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JAPAN-SOUTH KOREA'S RIVALRY:

The Semiconductor Industry Instrumentalization and its Implication for the Future of Japan-South Korea Economic Interdependence

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ABSTRACT

The 45th US president, Donald Trump, has created an environment suitable for bilateralism and trade conflict. Pursuing a similar path, Japan launched in July 2019 an export restriction toward South Korea on three key chemicals for the semiconductor industry. With South Korean firms being leaders for memory semiconductors and highly dependent on Japan for chemicals, this export restriction could deeply impact South Korea's semiconductor business as well as the world offer for memory semiconductors. Having a lingering historical dispute with South Korea, Japan tried to use these trade restrictions to put pressure on the country. However, Japan did not enforce its restriction too harshly in order to both save its face internationally and its local industry. Nonetheless, the decoupling process of the semiconductors industry with South Korea is ongoing and unlikely to go back.

On July 1, 2019, the Japanese authorities announced an export restriction targeting South Korea on three strategic chemicals unknown to the general public: Fluorinated Polyimide, Photoresist, and Hydrogen Fluoride. These restrictions took effect on July 4, 2019 and put the electronics industry in disarray. Indeed, Fluorinated Polyimide and Photoresist are crucial for LCD and OLED displays, and Hydrogen Fluoride is essential to make LSI, DRAM, and NAND flash memory. These electronic products are made of semiconductor devices in which billions of transistors are inlaying. The Japanese government argued that the mismanagement by South Korea of these dual-use chemicals is a potential threat to their national security. Thus, since July 4, 2019, every Japanese company willing to export these substances has to seek permission in a process that lasts 90 days. Moreover, the procedure grants the company a single export authorization, meaning that the procedure has to be repeated for each transaction the company makes in order to export the chemicals. This move disturbed the electronics industry that heavily depends on Japan and South Korea; these two countries assuming key positions in the sector.

The semiconductor industry is a crucial element of our modern economy and lifestyle. Interestingly, everybody knows how much our societies are dependent on oil and other fossil energy, but almost no one knows about the semiconductor industry's importance.

Without oil, the world economy would collapse almost instantly. It is also true for semiconductors. Indeed, every smartphone, computer, TV, and even car integrates semiconductor devices. The industrial sector also increasingly relies on semiconductors for the manufacturing and the management process. The Silicon Valley in the USA was named after the material required to build semiconductors and the whole region's development has been based on it. Without silicon, there is no semiconductor, and without semiconductors, no computer and so, no internet. The American GAFAM, a major tool of the US's economic power, would have not risen. The world without semiconductors could be almost as different as the world without oil.

The Japan-South Korea trade dispute can be rooted in the big picture of the enduring rivalry between these two countries. The real reason why Japan decided to restrict the exportation of these materials is related to political issues with South Korea that stem from the colonial era. Actually, the Supreme Court of South Korea has previously condemned Japanese companies for their use of Korean forced labor during the colonial era. Here, trade is used as a means to achieve political goals, and this aggressive instrumentalization of trade is directly linked to the election of Donald Trump at the presidency of the USA. Less than one year after his election, President Trump started a trade war with China. He therefore shifted from multilateralism to bilateralism and used both economy and trade as a weapon to reach his political goals. Trump's presidency influenced the structure of international relations and created an environment conducive to trade disputes and bilateralism. The Japanese government wields this international environment in its enduring rivalry with South Korea on historical issues.

OVERVIEW OF THE JAPAN-SOUTH KOREA TRADE DISPUTE

Historical Background

The relation between Japan and South Korea is haunted by colonialism. This period is still at the root of many conflicts between these two states. Historical beliefs from both sides highly impact the present and the people's support on foreign policy matters. It is therefore essential to understand the past relations of the ROK (Republic of Korea, the official name of South Korea) and Japan to better interpret the current situation. The

trade dispute is part of the ongoing historical conflict between Japan and South Korea, which stem from Japan's colonialization of the peninsula. However, to fully understand their relation it is important to consider the Imjin War (1592-1598), which could be seen as a prequel of the colonial era.

There are similarities between the Imjin War and Japan's colonization of Korea. First, the real target of Japan was China, in an attempt to obtain supremacy over East Asia. During the Imjin War, Japan wanted to used Korea as a way to invade Ming China to re-establish trade relations, ruptured since Japan was excluded from the tributary international system led by China. Joseon Korea was just a means for Japan to achieve its goal. Secondly, the post Imjin war, similarly to the post-colonial war, led to great losses in Korea. The Imjin war weakened Ming China and Joseon Korea which allow the Manchu to invade Joseon twice (1627 and 1637), and eventually defeat the Ming in 1644. This deeply affected the East Asian order and redefined Korea's role for the worst, by weakening the moral power on which the Joseon dynasty was based on. On the other side, the end of the colonial era led to the division of the peninsula into two states, followed by the Korean war (1950-1953). Thus, the Imjin war is a milestone in Japan-South Korea's relation. For Japan, it is related to the then-recent unification of the country while South Korea considers this war as Japan's first attempt to submit the Korean Peninsula. Both countries built their own nationalistic narrative around this war that also stained western scholars' approach to this conflict.

The colonization of Korea by Japan was a long process that began in 1976 with the Japan-Korea Treaty of 1876 (known as the Japan-Korea Treaty of Amity in Japan, and the Treaty of Ganghwa Island in Korea). This treaty extended the Japanese's sphere of influence onto the Korean Peninsula. While Japan did not exercise real control over the peninsula, military, business, cultural, and political elites started to integrate within Korea. Then, with the Treaty of 1905 (known as the Eulsa "Unwilling" Treaty in Korea, and the Japan-Korea Protectorate Treaty in Japan), Japan deepened its control over the country. Finally, with another treaty in 1910, Japan officially took full control of Korea until its defeat in 1945. The Joseon dynasty technically ended in 1948, but it had already lost its power in 1910, with the beginning of colonization.

The colonial rule over the land of the morning fresh aimed at destroying Korean culture and assimilate it into Japan. It is considered as the biggest trauma in the Korean collective psyche. The colonial era is the period from which ensued most of the disputes between these two nations. However, the different perspectives over this period from each side prevent any settlement between Japan and Korea. Korea often react emotionally to the colonial issue while nationalists in Japan tend to regard Korean colonization as part of the "Pacific War", to protect Asia from western influence and judged Korean claims as opportunists and spiteful. Issues that arise from this period are the following: the "comfort women", a euphemism for the use of sex slaves, mostly from Korea, by the Japanese imperial army; the Yasukuni Shrine in which the soul of class-A war criminals from World War II rest; the Dokdo/Takeshima islands that both countries claim; the issue of forced labor and forced recruits.

Neither country had official diplomatic relations until the Normalization treaty of 1965, signed by the then dictator of South Korea Park Chung-Hee and the Prime Minister of Japan. While South Korea's successful economic development was the most desired outcome for the government, the USA pushed Japan to participate in South Korea's development in its ideological competition against communism. More than just normalizing diplomatic relations between these two countries, the treaty came with financial compensation from Japan, designing at resolving historical disputes. However, this state-to-state treaty only settled government relations between both countries which left the door open for more disputes over colonial issues. The normalization ushered in a period of conflict and cooperation that lasts until nowadays.

The Economic Relation

Security and historical issues have never restrained trade and economic ties in East Asia. Notwithstanding complicated relations, China, Taiwan, Japan, and South Korea have always traded with each other. Nevertheless, the recent export restriction imposed by Japan and studied in this paper modified this trend. As mentioned previously, the trade war between China and the USA, initiated by President Trump, is related to this specific Japanese government's action. Japan understood that competitive advantage from a dominant position in the supply chain is a way of controlling the whole process. If Japan

already inflicted countervailing duties on SK Hynix DRAM's imports 2006-2009, it has never imposed such a harsh export restriction on semiconductor chemicals toward South Korea. At first, Japan expected that this export restriction would hit the ROK's semiconductor industry harder than its own industry. Japan's calculus was aimed at putting pressure on South Korea to change its position toward the Supreme Court's decision to sanction Japanese companies for forced labor during the colonial era.

The economies of Japan and South Korea are deeply interdependent, reaching similar levels than between some EU countries. However, if a trade dispute happens between the ROK and Japan, the same trade dispute would not be possible within the European Union. Indeed, the EU is economically integrated with a common market. Rules are clear and institutions have been built to avoid and manage such conflicts between its member States. However, economic integration did not happen between South Korea and Japan, despite shared values and economic interdependence, given the antagonism between the ROK and Japan. Similar to security issues, this enmity prevents the establishment of institutions able to manage such conflicts. Another solution would be the establishment of a formal mediation led by the World Trade Organization (WTO) with all the stakeholders involved. However, with the relative withdrawal of the USA on the international arena, the only country able to create a framework for mediation, the situation is uncertain.

JAPAN AND SOUTH KOREA SEMICONDUCTOR INDUSTRY

Two Leading Countries

South Korea is the leader of semiconductor memory devices by far. Samsung and SK Hynix are leading in this segment (more than 60% of the share) and together they account for 18% of the world's total semiconductor revenue (all segments included). This specialization into memory devices let the two Korean giants take the lead in this category of devices. This position, however, increases their vulnerability. The semiconductor revenue's drop in 2019 was higher for memory chips segment, impacting Samsung and SK Hynix more than other firms[1]. Moreover, this revenue decrease came at the worst time for South Korean companies which were facing a Japanese export restriction on the chemicals needed for their memory chips. South Korea relies on foreign firms for equipment and materials: indeed, Semes is the only Korean firm in the leading group of equipment suppliers, this group being dominated by the Dutch ASML, Japanese, and US companies. Nonetheless, South Korea is still a leading nation for semiconductors, in terms of manufacturing, research, and facilities.

In the case of Japan, the country has a dominant position on equipment as well as strong IDM[2] companies. IDMs control the whole manufacturing process and most equipment can be supplied by Japanese firms. It thus gives Japan a strong resilience, acquired by the almost complete integration of the whole supply chain, except for silicon and certain types of equipment.

Japan and South Korea are home to a large number of factories. 125 fabs[3] are located on their territories (WSTS 2020, SEMI 2020, Companies' data 2020). Furthermore, in the case of South Korea, almost all these factories are owned by national companies. Japan also has many fabs owned by its national companies, moreover, Japan's top companies Sony and Toshiba have all their fabs located within Japan.

[1] https://www.gartner.com/en/newsroom/press-releases/2020-01-14-gartner-says-worldwide-semiconductor-revenue-declined-11-point-9-percent-in-2019

[2] IDM stand for Integrated Device Manufacturer; this refers to companies that perform all the different stages of manufacturing semiconductor devices. Samsung and SK Hynix are also IDM companies

[3] A fab, also named foundry, is a factory that manufacture semiconductors devices

High Level of Dependence From South Korea's Firms Towards Japan

South Korea and Japan are both at two different positions in the semiconductor industry. They are highly interdependent and complementary. While South Korea's IDM firms are leaders in the semiconductor memory segment, Japan is a key player for equipment, especially chemicals. While Japan does not buy a lot of memory chips, South Korea relies on Japanese chemicals. This creates a supplier-buyer relation in which Japan has a dominant position.

In 2018, 44% of Hydrogen Fluoride imported by South Korea's firms came from Japan, and this number reached 88,6% for Photoresist chemicals and 90% for Fluorinated Polyimide (KITA 2020, OEC 2020, COMTRADE 2020). In value, South Korea imported nearly 70 million USD worth of Hydrogen Fluoride and about 300 million USD worth of Photoresist chemicals, with both chemicals representing less than 400 million USD. In the first five months of 2019 (before the export curbs), the value of South Korea's imports of these three chemicals reached 144 million USD. This is why Japan has a dominant position in the relation: these 400 million USD are crucial for manufacturing semiconductors that represent dozens of billions USD, and that are also the most exported goods of South Korea. By only damaging its chemical industry by a few hundred million dollars, Japan could hit the South Korean industry by hundreds of billions worth of semiconductors. It gives the Japanese government a powerful card to play in its relationship with its East Asian neighbor.

This unbalanced relation was molded during the very beginning of the semiconductor industry in the ROK. In the 70s, South Korea started developing its semiconductor industry. Focusing all their efforts into catching up with the advanced technology needed to manufacture semiconductors, firms in South Korea neglected the basic chemicals required for this industry. They decided to import those chemicals from Japan, which was the semiconductor's number one power at that time. Chemicals made in Japan were the very best available on the market. The close geographical location coupled with the improving relations since the diplomatic normalization of 1965 convinced South Korean firms to rely on Japan. Moreover, the 1986 US-Japan trade agreement forced Tokyo to decrease its semiconductor production and created an opportunity for Seoul. Since then,

South Korea has seen its share in the semiconductor devices industry increase while Japan lost its predominance in the sector but took a leading role for equipment.

In the following decades, the semiconductor industry became concentrated and globally dispersed, which allowed a few firms to share most of the market. Nowadays, Samsung and SK Hynix are the top IDMs and Japan is one of the best providers when it comes to equipment. In 2019, Tokyo Electron, Hitachi High-Technologies, and Dainippon Screen were making up for about 27% of the total equipment market. This win-win situation has never been questioned by firms, but political tensions disclosed South Korea's dependence on Japanese chemicals. Japan also dominates market shares in cellulose triacetate film, cathode material, anode material, and other key elements for the semiconductor industry. However, the Japanese hegemony on some chemicals does not only concern South Korea. Four Japanese firms hold 75% of the world's market of EUV Photoresist chemical. EUV technology is essential for the newest 7 nanometers memory chips developed by Samsung and SK Hynix. Therefore, finding alternative suppliers is complicated for any firm in the world. Thus, Japan has more cards to play in case of a trade retaliation from Seoul.

For its part, the ROK's firms account for more than 60% of the world's production of memory chips. Any halt in Samsung and SK Hynix production line could disturb the whole supply chain and create a shortage of memory chips. In 2019, Apple, Lenovo, Samsung, Dell, HP Inc. were among the top semiconductor buyers. All these companies provide essential electronic goods for consumers, and any disruption in their supply of semiconductors could impact their ability to meet demands. SK Hynix and Samsung being the unbeaten leaders of memory chips production, finding alternative suppliers for these devices is extremely challenging.

Chemicals at Stake

First, the focus should be put on Hydrogen Fluoride (HF). In 2019, South Korea imported 44% of its Hydrogen Fluoride from Japan. In terms of value, it represented 66 million USD. Nonetheless, Japan is not South Korea's main supplier when it comes to this chemical: indeed, China exported for a total value of 83 million USD of Hydrogen Fluoride

to South Korea the same year. Moreover, to produce HF, acid grade fluorspar has to be mined and then transformed. 63% of the world's total acid grade fluorspar is mined in China. Subsequently, this mineral is transformed into HF in China before being exported worldwide. Japan relies almost exclusively on the Chinese-produced HF. Furthermore, HF is used in the manufacturing process of semiconductors, but it is also used to make Fluorinated Polyimide, another chemical Japan targets in its export restrictions. Considering the above-mentioned data, one can be tempted to consider that South Korean firms can easily find alternative suppliers of HF. However, trade data fails to provide detailed yet crucial elements regarding this product. Indeed, HF as to be refined to be used in the semiconductor industry. High-quality HF is crucial to produce advanced semiconductors. China having limited capacity to refine HF, Japan is the leader in this segment. Thus, all of South Korea's imports of HF from Japan only concern highly refined HF, which is exceptionally hard to find internationally.

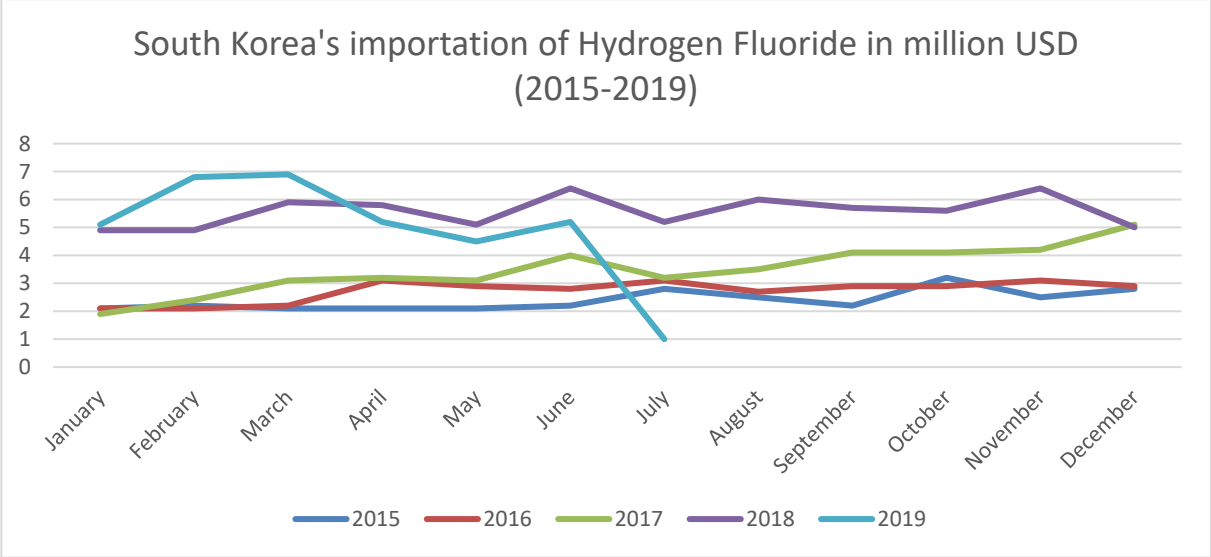

Figure 1: South Korea's importation of Hydrogen Fluoride from Japan in million USD (2015-2019) (sources: KITA, US Office of industries, Ihsmarkit)

The second chemical of interest is Photoresist. Indeed, among the three chemicals, it is the most important one imported from Japan in terms of value. Choosing Photoresist for semiconductor production is a long process that can take several months. When a firm wants to start the production of a specific semiconductor device, it asks samples from a Photoresist manufacturer, selects the best among the samples, and then asks the

manufacturer to refine the chosen sample. When the refining process is completed, the semiconductor manufacturer tests the refined product, and if it meets its expectations, the Photoresist company launches the full-scale production. This process can take several months, which makes it difficult to find an alternative buyer in the short run. Additionally, the shelf life of Photoresist is only about 3 to 6 months, making any stocking option time sensitive. Lastly, the Photoresist used in the EUV production technology requires advanced expertise; Japanese companies being the unbeaten producers of highly refined Photoresist chemical needed to produce the newest chips.

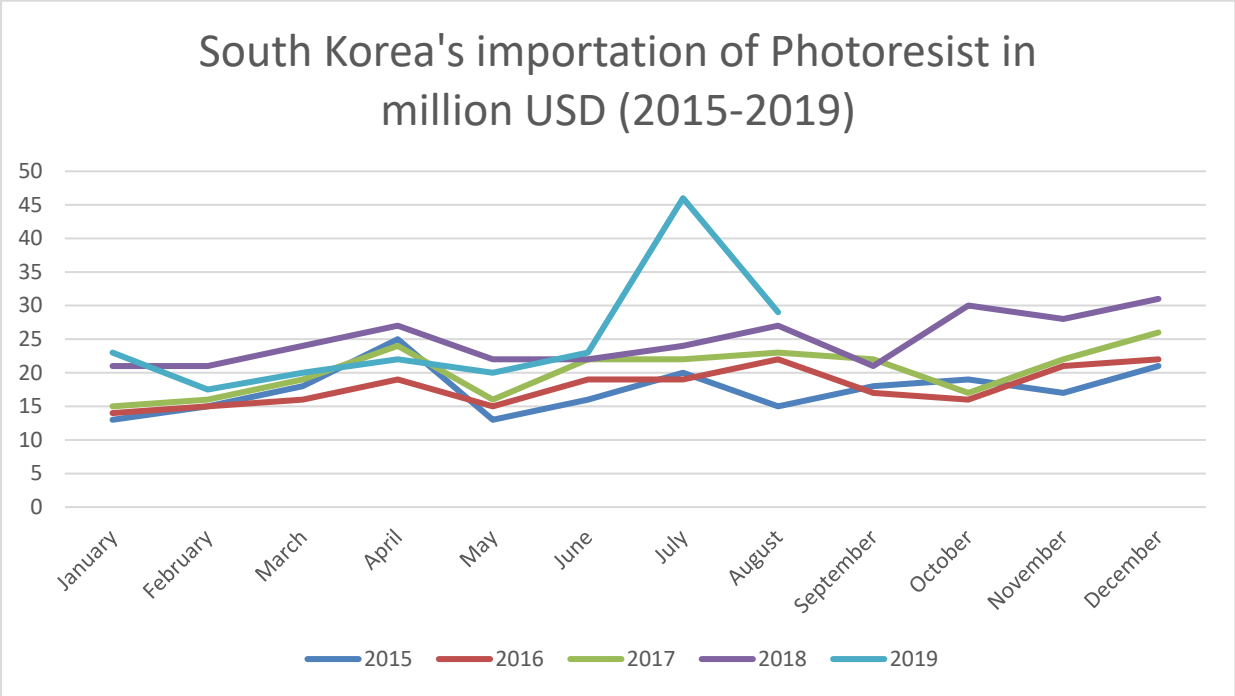

Figure 2: South Korea's importation of Photoresist from Japan in million USD (2015-2019) (sources: KITA, US Office of Industries, Ihsmarkit)

The last chemical is Fluorinated Polyimide. It is used in the semiconductor industry and also in displays' production. Japan claims to be in a dominant position in the world market concerning this chemical. However, this claim is difficult to verify since Fluorinated is part of a commodity group in world trade statistics. Fluorinated Polyimide is actually a by-product of Polyimide, which has an export/import code and is subject to statistics. Consequently, trade data does not differentiate refined and unrefined HF, and the same issue applies for Polyimide and Fluorinated Polyimide, which are not considered separate. The KITA (Korean International Trade Organization) does provide data about

South Korean imports of Fluorinated Polyimide, but such initiatives have not been taken globally. Polyimide production is concentrated in Asia, but nothing is verifiable regarding the supposed Japanese dominance in the Fluorinated Polyimide sector. Nevertheless, it is known that in the case of South Korea, the country relies almost exclusively on importations from Japan.

THE IMPACT OF THE TRADE DISPUTE

Companies at stake

In Korea, Samsung and SK Hynix are threatened by this trade dispute. Since they produce the most advanced memory chips, they need the most refined chemicals that Japan produces. Only one Korean company can sell refined Hydrogen Fluoride to Samsung and SK Hynix: Foonsung. Foonsung was already selling HF to Samsung and SK Hynix prior to the Japanese restrictions. However,

Foonsung does not have the industrial capacity to sell enough HF to meet the demand of both Samsung and SK Hynix. Furthermore, SK materials and Soulbrain are also firms specialized in chemical production. They can produce HF, but they have not worked with Samsung and SK Hynix. For Photoresist chemicals, South Korea is home to several companies. Dongjin semiconductors and Dongwoo sell Photoresist chemicals that they produce nationally. The American firm Dupont has three facilities in South Korea that also specialize in the production of Photoresist chemicals. However, these firms' facilities (Dupont, Dongwoo and Dongjin) only produce an earlier version of Photoresist which is unsuitable for the EUV means of production used by Samsung and SK Hynix.

Japan has two national companies producing Photoresist that suit EUV production, and three other companies that produce former versions of Photoresist. JSR Corporation (not to be confused with JSR Micro Inc) and Tokyo Ohara Kogyo (TOK) are the leading firms for high-quality Photoresist. Since few companies can produce chips that require their last EUV Photoresist technology, which is the case for Samsung and SK Hynix, JSR Corporation and TOK rely on these Korean firms for a certain share of their revenues. However, they both have facilities outside of Japan, more specifically in the US, Taiwan, South Korea, and in Europe (Belgium and Netherlands). Besides, Fujifilm Electronic Materials, Sumimoto

chemicals, and Shin-Etsu Chemicals are also Japanese companies manufacturing Photoresist. However, they only produce former generations of Photoresist that they also export to South Korea. In this domain, Shin-Etsu Chemicals is the most important supplier of earlier versions of Photoresist for South Korean firms.

For Hydrogen Fluoride, there are two main companies in Japan that provide HF in gaseous form: Showa Denko KK and Kanto Denka Kogyo. They both offer the best refined HF that Samsung and SK Hynix need for their semiconductors. These two companies account for most of the South Korean Hydrogen Fluoride imports, but they also strongly depend on South Korean demand for their revenues. The Japanese Stella Chemifa and Morita Chemicals also provide South Korean firms with HF but in its liquid form.

Concerning Fluorinated Polyimide, Daikin Chemical and Sumimoto are the main supplier of Korean firms. These companies supply Samsung and SK Hynix with Fluorinated Polyimide but also LG with other Polyimide products used for the manufacturing of flat panel displays. There are only Kolon industries and SKC (a subsidiary of SK Hynix) that are able to produce Fluorinated Polyimide in South Korea.

In the world, they are few companies offering the three chemicals I have reviewed in this section. In the US, the most noticeable firm is Dupont, which is also one of the world's leading firms for chemical production. Dupont offers excellent quality and has many facilities around the world, including South Korea. German companies also offer high-quality chemicals, the best being BASF, Merck, and Siemens.

The impact of Japan's export curb on South Korea's reliance towards Japan

In 2019, Samsung and SK Hynix suffered from a huge decrease in their revenues, Samsung losing its leading position as the world's number one semiconductor firm. This drop occurred because of the decrease in demand on the memory chip market that both companies rely on for their growth. Moreover, the trade restriction imposed by Tokyo was likely to foster this decrease. However, in the first half of 2020, Samsung's revenue grew by 12% while SK Hynix experienced a 13% growth YoY (year-on-year). These growth rates are lower than the growth in revenue for the top 10 semiconductor firms

(23,7%). Nonetheless, Samsung and SK Hynix's revenues experienced an approximate twofold increase compared to the overall semiconductor industry, which has grown by only 6,77%. Therefore, this implies firstly that the memory chip market has not been suffering from the Japan-South Korea trade dispute since it essentially relies on Samsung and SK Hynix. Secondly, it shows that the decrease in 2019 was due to the drop in memory chip demand and not due to the trade dispute. Indeed, the trade dispute is still ongoing while the demand in memory chips has grown (the demand in memory chips is expected to grow during the entire year of 2020)[4]. The price for memory chips increased at the same time as the demand and Samsung seems able to meet that demand[5]. It demonstrates that the trade dispute did not impact the South Korean semiconductor industry.

SK importation of Hydrogen Fluoride post-exports curbs (July 2019-May 2020)	SK importation of Hydrogen Fluoride pre-exports curbs (July 2018-May 2019)	Change in %	SK reliance on Japanese HF 2019	SK reliance on Japanese HF 2020
7 million USD	**63 million USD**	**-89,4**	**44%**	**10-12%**
SK importation of Photoresist post-exports curbs (July 2019-May 2020)	SK importation of Photoresist pre-exports curbs (July 2018-May 2019)	Change in %	SK reliance on Japanese Photoresist 2019	SK reliance on Japanese Photoresist 2020
275 million USD	**265 million USD**	**3,77**	**92,8%**	**86,7%**
SK importation of Fluorinated Polyimides post-exports curbs (July 2019-May 2020)	SK importation of Fluorinated Polyimides pre-exports curbs (July 2018-May 2019)	Change in %	SK reliance on Japanese Fluorinated Polyimides 2019	SK reliance on Japanese Fluorinated Polyimides 2020
30 million USD	**22 million USD**	**36,3**	**92,7%**	**92,0%**

Table 1: Korean importation of Hydrogen Fluoride, Photoresist, Fluorinated Polyimide for July 2018-May 2019, and July 2019-May 2020, and reliance of South Korea to Japan for each material (sources: KITA, Ihs, Omdia)

[4] http://www.koreaherald.com/view.php?ud=20200419000088
[5] https://www.cnbc.com/2020/04/07/samsung-q1-profit-guidance.html

This was made possible by the high reliance of South Korean firms towards Japan and the scarcity of alternative suppliers that should have damaged South Korea's semiconductor industry. As I explained, Shinzo Abe, the then Prime Minister of Japan imposed export curbs mainly for political reasons. His motivations had nothing to do with the trade relation between Seoul and Tokyo, both parties being complementary in many fields as exemplified by the semiconductor industry. Japan even enjoys a surplus in its trade balance with South Korea since the normalization of their relations in 1965.

However, these export restrictions were likely to damage the whole memory chip supply chain, and therefore the final consumers of these semiconductor devices. Among the top semiconductors' buyers, many are from the US, such as Apple, Dell, or HP Inc. Moreover, Dell and HP Inc need numerous memory chips to manufacture their goods. It seems that Japan was not ready to reach such far extent in its conflict with South Korea as the restriction imposed by Tokyo could have hurt.

the businesses of its greatest ally. As Table 1 shows, except for Hydrogen Fluoride, South Korea's importations of Japanese chemicals increased. In fact, South Korea's Hydrogen Fluoride importations dropped from 63 million USD to 7 million between July 2019 and May 2020 YoY. The drop represents 89,4%, and South Korea's reliance on Japan for this material decreased from 44% to 10%. The importations of Hydrogen Fluoride were already on the decline before Japan announced the export curb, so I expected South Korea to be able to find alternative suppliers -domestically or abroad - for this chemical.

The situation was different for Photoresist. Figure 2 shows a sudden increase of Photoresist importations during the month of July, after Japan's announcement, and before the export curbs became effective. Since South Korea's reliance on Japanese Photoresist being higher than its reliance on Hydrogen Fluoride, I expected tough consequences on South Korea's firms. However, as Table 1 indicates, South Korean importation of Photoresist increased in value after the restrictions, increasing from 265 million USD to 275 million USD. However, South Korea's reliance on Japanese Photoresist declined from 92,8% to 86,7%. This decline is non-negligible although not really significant. Circumstances are similar for Fluorinated Polyimide: the importation in value

also increased and the reliance decreased (although less than for Photoresist).

If importations increased in value for Photoresist and Fluorinated Polyimide, it is because Japan authorized many shipments since October 2019. In fact, on this specific month, Japan approved 7 shipments to South Korea, and in December 2019, Japan's authorities delivered a special bulk permit of three years to export Photoresist to South Korea.

Furthermore, soon after the export curbs announcement, Samsung started prospecting to find an alternative supplier of Photoresist. Samsung therefore turned to a Belgian company having ties with JSR, the main Japanese Photoresist exporter to the ROK. Japanese authorities did not prevent any delivery of Photoresist from this company, arguing that JSR has to seek approval to export Photoresist to South Korea from Japan only[6].

If South Korean firms did not suffer from the Japanese export curb, it is not because their supply chain adapted to the changing situation, but it is because Japan decided not to damage South Korea's semiconductor industry. The decision was taken due to domestic matters and international.

reputation, and Japan hence allowed the chemicals to be exported in South Korea. Nonetheless, Japan did not terminate the export curb, which means that Japan can use it more abruptly in the future if the situation demands it. However, this exportation curb will leave traces in the future of their commercial relationship, which will be discussed in the following part.

THE FUTURE OD THE SOUTH KOREA-JAPAN SEMICONDUCTOR INDUSTRY AND ECONOMIC INTERDEPENDENCE

This paper reveals that South Korea was still relying on Japan for more than 80% of its Photoresist and Fluorinated Polyimide importations. Nonetheless, this reliance is

6 https://asia.nikkei.com/Spotlight/Japan-South-Korea-rift/Samsung-secures-key-chip-supply-in-Belgium-as-Tokyo-curbs-exports and https://www.sammobile.com/news/report-samsung-to-acquire-japans-photoresist-through-a-belgian-firm/

declining since Japan initiated export curbs, and South Korea is building domestic productions for the three chemicals that Japan imposed restrictions on. In the case of Photoresist, Dongjin chemicals, a national company, is expanding its production capacity in close relation to Samsung and SK Hynix. Dupont, a leading firm for chemicals in the world, is building a factory in South Korea to produce EUV Photoresist. Samsung has made a joint venture with a Belgian company to secure the supply of Photoresist. Since July 2019, South Korea's importations of Photoresist from Belgium multiplied by 10. Despite still being dependent on Japan for Photoresist, South Korea is moving to more sovereign production of this chemical by attracting foreign firms on is territory and developing national businesses.

The situation is similar to the two other chemicals. SK materials and Soulbrain have developed a production of Hydrogen Fluoride able to satisfy Samsung and SK Hynix in terms of quality. SK materials are now able to produce 15 tons of Hydrogen Fluoride refined at 99,999% in its Yeongju factory. Moreover, the company is building another factory in the country with a capacity of 50 000 gallons of Photoresist per year that will be ready in 2021[7]. They successfully refined this chemical to be used in the production of memory chips. According to Brad Glosserman, a professor at Tama University, South Korea's companies will meet 70% of South Korea's Hydrogen Fluoride demand by 2023[8]. Regarding Fluorinated Polyimide, Kolon industries and SKC are developing its mass production. SKC, a subsidiary of SK Hynix, would now produce about 1 million square meters of Fluorinated Polyimide per year to fulfill SK Hynix's needs. Since the launch of the export curb by Tokyo, Soulbrain and Dongjin have seen their share value rise by more than 90%, while SKC and SK materials' share value increased by 60% and 26% respectively[9]. The South Korean government

plays the main role in the successful development of the capacity of these companies. Indeed, the government allocated 1,74 billion USD to secure the supply and production of 100 key items to protect the semiconductor industry as well as other key industries for the country. In June 2020, the government expanded the list to 338 items with

[7] http://www.koreaherald.com/view.php?ud=20200625000809
[8] https://www.japantimes.co.jp/opinion/2020/07/22/commentary/world-commentary/south-koreas-trade-fight-threatens-serious-long-term-harm-japan/
[9] https://pulsenews.co.kr/view.php?year=2020&no=648125

approximately 1,7 billion USD allocated per year. This capital would be used for advanced materials and equipment that South Korea's economy needs to keep growing. The South Korean government stands as a key player in securing the supply of semiconductors, and the rise of SKC, SK materials, Dongjin, Kolon, and Soulbrain is due to its proactive behavior. It additionally shows that South Korea's political power realized the need to secure supply chains and decrease the country's dependency on other nations. Therefore, it appears that States will increasingly be involved in the semiconductor industry.

Even though Japan would cancel the export restrictions, South Korean semiconductor companies are not likely to return to the previous situation of dependence over Japanese chemicals. In a survey realized by the Federation of Korean Industries on 149 companies from the ROK that used to import Japanese chemicals, most consider their competitiveness to have increased since the export curb, especially for high-tech firms[10]. As time moves forward, South Korea and Japan are likely to further decouple their semiconductor industries. Moreover, export curbs are likely to be used by Tokyo in the future. Indeed, even though Japan allowed enough exportations of chemicals to let Samsung and SK Hynix produce their chips, Japan did not cancel the export curbs. In fact, export curbs are intended to the domestic audience in order to create a rally to the flag effect that benefits the ruling party. Even with Abe's resignation, Yoshihide Suga is expected to pursue Abe's foreign policy line, especially if the Liberal Democratic Party (LDP) maintains its power in the next legislative election (it is important to note that since the end of WWII, the LDP has won most of the national elections, with a very few political alternations). Since the Normalization Treaty of 1965, South Korea-Japan's relation has been experiencing a circle of ups and downs. The current world environment encourages countries to use trade as a political tool for domestic and foreign audiences and consequently, Japan is probably going to strengthen or respite export curbs in the wake of its relationship with the ROK and its domestic political needs. Some argue that Japan has already a list of goods on which South Korea's industry depends and regarding the evolution of their relation, Japan will decide to restrict or not exportations for these products. Japan's recent opposition to South Korea's participation in the G7 and its opposition to the nomination of Yoo Myung-Hee as the head of the WTO are signs that their relationship is not going to improve soon.

[10] https://world.kbs.co.kr/service/contents_view.htm?lang=e&menu_cate=business&id=&board_seq=387276

Japan and South Korea could easily be trapped in a vicious circle. The more their relation deteriorates, the more they will decouple their economies, therefore the fewer incentives to cooperate they will receive. ■

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By LOÏC DUMAS / Analyst in Market Intelligence with Cision

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