crude

steel use and crude steel production from 1970 to 1997 increased at compound annual growth rates (CAGR) of 12.5% and 17.9%, respectively, but a mere 2.1% and 2.5% from 1997 to 2016. In particular, crude steel use has stagnated since the financial crisis of 2008, and even by 2016 it had failed to recover the levels in 2008. Meanwhile, crude steel production has surged since the operation of Hyundai Steel's blast furnace in 2011, and the gap between supply and demand has widened.

Examining the changes that took place around the crisis of 1998 based on factors related to steel use, there are two distinctive items. The first is as shown in Figure 4—a significant slowing in the urbanization rate after 1996. Second, gross capital formation as percentage of GDP declined after peaking in 1996 (See Figure 5). Along with industrialization, urbanization is an important driver of both economic growth and steel demand. Gross capital formation, comprised of invest-

Figure 4. Urbanization Rate

Source: IMF

Figure 5. Gross Capital Formation (% of GDP)

Source: BOK, worldsteel

ments in construction and facilities, is also closely related to steel demand. Namely, stagnating urbanization around the financial crisis of 1998 and a plunge in investment caused by aggravated oversupply in the Korean economy led to stagnation in steel demand.

Interestingly, the Korean economy shifted from government-driven to market-driven in 1998. The Korean government had implemented seven Five-Year Economic Development Plans, with the final installment ending in 1997. Recognizing the limitations of government-led operations in expanding the economy, Korea attempted to shift to a more market-led economy, but was hit by the Asian financial crisis of 1997-98. Korea accepted emergency loans from the International Monetary Fund (IMF) and accordingly took measures to deregulate markets, such as introducing a fully-floating exchange rate system and opening the stock and bond markets. As a result, the year 1998 became a turning point for the Korean

economy as it shifted from government-driven to market-driven.

Success factors for the Korean steel industry

This article examines the development of the Korean steel industry from a theoretical perspective and draws policy implications for latecomers. It is no easy task to apply only a single perspective and generalize success factors for what has been dubbed Korea's "Miracle on the Han River." Therefore, it is important to consider varying economic theories to identify such factors.

Based on existing research on the success of the steel industry by academia, research institutions, and the media, the author adopted various theories to re-examine the success factors and offer implications for developing nations—catch-up theory, infant industry argument, fourth factor of

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production, Lewis turning point, and endogenous growth theory.

Explanation of Success factors based on catch-up theory

The catch-up theory was represented by Seoul National University Professor Keun Lee.¹ This part mainly leans upon his explanation and analysis. According to

the catch-up theory among countries, industries, and companies, there are windows of opportunity, in which latecomers can catch up with first movers. Four representative windows are the emergence of new technological and economic paradigms, recession in business cycles, changes in demand conditions, and industrial policies and

government restrictions.

Even when a window for opportunity opens, not every latecomer is able to seize the opportunity and outperform first movers. The result varies depending on how the first movers

react and how well latecomers overcome their disadvantages and make the most of their advantages. As first movers wish to retain their own advantages in the market, they often ignore new technologies and fall into the first-mover trap. On the other hand, latecomers are disadvantaged by their requirement of massive funds and government support in the initial stage, but they are able to skip stages by adopting first movers' advanced technologies at low cost, and even become first movers themselves. If willing to take risks, they are given an opportunity for leapfrogging.

This catch-up theory explains how the Korean economy was able to take a window for opportunity and succeed in catching up to advanced economies. This is also true not only for the steel industry, but for other sectors as well, including electronics, automobiles, and petrochemicals.

The catch-up cycle for the Korean steel industry is divided into three stages. The first is the entry stage (1968 – 1972) when its development was fueled largely by government activism. The Korean government incorporated POSCO as a

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Keun Lee and Jee-hoon Ki, "Rise of the Latecomers and Catch-Up Cycles in the World Steel Industry," Research Policy, Volume 46, Issue 2 March 2017, Pages 365–375

state-owned company in 1968, and enacted the Steel Industry Promotion Law to actively support the establishment of the Pohang Steelworks. In addition, POSCO was provided with a variety of benefits: long-term loans at low interest rates, establishment of infrastructure, reduction or abolition of taxes and tariffs, and reductions in utility rates.

The second phase is the gradual catch-up stage (1973 – 1986) in which global economic recessions sparked by the first and second oil shocks offered a sort of opportunity to Korea. Pohang Steelworks began producing steel in 1973 and expanded production capacity through 1983. Under the global recession that followed the first oil shock in 1973, POSCO was able to purchase old equipment at prices lower than normal. The government also implemented policies to nurture heavy and chemical industries (1973-1979), focusing on six sectors—steel, petrochemicals, machinery, shipbuilding, electronics, and non-ferrous metal. This significantly drove up steel demand.

Third is the forging ahead stage—a period of soaring expansion after 1987. POSCO started building its Gwangyang Steelworks in 1981. The second oil shock of 1979 and subsequent economic recession had provided a chance for POSCO to catch up with first-movers. POSCO took advantage of this recession to promote competition among equipment suppliers and managed to buy equipment at reduced prices. Moreover, the recession also offered a further opportunity for POSCO to introduce cutting-edge technologies at reasonable cost. During this stage-skipping catch-


up phase, POSCO was able to secure greater cost advantage than ever before.

To summarize, the Korean government established the state-owned steel company POSCO in an effort to enter the steel industry, and recessions in the global steel industry and domestic industrial policies provided Korean companies with opportunities. Due to stagnation in the global steel industry in the 1970s and 1980s, POSCO could save on costs of new investment. Namely, the success of POSCO is characterized by path-following at the early stage and then by stage-skipping.

The infant industry argument and the government's role

As suggested by the catch-up theory, the Korean government has played a pivotal role in the growth of the steel industry. Examining government policies of the time, it basically implemented development strategies based on the infant industry argument. The core of this argument is that nascent industries often lack the competitiveness of their better-established competitors in other countries and thus require protection until they are able to attain similar competitiveness and contribute to national development. This argument was first fully articulated in the 1790s by the US statesman Alexander Hamilton and later systematically developed by the German economist Friedrich List. Korea is a good example of turning a disadvantaged industry into one with a comparative advantage.

The Korean government's role at that time



One of the most important theories to explain the splendid growth of the Korean steel industry is the fourth factor of production—entrepreneurship and leadership.

can be categorized into five patterns. First, it established a state-owned company and provided focused government support. This is a “selection and concentration” strategy. In fact, this strategy is seemingly the only choice for a country lacking the resources, technologies, or capital for nurturing key industries. The second is an industrial strategy centered on heavy and chemical industries. Industrialization is key in that it has a high industrial linkage effect and can easily create high added value based on improved effectiveness. A virtuous cycle was effectively created in that the development of heavy and chemical industries increased steel demand and fueled the steel industry, while the rise of the steel industry secured economies of scale to supply cost competitive products to steel-consuming industries. Finally, the steel-consuming industries were able to grow further.

Third, the government was actively involved in building infrastructure, such as roads, railways, and ports, even in the early stages of economic development. When the Korean government

began constructing the Gyeongbu Expressway connecting the southern and northern reaches of South Korea, it was met with pessimism and the opinion that pouring such a tremendous amount of money into infrastructure was inappropriate while people were struggling to make a living. However, the construction of infrastructure increased logistics efficiency and enhanced industrial competitiveness. In addition, steel demand was created while the infrastructure was being erected.

The fourth pattern is import restrictions and export-driven growth strategies. The government delayed market openings for as long as possible in an effort to help the industry gain competitiveness and sought export-driven strategies with a view to overcoming the small domestic market. The export-driven strategy is advantageous for a country with a low sovereign credit rating seeking to borrow foreign funds for purchasing facilities, as well as to ensure global competitiveness in the competition for exports.

Fifth, the government has stepped forward to

instill labor consciousness, and was actively involved in sourcing experts for the industry. Under the slogan “Let’s live well,” the government inspired passion and boosted labor consciousness. In response to Koreans’ fervor for education, the government expanded educational systems and provided talent to companies in a timely manner.

The fourth factor of production—entrepreneurship and leadership

One of the most important theories to explain the splendid growth of the Korean steel industry is the fourth factor of production—entrepreneurship and leadership.

There are three basic factors of production: land, labor, and capital. In addition, entrepreneurship is often appended as an additional factor. When the Korean government began nurturing the steel industry, very few expected success. The Korean government sought international financing to build a steel mill in the 1960s, but the International Bank for Reconstruction and Development (IBRD, now the World Bank) issued a report skeptical of Korea’s steel industry prospects in 1969. The report insisted that it was too early for Korea to enter such a capital and technology-intensive industry as steel, and advised it to first develop more labor-intensive industries. Namely, it claimed that a strategy of producing intermediate products to replace imports would increase steel production costs in Korea as well as export costs and eventually erode the country’s global competitiveness.

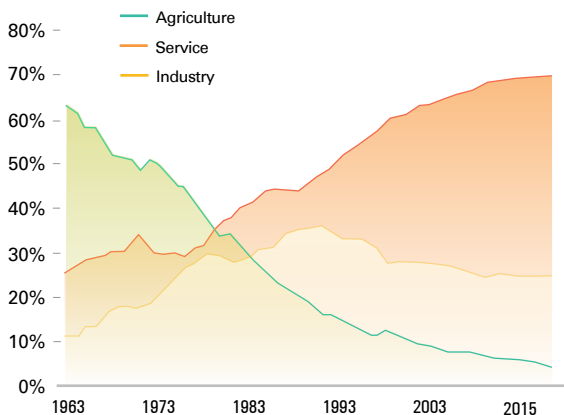
Then-CEO of POSCO, Park Tae-joon, suggest-



Source: POSCO

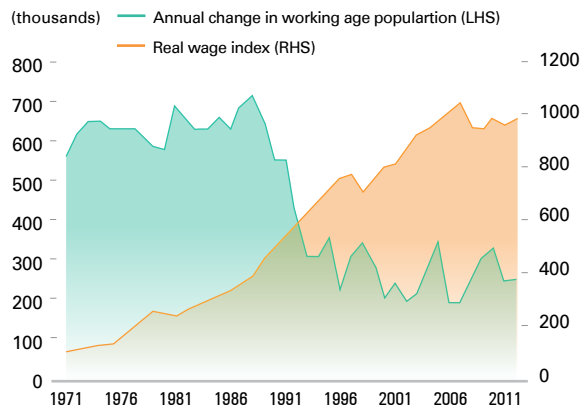
ed that the government allocate Japanese war reparations to build a steel mill, and eventually made the impossible possible. In 1986, 17 years after the IBRD report, Park met the author of the report, Dr. John W. P. Jaffe on business trip to London and asked him whether he still believed his report was correct. Jaffe stood by his original analysis, but added that the report turned out to be incorrect since not all variables were known. One was Park Tae-joon. There is another interesting anecdote, as well. When the Chinese leader Deng Xiaoping visited Nippon Steel in August 1978 and asked Chairman Yoshihiro Inayama for help to build a steel plant like that of POSCO, Mr. Inayama said, “It’s impossible. A steel company is not built with money or technology, but with

Figure 6. Proportion of Employment by Industry



Source: World Bank

Figure 7. Annual Changes in Working-age Population and Real Wage Index



Source: UNCTAD, Economic Statistics Yearbook

men,” he added, “but China does not have a man like Park.” Deng replied, “I shall import Park Tae-joon.” Additionally, a report published in 1991 by the Mitsubishi Research Institute analyzed that a major factor for the success of POSCO was the outstanding leadership, insight, and drive of Park Tae-joon.

Korea’s demographic changes and the Lewis turning point

Urbanization increases steel demand by creating construction demand. Rural to urban migration allows cheap labor and lays a foundation for successful industrialization. The renowned economist Jeffrey Sachs said in his book *The End of Poverty* that China was able to achieve economic reform based on its cheap

Another success factor was the demographic changes taking place at the time and the subsequent urbanization and industrialization.

Urbanization increases

rural labor. In the case of Korea, only 20% of the population lived in urban areas in the 1960s, but 30 years later in the mid-1990s, this figure had surged to about 80%. Under the policy with emphasis on industry, massive industrial employment was created thanks to the transfer of surplus rural labor. Examining the proportion of employment by industry as shown in Figure 6, the share of agriculture continued to decline, while that of industry increased into the early 1990s but fell afterwards. There are several reasons for this. One may be that the decline in cheap labor migration pushed up manufacturing labor costs and reduced industry job creation. Figure 7 shows that annual changes in the working-age population also slowed profoundly in the 1990s, and the real wage index surged in the 1990s prior to the Asian financial crisis.

Such changes can be explained by the Lewis turning point, named after Nobel Prize winner W. Arthur Lewis. The Lewis turning point describes a

moment at which surplus rural labor is depleted. This in turn typically causes urban wages to rise and economic growth to dwindle. When a country reaches this point, there occurs a mismatch between the supply of and demand for labor, leading to a spike in wages and the entrenchment of a high cost-low efficient structure across society. Korea experienced such a Lewis turning point in the 1990s, and its GDP growth rate and steel demand growth rate have slowed gradually ever since.

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The endogenous growth theory—accumulation of technological innovation, knowledge, and human capital

The endogenous growth theory, first suggested by Paul Romer, holds that technological innovation is not driven by external forces, but through knowledge accumulated by human capital, and that such technological innovation significantly contributes to economic growth. Notably, corporate efforts and government support for achieving technological innovation is one of the most important factors for the success of the Korean steel industry.

For example, at the time of its establishment POSCO adopted technologies from Nippon Steel and worked diligently to learn everything it could from this advanced Japanese steelmaker, from operational technology to product technology. As the Korean steel industry grew rapidly after the late 1970s, steel companies in Japan and other advanced countries became no longer willing to transfer new technologies. Therefore, POSCO


established POSCO Technical Research Lab, RIST, and POSTECH to develop technologies unassisted. POSCO has earmarked more than 1% of sales for R&D in order to foster advanced technologies and build high value-added production systems. POSCO's relentless efforts paid off over time. In 2007, POSCO built the world's first commercial FINEX plant, which was able to replace the conventional blast furnace-based steelmaking process. Today POSCO is even selling its unique technologies overseas, such as POIST (POSCO Innovative Steelmaking Technology), FINEX, and CEM (Compact Endless Cast and Rolling Mill). It is attempting to improve profitability by increasing sales of WB/WF (World's Best & World's First) products. In short, these continuous efforts to secure global competitiveness through technological innovation has been a key contributor in the Korea steel industry overcoming fierce competition with other advanced steel companies and eventually emerging as a steel powerhouse.

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Lessons for late-arriving developing nations

Based on its analysis on the development and success factors of the Korean steel industry, this article offers several policy implications for developing countries.

The first is the importance of the government's role and strategic decisions. At an early stage of economic growth with only scarce resources, it is necessary to maximize efficiency through selection and concentration. Korea offers a good example in that the government priori-



Developing countries can draw lessons from Korea's experiences and overcome the disadvantages faced by latecomers. They can make full use of the given opportunities to catch up. Then, there will be more positive cases in developing countries mirroring the success that took place in Korea.

tized economic development through its Five-Year Plans and allocated resources accordingly. As a capital-intensive process, the steel industry faces high entry barriers and can secure economies of scale only with a certain degree of production capacity. Therefore, the government should focus resources on the steel industry and provide benefits in terms of finance, taxation, foreign loans, and technological development. One viable strategy is establishing a representative state-owned company and focusing resources on nurturing it.

The government's strategic choices are of high importance as well. For instance, despite negative public sentiment, at the early stage of economic development the Korean government concentrated resources on infrastructure construction, which later served to increase logistical efficiency and drive economic growth. In addition, the authorities implemented policies with emphasis on heavy and chemical industries that triggered mutual growth in steel and steel-consuming industries and finally realized economic growth as well. The Korean government also protected its market

until the industry had gained the required degree of competitiveness. Taking into account this importance of strategic decision-making, developing countries should make optimal decisions based on their own conditions and drawing upon the experiences of advanced countries.

The second implication is entrepreneurial leadership and a "can-do" attitude. Korea's nascent steel industry was able to overcome its comparative disadvantage and write a new chapter in its history because of POSCO founder Park Tae-joon's passion, drive, sacrifice, vision, and strong leadership. This has been acknowledged by Korean scholars, in the media, and even by foreign industry insiders. In addition to this entrepreneurial leadership, another factor was involved—Korean workers' labor consciousness and desire for economic growth. With their "can-do" attitude, Korean laborers' hard work is certainly the foundation for the country's industrial development. However, this consciousness movement was also led by the government—a fact that developing countries should keep in mind.



The third is the importance of industrial policy based on medium- to long-term outlook for supply and demand. As shown in the case of Korea, there are several key variables to consider for mid- to long-term steel demand outlook: demographic shifts, industrialization, urbanization, and the advent of the Lewis turning point. Based on these variables, demand forecasts should be updated annually and supply policies should be carefully implemented to prevent a widening of the gap between supply and demand. Steel demand in Korea plunged after the two financial crises of 1998 and 2008, but the variables affecting mid- to long-term steel demand had begun to change even before. Considering this, it would be advisable for developing countries to first examine these variables and take pre-emptive actions. In other words, economic crisis management is important. If a crisis occurs, capital investment growth plunges and steel demand falls into prolonged recession, resulting in an aggravation of

oversupply. In Korea, oversupply significantly worsened after 2010 as capacity expansion policies were implemented despite sluggish demand.

Finally, there is the importance of determined drive of technological development and R&D investment. Before becoming a steel powerhouse, the Korean industry underwent an extensive period of knowledge accumulation, technology development, and R&D investment. Without improvements in product competitiveness through technological advancement and cost competitiveness, it is impossible to survive in global competition.

In conclusion, developing countries can draw lessons from Korea's experiences and overcome the disadvantages faced by latecomers. They can make full use of the given opportunities to catch up, since luck is what happens when preparation meets opportunity. Then, there will be more positive cases in developing countries mirroring the success that took place in Korea. 🗨️