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Evolving Global Supply Chains: Friction, Transformation, and Possibility

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Evolving Global Supply Chains: Friction, Transformation, and Possibility*

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Abstract

This paper analyzes the factors driving friction and transformation within global supply chains (GSCs), focusing on economic and geopolitical aspects, as well as the potential of evolving GSCs due to the increasing trade of knowledge-intensive task. GSCs have been enlarged by the technological improvement of communication and transportation and the reduction of trade costs as well as China's integration into the global trade. China's rise in global production and consumption, along with its dominant role in GSCs, faced challenges due to escalating trade tensions with the United States. Concerns about national security led to the restrictions of trade, investment, and technology transaction in advanced semiconductors, causing shifts in supply chains away from China. The COVID-19 pandemic further exposed vulnerabilities in GSCs, prompting nations to reconsider the risks of economic dependencies within GSCs, which led to diversify sources and destinations within GSCs. The paper discusses the transformation of GSCs with a shift towards high-value-added production processes incorporating knowledge-intensive tasks, and asserts that intellectual property protection becomes crucial in this context, impacting the formation of new GSCs. Lastly, the paper explores the potential for new GSCs between Japan and South Korea in knowledge-incentive sector like the semiconductor industry. Two nations share the similar trade rule and legal system for intellectual property right protection. The recent development of GSCs between the two nations in knowledge-intensive manufacturing is exemplified by their collaboration in the semiconductor industry.

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1. Introduction

The fragmentation of the production process and offshore sourcing, which were accelerated by technological advancements in information and communication, the development of transport networks, and the reduction of trade costs through the elimination of tariff and non-tariff barriers in the late 1990s and 2000s, played a pivotal role in driving the expansion of global supply chains (GSCs). China's accession to the WTO in 2001 facilitated its integration into international trade, transforming it into a major player in global production and consumption. The swift growth of the Chinese economy after the 2009 world financial crisis further amplified its engagement in global markets, solidifying its position as a hub of GSCs in East Asia.

However, China's centrality in GSCs is undergoing changes in the late 2010s due to escalating trade tensions with the United States. In 2015, China unveiled the "Made in China 2025" industry policy, designed to enhance its global competitiveness through government subsidies to state-owned enterprises. This move triggered a reaction from the United States, which imposed higher import tariffs on Chinese goods. China reciprocated by raising tariffs on American products, leading to a surge in trade barriers between the two nations. Concerns about national security prompted the US government to impose restrictions on trade, investment, and technology transactions related to advanced semiconductors with China. Additionally, critical minerals, such as rare metals, shifted their sourcing away from China to friendly countries. Countries like the EU, South Korea, and Japan, aligning with the United States, began implementing restrictive measures on trade, investment, and technology transactions involving advanced semiconductors and shifted their critical mineral supply chains away from China[1].

The outbreak of COVID-19 also exerted a significant impact on the evolution of GSCs. To contain the virus's spread, the Chinese government imposed stringent restrictions on domestic economic activities, leading to the suspension of production in Chinese-linked manufacturing facilities worldwide. This disruption in the supply chain caused abrupt demand and supply imbalances, even temporarily, which rippled through the GSCs and made manufacturers in Western countries cautious about overreliance on Chinese firms.

[1] Refer to Spillner, Ole and Wolff, Guntram (2023).

This paper aims to analyze the factors that have elevated friction costs within GSCs and triggered their transformation, considering both economic and geopolitical perspectives. The subsequent section delves into the factors driving increased costs in maintaining GSCs, rooted in political and national security motivations. Following this, the third section explores the elements contributing to the emergence of alternative GSCs within Western economies. The fourth section investigates the potential for the development of new GSCs between Japan and Korea. Finally, the paper concludes by summarizing the key points of discussion.

2. Friction of GVCs

2.1 De-risking with Authoritarian States

China's accession to the WTO in 2001 marked a significant turning point, propelling its exports into the free and open global market. Driven by a substantial expansionary demand policy following the 2009 financial crisis, China emerged as the world's largest country in terms of both exports and imports. The impact of China's economic growth gained momentum after the Lehman shock. In response to the global demand contraction caused by the Lehman shock, China enacted a large-scale expansionary demand policy totaling 4 trillion yuan. This policy injected additional demand into the global economy through international trade, and China's demand expansion played a pivotal role in the world economy's recovery following the Lehman shock in 2010. Subsequently, China's presence in global trade, both in exports and imports, experienced a rapid ascent. By 2022, China accounted for a remarkable 15% of the global trade value, solidifying its position as the world's largest producer and consumer. Notably, China currently holds the title of the world's largest production and consumption market. China has also demonstrated its commitment to infrastructure investment in developing nations across Asia and Africa through initiatives like the "One Belt One Road." This endeavor has been facilitated by the establishment and operation of the Asian Infrastructure Investment Bank, which has concurrently bolstered China's political and military influence on a global scale.

Democratic nations, including the United States, the EU, and Japan, initially welcomed China's integration into the global trade landscape and its subsequent economic

growth. These democratic nations anticipated that China's WTO membership would encourage further liberalization of its domestic markets, foster shared democratic values with Western counterparts, and contribute responsibly to global economic development. However, China's rapid economic progress has not fully aligned with the expectations of Western nations. Operating under an authoritarian state model rather than a democratic one, and adhering to principles of a market economy, China's ascent in economic, political, and military power has generated economic and political tensions with democratic countries. These tensions have led to caution in maintaining deep interdependencies in GSCs with China.

Economies interlinked through GSCs are inherently susceptible to economic fluctuations within their trading partners, both in terms of forward and backward integration. The extent of reliance on GSC-linked trade partners directly influences the magnitude of economic shocks transmitted between them. Close GSC ties can serve as leverage for political and military coercion, particularly when partners hold varying degrees of economic power.

Democratic nations are mindful of the potential risk stemming from China's dominance in supplying critical materials like rare earths and its increasing production of high-tech goods, such as semiconductors, which could confer coercive influence over GSC-linked trade partners. To mitigate associated economic, political, and military risks arising from trade with China via GSCs, these democratic nations are collaboratively adopting a policy approach to "de-risk" their trade interactions with China. However, there are uncertainties regarding the extent to which such de-risking strategies may distort global trade, the associated costs for the world economy, and whether these measures effectively mitigate the identified risks.

2.2 Decline of Production Unbundling

The production of semiconductors involves a complex amalgamation of multi-stage processes. These encompass the development and design of logic, the creation and manufacturing of materials like wafers and specialized gases, the production of semiconductor manufacturing equipment, and the refinement of microfabrication technology. Semiconductors, often referred to as the "rice of industry," are fundamental components in a broad array of high-tech products, including communication devices like

smartphones and computers, as well as consumer goods like home appliances, automobiles, aircraft, and even weapons such as missiles.

The timeline of semiconductor production history reveals a dynamic shift: originating in the United States during the 1970s, the mantle was then passed to Japan in the 1980s, and subsequently to South Korea, Taiwan, and China. Presently, a significant portion of semiconductor manufacturing takes place in Taiwan, South Korea, and China, with the United States and Japan no longer at the forefront. While Japan led the global semiconductor production in the 1980s, its current role is primarily centered on providing specialized gases and a subset of manufacturing equipment. However, it lags behind Taiwan and South Korea in terms of microfabrication production processes.

China's foray into semiconductor production was facilitated by technology transfers from the United States and Japan. In 2000, China established SMIC, a national foundry company, with the aim of establishing a domestic foundation for semiconductor manufacturing. Through the assimilation of cutting-edge technology, SMIC managed to enhance its production capabilities, bridging the gap with foreign counterparts. In its pursuit of bolstering both civil and military semiconductor production capacities, China recognized the vulnerability posed by its reliance on foreign semiconductors, which could potentially jeopardize national security. To mitigate this risk, the Chinese government initiated subsidies to support the growth of domestic semiconductor manufacturers.

Given that semiconductors serve critical functions, including military applications, the United States grew apprehensive about China's ability to develop and produce high-end semiconductors, fearing the erosion of its military power advantage. Additionally, concerns arose over intellectual property theft, particularly involving Huawei, and the potential leakage of confidential information through backdoors in Huawei's communication equipment. Consequently, the U.S. implemented measures such as banning government procurement of Huawei products, limiting imports, and constraining semiconductor supply to Huawei. Furthermore, the United States restricted advanced semiconductor technology exports to China in 2022 and curtailed overseas investments to semiconductor firms in China in 2023. Comparable trade restrictions are being also adopted by other nations, including the EU, Japan, and South Korea. As a consequence, China's access to advanced semiconductors via GSCs has been narrowed.

In response to the shrinking availability of advanced semiconductor GSCs, the United States, South Korea, and Japan embarked on efforts to expand their domestic production capacities to mitigate potential supply shortages. For instance, the United States extended invitations to TSMC and Samsung to establish operations in Arizona and Texas, respectively. Japan, similarly, plans to host TSMC in Kumamoto Prefecture and Samsung in Yokohama. Additionally, a new company named Rapidus is being established in Hokkaido to facilitate the mass production of logic chips.

In parallel, China has taken proactive steps to bolster the production capacity of high-end semiconductors, chiefly through substantial government subsidies to manufacturers. Consequently, the proportion of domestically produced components used in Huawei's 5G communication standard has risen to 55%, with Huawei's subsidiary, Hi-Silicon, playing a major role in semiconductor production. In contrast, the share of U.S.-made components has dwindled to a mere 1%.

It is pertinent to acknowledge that the process of unbundling trade and co-locating semiconductors, as discussed earlier, entails considerable costs in terms of subsidies and trade distortions. The question arises whether the substantial subsidies extended to foster the growth of domestic semiconductor industries in the United States, China, and Japan, in exchange for the trade advantages of stemming from unbundled production of semiconductors through GSCs, effectively serve the purpose of safeguarding national security.

2.3 Geopolitical Risk

In response to Japan's decision to nationalize the Senkaku Islands, China implemented a ban on the export of rare earths to Japan in September 2010. As the world's primary supplier of rare earth elements, China's embargo had significant repercussions, causing substantial economic harm to Japanese companies reliant on China for their supply chain needs. Furthermore, the boycott of Japanese goods led to considerable damage to the automobile sector[2]. This event underscored how economic control wielded through GSCs can be an effective means of exerting trade-related pressure, potentially involving political and military implications. The recurrence of such tactics remains a

[2] Refer Tanaka, Ito, and Wakasugi (2019).

possibility. China's actions extended beyond rare earths. Notably, it imposed import tariffs on Australian wine and barley in 2020, ostensibly linked to investigations into the origins of the new coronavirus. This move adversely impacted Australian producers and illustrated how economic leverage could be employed for political ends. Similarly, China suspended imports of Taiwanese pineapples in 2021, ostensibly due to pest-related concerns, as a means of exerting pressure on Taiwan's leadership.

The strategic use of economic power within GSCs can lead to not only economic disadvantages for trade partners but also create political and military threats. Consequently, countries engaged in GSCs may prioritize optimizing the benefits of GSCs over merely maximizing trade volume. To enhance national security and mitigate risks, nations like the United States, the European Union, and Japan have pursued diversification strategies for critical minerals such as rare metals and rare earths. This involves seeking sources from a variety of countries to avoid overreliance on a single supplier. Moreover, efforts are being made to diversify both the sources for procurement and the destinations for supply within GSCs. By doing so, these nations aim to reduce the potential for the contagion of economic power through GSCs.

The interplay of geopolitical risks significantly amplifies the friction costs associated with GSCs. The events discussed demonstrate how economic dependencies within these chains can be exploited for political and strategic gains, underlining the complex and multifaceted challenges posed by the interaction of trade, security, and global politics.

3. Evolving GSCs

3.1 Unbundling vs. Co-location

The expansion of global trade since the 1980s has been significantly influenced by the rise of intra-industry trade, which differs from traditional inter-industry trade. According to new trade theory, the presence of economies of scale in producing differentiated goods has led to increased profits from international specialization and trade. In recent times, intra-industry trade has evolved from the level of goods to the more granular level of tasks. This shift has been made possible by the fragmentation of production processes, which involves breaking down production into various stages and outsourcing them to different locations. This process, known as unbundling and

offshoring, has been facilitated by the reduction of coordination costs, including trade costs, international transportation, and communication expenses. The key driving force behind the development of GSCs is the realization of economies of scale and efficient production through this unbundling process. As a result, labor-intensive stages of production are moved to the countries with lower wages, while capital- and knowledge-intensive processes are located in nations with abundant capital and skilled labor.

When China joined the World Trade Organization (WTO), it possessed a labor-intensive, low-wage workforce, making it an attractive location for offshoring labor-intensive production processes. China's incorporation into GSCs began in the early 2000s, leading to the emergence of a significant trade triangle between Japan, China, and the United States. Over time, China's economic growth has led to the concentration of assemblers responsible for the production processes of foreign-affiliated companies within its borders. This has resulted in the accumulation of a wide variety of production processes. Many companies around the world have become interdependent with Chinese firms for their production activities, turning China into the world's largest factory and a hub of GSCs in East Asia. Foreign firms have established strong connections with Chinese counterparts through GSCs.

The choice of a firm's location is determined by a balance between comparative advantage, driven by factors such as differing production costs, and the benefits of co-location due to agglomeration effects. The reduction of trade costs, communication, and coordination expenses has made it easier for production to relocate based on comparative costs, thus fostering the expansion of GSCs. However, recent developments have highlighted potential risks associated with the concentration of GSCs in China. The outbreak of COVID-19 and China's stringent measures to control its spread led to the suspension of production activities, causing disruptions to firms linked to Chinese partners. This prompted many foreign firms to reconsider their reliance on China and seek alternative export destinations or import sources in Southeast Asia or even re-shore production back to their home markets.

The diversification of GVCs and offshoring, though crucial, is not straightforward, as the choices made by firms regarding assemblers and parts manufacturers are not consistently determined. These choices can vary depending on the nature of production, whether it resembles a "Snake" pattern with sequential stages or a

"Spider" pattern with a more complex web of interdependencies[3]. This complexity underscores the intricate dynamics at play in the global production landscape.

3.2 Knowledge Intensive GSCs

The G7 Hiroshima Summit highlighted the urgency of establishing resilient GSCs and showcased the collaborative efforts of developed nations towards this objective. The summit's declaration introduced key terms like "friend shoring" and emphasized the creation of GSCs with nations that uphold similar values, indicating a novel direction in the evolution of GDCs.

Initially, the formation of GSCs commenced with offshore sourcing, a strategy involving the segmentation of labor-intensive production processes in countries with low wages. However, as the global economy expands in tandem with GSC development and labor wages rise, the economic viability of low-value-added production processes employing low-wage workers diminishes. Such processes are increasingly confined to regions with low labor costs. Consequently, the focus is shifting towards high-value-added production processes that incorporate a higher degree of knowledge-intensive tasks. This shift ensures profitability even in areas with elevated wage rates. The relocation of labor-intensive production processes from China to Southeast Asia and Africa, characterized by lower wages, underscores this transition and underscores the growing importance of knowledge-intensive tasks.

As the proportion of intellectual property within goods and services traded through GSCs rises, the proper safeguarding of intellectual property becomes imperative. With the escalating prominence of intellectual tasks traded, countries connected by GSCs must guarantee the protection of intellectual property rights associated with these tasks. This dynamic prompts a shift of participation in GSCs from jurisdictions with weaker intangible property (intellectual property) rights protection to those that uphold a robust legal framework for such protection.

The assurance of ownership and utilization rights for intangible property is upheld by legal regulations and rules. As a result, the expansion of a new breed of GSCs – encompassing the outsourcing of processes for producing high-value-added goods and

[3] Refer Baldwin and Venables (2013).

services – is anticipated to be most pronounced in countries where intangible property rights are effectively upheld through robust legal and regulatory mechanisms. GSCs, constituting a series of interconnected tasks aimed at producing high-value-added goods and services, are expected to flourish among countries and regions that share a commitment to stringent rules for safeguarding intellectual property rights. The trajectory of current GSCs is set to transform based on their ability to satisfy these conditions and adapt to evolving dynamics in the global production landscape.

4. GVCs between Japan and Korea

Figure 1 depicts the extensive human exchanges between Japan and South Korea, reflecting the substantial connectivity between the two nations. The flight duration between Tokyo and Seoul, a mere two hours, is equivalent to the travel time of the Shinkansen between Tokyo and Niigata. Despite favorable factors like geographical proximity, reasonable transportation costs, and shared cultural ties, as demonstrated in Figure 2 and Figure 3, the trade volume between South Korea and Japan remains comparatively modest in contrast to their trade relationships with the United States and China, respectively. This phenomenon can be partially attributed to the independent trade triangles that Japan and South Korea respectively establish with the United States and China, leading to limited trade complementarity between the two countries. The considerable resemblance in their structures of comparative advantage further contributes to this dynamic.

However, the potential for a new form of GSCs that involve a sequence of tasks to create high-value-added goods and services could potentially enhance trade between Japan and South Korea. It's worth noting that the similarity in the structure of comparative advantage doesn't necessarily dictate the volume of trade between two nations. To illustrate this point, consider the semiconductor industry. South Korea, a significant exporter of semiconductors worldwide, notably represented by Samsung, plays a key role in supplying semiconductors globally. Japanese companies, while not engaged in the final production of semiconductors, contribute by producing and providing materials, special gases, and semiconductor manufacturing equipment as part of Samsung's GSCs. The composition of Samsung's supply chain reveals that among the contributing countries, South Korea has 48 companies, Japan has 18, the USA has 15, China has 10, and Taiwan

has 4. This exemplifies the international division of labor in the semiconductor sector, showcasing a GSCs model that involves the trade of tasks embodying intellectual property.

The evolution of GSCs has transitioned from a labor-intensive production process via offshore sourcing to a model centered on sourcing tasks that encapsulate intellectual assets. Both Japan and South Korea have established robust legal frameworks, regulations, and judicial systems to safeguard intellectual property rights. The collaborative efforts within the semiconductor industry underscore the potential for knowledge-intensive trade development through GSCs between the two countries. However, effective sharing of laws and regulations necessitates a high level of commitment to a free and open trading system that goes beyond the scope of the World Trade Organization's Most Favored Nation principle. While Japan and South Korea have established bilateral and multilateral Free Trade Agreements (FTAs) with various third countries, the deep harmonization of trading rules, as seen in initiatives like the Trans-Pacific Partnership (TPP), is not be yet realized between the two nations.

5. Conclusions

GSCs, which emerged due to the technological improvement of communication and transportation and the reduction of trade costs, have been a source of development of the world’s export and import. China's entry into the World Trade Organization (WTO) in 2001 marked a significant turning point, propelling the country into a major player in international trade. The subsequent growth of China's economy, particularly in the aftermath of the 2009 financial crisis, solidified its position as a GSCs hub in East Asia. However, China's transformation into an economic powerhouse brought about concerns among democratic nations, given its state-controlled economic structure.

Geopolitical tensions such as restricting rare earth exports to Japan and suspending Australian imports were exercised through Chinese economic control. It demonstrates how economic power can serve political objectives. The COVID-19 pandemic further exposed vulnerabilities in GSCs, as China's stringent containment measures disrupted global production and supply networks. The vulnerabilities have been exacerbated by the US-China trade friction, characterized by retaliative tariffs, and restrictions on investment and technology transactions. China's rapid growth of the

semiconductor manufacturing raised national security concerns of the United State and other western countries and led the US, EU, Japan, and Korea to change GVCs to diversify the trade partners.

The rise of economic and political tension highlighted the potential fragility of GSCs and prompted manufacturers to reevaluate their dependencies on specific countries and led countries like the United States, Japan, and European countries to explore diversifying supply chains and seeking alternative sources of critical materials, for de-risking to mitigate potential economic and political risks associated with a large reliance on the trade with the specific countries. However, it must be mentioned that their introduction of de-risking trade policy come with substantial costs of the government subsidies and the trade distortions. They possibly undermine the liberalized international trade, and eventually may lower the welfare of the world.

The paper explores the evolution of GSCs towards knowledge-intensive tasks. While China initially attracted labor-intensive production due to low wages, it now faces challenges as wages rise. GSCs are shifting from labor-intensive tasks to those embodying intellectual property. The protection of intellectual property becomes crucial, and countries are expected to develop GSCs with strong IP protection frameworks. However, effective cooperation requires a high-level free and open trading system beyond the WTO's MFN principle.

The paper lastly discusses the potential for new GSCs between Japan and South Korea. Despite favorable conditions shown by the extensive human exchanges between the two countries, the bilateral trade volumes were relatively low due to independent trade triangles with the US and China. However, the recent development of GVCs between the two nations in knowledge-intensive manufacturing is exemplified by their collaboration in the semiconductor industry.

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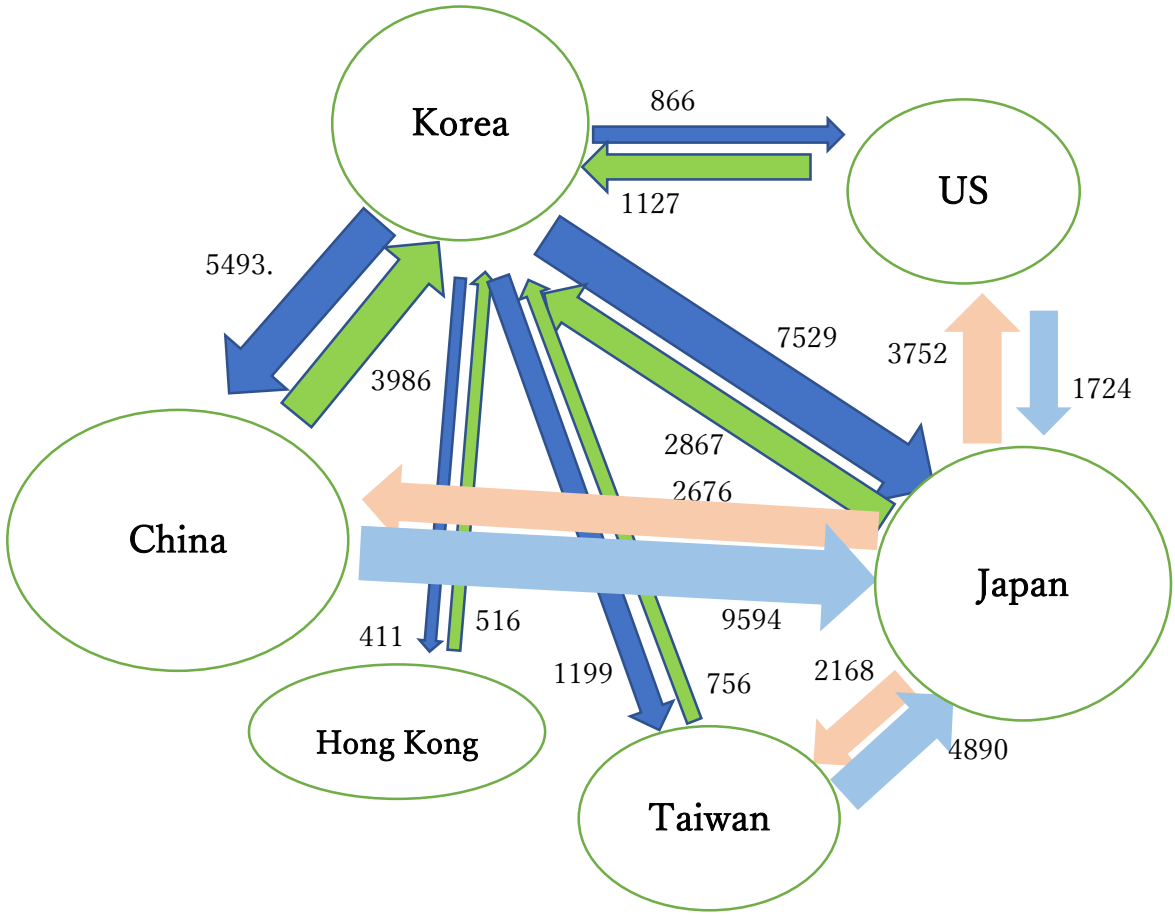
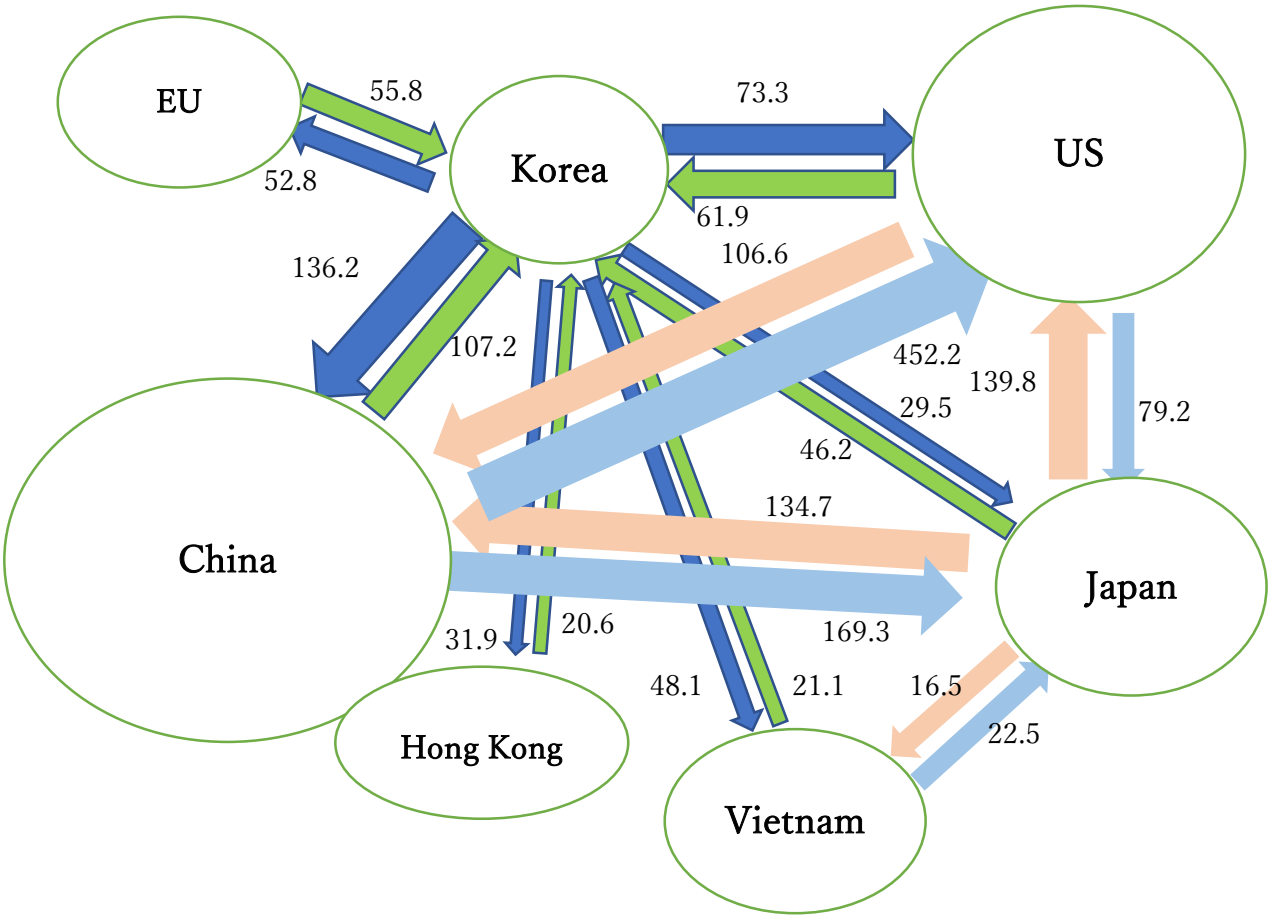
Fig. 1 Visitors of Korea-Japan-China in 2019 (Thousand persons)



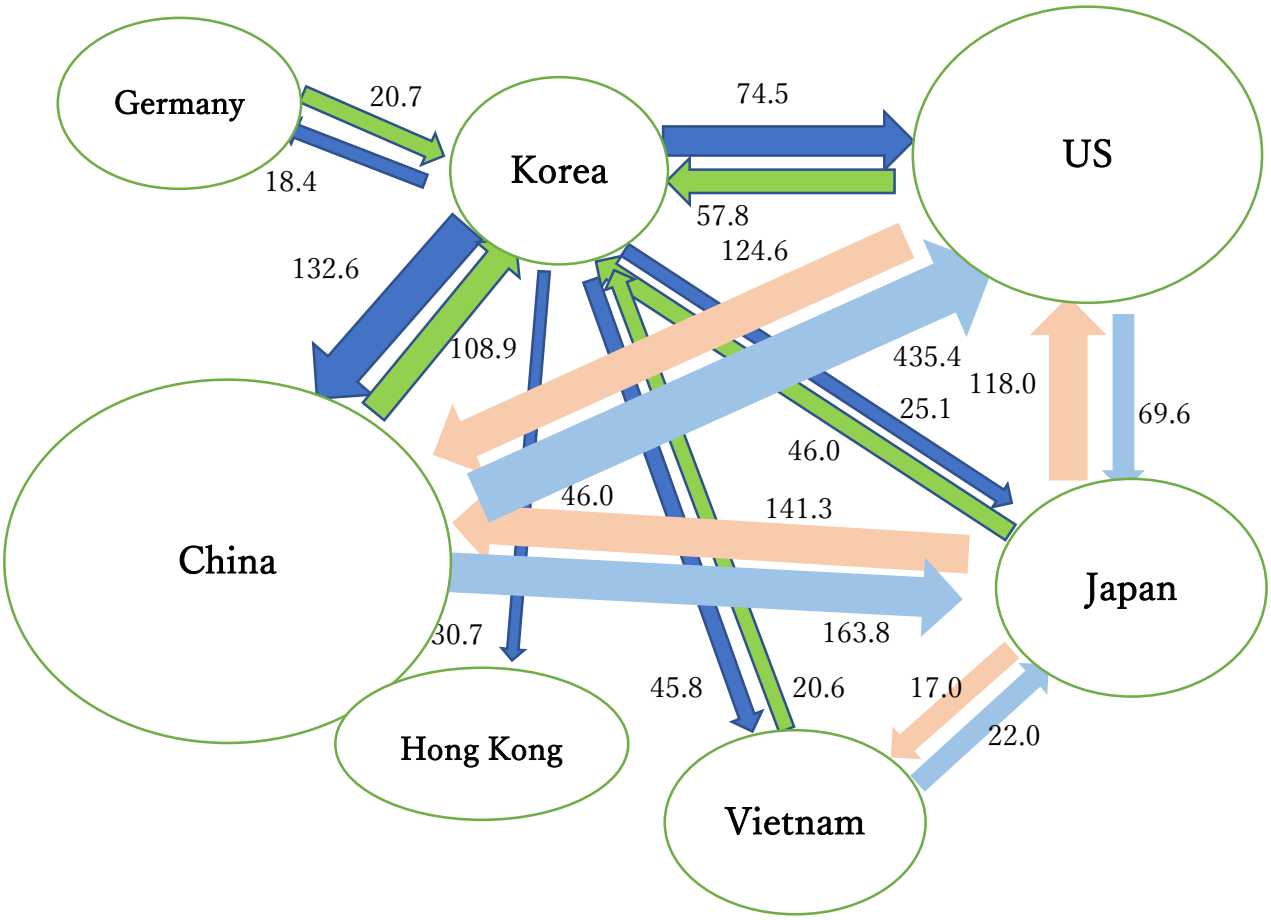
Source: Author's calculation, using the data of KTO and JVTO.

Fig. 2 Trade Triangles among Korea-China-US and Japan-China-US in 2019 ($Billion)



(Source) Author's calculation from the data of WB.

Fig. 3 Trade Triangles among Korea-China-US and Japan-China-US in 2020 ($Billion)



(Source) Author's calculation from the data of WB.