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Master's Thesis of International Studies

Empirical Analysis of Korea's Supply Chain Vulnerability

- Evidence from Korea's Import Reliance on
China's Products -

한국의 공급망 취약성에 관한 실증분석:
-대중국 수입의존도를 중심으로-

August 2023

Graduate School of International Studies
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Abstract

The emerging pandemic COVID-19 caused unexpected global supply chain disruptions, and other crisis factors have continued to expand. As a part of the crisis, Korea also experienced supply chain disruptions resulting from China's unexpected export controls. The sudden bottlenecks derived from Korea's excessive import dependence on China and supply chain vulnerability for a specific country have emerged as crucial issues.

Overall, the study aims to provide reasons for how Korea has become susceptible to China and explanations that "import reliance" could pose a threat to Korea's supply chain. Also, it is necessary to look at changes in dependence on intermediate goods with high-value added. As a result, it confirmed that Korea's import supply chain has changed according to China's industrial policies, which eventually deviated from the U.S.-centered import supply chain. Second, it discovered the dependence on parts and accessories used for machinery and transport equipment is high. Finally, it suggested that "import reliance" cannot be a long-term threat, given Korea's preparation for sudden suspension of imports through previous trade dispute and the new phase of 'de-risking' approach towards China in 2023.

Keywords: Trade, Supply Chain Vulnerability (SCV), Import Dependence, China-Korea Trade, Supply Chain, Supply Chain Disruptions

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Chapter I. Introduction

1.1. Research Background

For many years, the world has taken advantage of globalization under treaty-based international trading rules and free-trade environments. The emerging COVID-19 pandemic, however, has caused unexpected global supply chain disruptions, and other crisis factors have continued to expand, including intensifying strategic competition between the United States and China for technology hegemony and prolonged Russia-Ukraine war. As a result, global movements for national-level support systems and reinforcement of bilateral and multilateral cooperation have been made as a part of efforts to build a resilient supply chain.

Since 2021, the U.S. has made major progress in a national-support system of semiconductors, batteries, and electric vehicles after the announcement of the Executive Order on America's Supply Chains. Furthermore, the EU (European Union) proposed a European Critical Raw Materials Act (CRMA) to increase the supply chain stability of crucial raw materials of high economic dependence for the members. For bilateral cooperation with allies, the EU-U.S. Trade and Technology Council (TTC) provided a forum to coordinate approaches and cooperate in the supply chain of rare earth magnet, solar, and semiconductor supply chains.

South Korea is no exception. There had been a shortage of urea supplies due to China's unexpected export controls resulting from

deteriorated trade relationship with Australia. As a result, it caused short supply in Korea since its import dependence on the very factor was over 90% at that time. The Korean administration later set up an Early Warning System (EWS) for 4,000 items and designated 100 to 200 key critical items to prepare for future supply chain disruptions. Moreover, the newly established Analysis Center of Global Value Chain (GVC) developed a government-private cooperation system that encompasses the entire real economy value chain, such as raw materials, parts, final goods, and distribution.

In the initial stage of the COVID-19 era, the outbreak of the virus resulted in temporary lockdowns of one's factory, leading to disruptions in the production of others. Moreover, under geopolitical instability, a supply chain with one-sided dependence is particularly expected to be more susceptible to bottlenecks and economic shocks from abroad. For instance, the increasing U.S.-China tension has generated various export-control policies, triggering not only cooperation but also confrontation involving possible supply chain risks. To make matters worse, Korea is in an unfavorable position to opt for one side since economic benefits and security interests should be obtained from both sides. Although the combined effects of these two major factors, COVID-19 and U.S.-China trade tensions, are intensifying the risks of dependence on China, it is still important for Korean businesses to obtain economic benefits from the Chinese markets for recovery. (Synder & Byun, 2021) Therefore, quick

adjustment and response to possible disruptions in the supply chain is becoming an issue to be considered carefully.

1.2. Purpose of the Study and Research Question

Purpose of the Study

The combination of diverse factors triggered disruptions in today's trade and economic activities, thereby distinguishing them from past ones. Such factors can refer to the unforeseen pandemic and dynamic of geopolitics and economic structures, which are contributing to a sudden freeze in national economic activities. With the unprecedented outbreak of disease and policy shocks, interconnected global value chains exposed its inherent weakness (Javorcik, 2020) and prompted countries to re-think the value of existing value chains. Therefore, the continual process to expect and react to imminent threats will be necessary to obtain 'resilience'¹. (Weick & Sutcliffe, 2001) In that sense, this paper aims to identify the risk inherent in Korea's trade, which is China-centered dependence that may compromise the resilience of the supply chain.

The asymmetry in economic and military power is one of the main characters in Korea-China relations. Diversifying the global supply chain is the most common policy recommendation to ease the dependence, nonetheless, the acquisition of superiority in

¹ The notion of 'resilience' has been used generally in diverse areas. The commonality of the concept is that it facilitates the management of any type of fluctuations and confusion occurring to a system. (Shishodia et al, 2021)

technological and industrial competitiveness should be preceded to be “treated” and “respected” by China. (Cho, 2022) Also, it has wider implications in that an increase in trade asymmetry could turn into a deterioration of political relations since the imbalance generates a favorable situation for the dominant partner to wield leverage. (Byun, 2021) With this significance, this study is going to conduct research in two parts to examine the ‘trade asymmetry’ between Korea and China. First, it investigates the situation of Korea’s supply chain vulnerability with China by highlighting the history and reasons for Korea’s import reliance on China’s products. Second, it provides a discussion of whether and how the dependence on one trading partner can be interrelated with supply chain resilience.

Research Question

Despite diverse policy efforts having been made in Korea, sufficient research had not yet been conducted. Only recently, the concern is being addressed by some scholars though some parts need supplementation. Previous studies offer a rough measure of import dependence on China and are only provided with recent trade data with little consideration of geopolitical changes. Therefore, this study will examine how interdependence between two countries has been formed to investigate the evolution of asymmetric trade in broader dimensions. Moreover, this paper will also conduct an empirical study on Korea’s import reliance on other economic powers including China by industry and critical item and examine

whether the dominant partner can exert influence using the dependent nation's 'import reliance'. The research questions are as follows.

1. How has the interdependence between Korea and China changed and developed over time? And what are the reasons for the change?
2. What are Korea's critical items with high import reliance on China, Japan, and the U.S.? Can it be said that 'asymmetric trade' with 'excessive trade reliance on imports' induces supply chain vulnerability for the dependent state?

Chapter II. Literature Review

Up to now, many scholars have researched the economic and trade relationship between Korea and China. Nevertheless, sufficient research about import reliance has not been carried out until recently. This section focuses on the evaluation of economic and trade relationships in three parts. The first section demonstrates the overview of economic, trade, and diplomatic interactions between Korea and China. The second section investigates Korea's trade reliance, highlighting the nature of its dependence on China. The last section discusses the empirical methodology for supply chain vulnerability.

2.1. Overview of Sino-Korean Trade, Economic, and Diplomatic Relations

In early 2000, Korea's trade volume with top trading nations was modest. From 2000 to 2014, however, China emerged as a foremost trading partner in terms of export and import destinations. Many scholars in Korea have discussed how meaningful the bilateral trade between Korea and China is. Jeong (2022) explored the development of Sino-Korean trade after the normalization by describing the trade as Korea's "continuation of exports of intermediate goods to China." Since 2001, not only have the total amount of bilateral trade increased, but also there have been significant changes in Korea's intermediate goods to China. The author indicated that not only have both countries relied on the parts

of intermediate goods but also the reliance on imports left Korea more dependent on China's products for a long time.

While the surplus-generating structure of bilateral trade is established, Chung (2012) proved that Korea's trade dependence on China (21%) was much higher than that of China (6.3%) in 2010 and maintained that trade with China becomes more crucial due to Korea's one-sided dependence. Simultaneously, China's "economic rise" becomes one of the reasons for Korea's economic vulnerability. (Chun & Cho, 2021) Furthermore, there is a high possibility that the countries having the power of high-tech industries will be negatively impacted by China's industrial strategy "Made in China 2025," and South Korea will be exposed to possible risks as outlined in the scenario. (Wubbeke et al, 2016)

Despite close trade relations with one of the largest trading partners, the strategy to form deeper trade relations had not ended yet at that time. Negotiations for the Korea-China Free Trade Agreement (FTA) have continued for quite a long time to settle each goal and interest by conducting joint research and launching official joint studies. Jee (2011) evaluated Korea's motivation for a bilateral FTA with China as the maximization of economic effects through "simultaneous FTAs with large advanced economic power." Meanwhile, China had negotiated with many countries to obtain "strategic" goals in FTA deals for dominance in the region, securing resources, and consolidating its position in the economic term. In other words, it placed greater emphasis on other various

accompanying effects that can be acquired through an FTA. Some identified the economic effects of Korea–China FTA on bilateral trade and employment in Korea (Kim & Shikher, 2015), however, others pointed out that it is difficult to find the significant contribution of this agreement to the increase of bilateral trade. (Bae & Chung, 2019)

Deeper interdependence, which was formed over three decades, eventually served as both an opportunity and a threat. For containment policy in the COVID–19 era, the Chinese government initiated a dynamic zero–COVID policy, which caused global supply chain disruptions leading to lockdowns of one of the world’s largest container ports, Shanghai. It also led to Korean companies having difficulty in logistics and operations, but Kang (2023) predicted that the sluggish exports are expected to enter a new phase due to China’s resumption of economic activities in 2023. This is because the impact of China’s reopening is expected to bring positive economic effects, especially on countries with a higher proportion of exports to China.

Moreover, the diplomatic relationship can be summarized as both cooperation and conflict. Historical and diplomatic security disputes harmed reciprocal relations, however, the cooperation for maintaining peace and stability on the Korean peninsula sustain the two countries in cooperative relations. This demonstrates the confrontation between the two governments’ foreign policy, which is China’s consistent policy related to its core interests and Korea’s

varying stance depending on the regime. (Cho, 2022) Considering the intense U.S.–China strategic competition, Kim (2022) anticipated that conflict factors in Korea–China relations would be on the rise along with the direction of the recent Korean administration’s policy solidifying alliance with the U.S.

In a nutshell, China’s economic growth and Korea’s dependence on various fronts created both a synergy effect and risk in the Korean economy. As such, many scholars have implied asymmetric balance in economic, trade, and diplomatic dimensions should be resolved to promote Korea’s strategic values in bilateral relations. The next section will closely examine the evolution of Korea’s trade vulnerability from the following perspectives.

2.2. Korea’s Trade Vulnerability with China

Robert O. Keohane and Joseph Nye, Jr. once argued that “The coercive power rests in asymmetrical vulnerability. Interdependence without asymmetry generates little power, but when asymmetry exists, interdependence creates weapons that can be used in strategic competition.” (Nye, 2020) The author demonstrated the various aspects of interdependence in the U.S.–China relationship and mentioned that the power in the trade dimension leads to ‘limits of power,’ which do not completely belong to either side. In other words, it is difficult for the U.S. to replace a range of critical items other than Chinese goods in the short term since they depend disproportionately on each other. Therefore, one of the sides cannot have all the cards

in economic power, thereby asymmetric balance could affect the ability to influence each other.

Likewise, asymmetric dependence in Sino-Korean trade relations does not directly mean disadvantages at leveraging in negotiations since the competitive advantages of one side cannot be readily replaced by others. Despite this fact, many empirical studies have acknowledged that Korea is at a greater disadvantage, implying that it has limited capacity to respond to changes in its trade relationship with China.

One, the trading system between China and Southeast Asian countries is fundamentally differentiated from US-China trading relationships. Song (2009) verified that China's intra-trade share in East Asia is substantial and increasing, which means that China is at the core position of regional trade. Also, the results confirmed that China accounted for an overwhelming share in the export of Korea and Japan, whereas overall China's export share of the region is stagnating. This finding indirectly confirmed that a vertical division of labor structure is formed between China and the intra-region. In other words, it is reasonable to infer that Korea's intermediate input exports are being used for Chinese final goods being exported to advanced countries abroad.

Two, there are limited options in Sino-Korean trade considering Korea's position in the U.S.-China competition. Given the high degree of economic integration in the Asia region, the relocation of the manufacturing base could be expensive. To give an example,

the United States initiated negotiations for a resilient supply chain with allied countries called IPEF (Indo-Pacific Economic Framework). However, this raises questions about how many participants can comply with the requests to tighten policies on export controls targeting China. (Goodman & Arasasingham; 2022) Furthermore, it is burdensome to be consistent with the U.S. policy in the long term, which could bring abrupt instant repercussions for Korean manufacturers in a way that raises production costs. (Lovely & Dahlman; 2022).

To sum up, the interconnected nature of global supply chains in East Asia makes it hard for Korea to shift and find alternative sources which are superior to previous supply chains. On the whole, China is positioned as an indispensable role and attractive site for Korea.

2.2.1. Export Dependence

Many findings proved that the power of China in Korea's export is substantial. Upon reviewing Korea's export structure with China, Heo (2014) found a distinctive feature after 2005. As a result of examining the top five export items to China, there was an explosive growth of flat panel displays and sensors necessary for assembling electronic device displays. The author explained that parts and accessories accounted for a high proportion of Korea's exports to

China, which means that processing trade² accounted for substantial parts in China. Additionally, Kim, et al. (2015) explained the direct correlation between China's trade policy and Korea's export. China had actively simplified tax benefits and trade procedures to encourage processing trade, thereby having a positive impact on Korea's exports of processing trade to China. However, it began to make diverse efforts to curb processing trade and restrict trade items into permitted, restricted and prohibited items. Consequently, bilateral processing trade started to slow down in the 2000s. Nevertheless, research findings confirmed that Korea still accounted for the highest proportion of China's imports in processing trade (20.2%) in 2014. After the subsequent research, it turned out that the Chinese restriction policy lowered the growth rate of Korea's export items, which were designated as restricted items, until the current quarter or the next quarter. In addition, China's export growth rate to the world was also found to have a positive relationship with Korea's export growth rate to China.

Furthermore, previous studies also paid attention to the ripple effect of one's economic slowdown on the other economy via trade channels. (Kireyev & Leonidov; 2016, Ahuja & Nabar; 2012) Today, Chinese high-tech products become more competitive under an ongoing "self-sufficiency" policy as part of the 'New Normal.' Given

² Processing trade refers to the trade activity of importing parts and accessories, all or part of raw materials from abroad, manufacturing more complete products in domestic, and re-exporting the finished products abroad.

the significant influence of trade policy, as proved in previous studies, it is highly likely that Korea should prepare for future risks and upgrade its export competitiveness.

2.2.2. Import Dependence

Next, high import reliance has potential risks resulting in supply chain disruptions, which affect the entire availability and reliability of critical items. In the past, imports served as an opportunity to increase productivity and products in Korea due to the nature of its trade structure, ‘processing trade.’ (Chang & Cho; 2015) As proven after the urea crisis in Korea, however, high dependency on imports from a certain country is likely to adversely affect the Korean industrial ecosystem rather than increase productivity.

Although there were several in-depth papers concerning the positive economic effect of imports through trade channels (Chang & Cho; 2015, Kim et al.; 2017), there had not many studies about import dependence from various viewpoints such as processing stage, items, and industry. When the Korea–Japan dispute occurred in 2019, many scholars began to pay attention to Korea’s reliance on imports. As a result of an analysis of Korea’s dependence on Japanese imports subjected to Catch-all regulations, Kim et al. (2019) confirmed that several items are highly dependent on Japan. In addition, several studies have been conducted on Korea’s economic dependence on China and examined China’s retaliation due to political issues and the deployment of THAAD. (Song, 2020; Yang, 2019)

Nevertheless, it was after supply chain disruptions that the research on Korea's import dependence came into the real spotlight. Due to the combination of global and regional factors, several papers and reports have been published which diagnose the degree of trade vulnerability by quantifying the rate of import dependence on specific countries. (Lee & Kim;2022, Kim et al.;2021, Shim & Hong;2022, Min & Lee;2022) Unlike in the past, substantial research efforts are made to diagnose current supply chain vulnerability for preventing future bottlenecks rather than to prove a positive correlation between trade and economic growth.

In this paper, the analysis of trade reliance can reveal how vulnerable the Korean economy is to China. As the global supply chain shock has emerged as an important agenda in the international economy, indicators have been developed and diagnosed by several research institutes. Following chapters will touch upon recent indicators used for estimating supply chain vulnerability and compare them with those previously used in the past.

2.3. Empirical Analysis of Supply Chain Vulnerability

While formulating the definition of Supply Chain Vulnerability (SCV) was attempted by many scholars, they are commonly noticing “sensitivity” or “exposure” to disruptive events in one's or global supply chain. In case of obstacles threatening the supply chain's capacity to effectively facilitate the flow of goods and services, it is called Supply Chain Vulnerability. (Bode & Wagner, 2015; Wagner &

Bode, 2006) Since the uncertainty of supply and demand in interconnected supply chains made managing vulnerabilities difficult (Blackhurst et al., 2018), the research on Supply Chain Resilience (SCRES) has become an essential policy task for withstanding and recovering disruptions. (Ivanov & Dolgui; 2021, Carmeli et al, 2020; Yang & Hsu, 2018)

Shishodia et al. (2021) identified nine important research areas, from conceptual development of supply chain resilience (SCRES) to emphasis on developing robustness in supply chain networks. Among them, there are empirical and survey-based studies to find out factors of supply chain vulnerability and risk elements. For initial works, Peck (2005) formulated an integrated model to describe diverse factors taking place at different stages of the supply chain. In addition, Colicchia et al. (2010) came up with a simulation-based framework for identifying, managing, and mitigating risks to promote SCRES. Moreover, there is a network-based model to visualize a highly connected supply chain structure and organize the propagation path to trace disruptive incidents in the supply chain. Blackhurst et al. (2018) envisioned a diagnostic approach to examine how the connectivity, dependence, and structure within the supply chain impact vulnerability. IMF (2017) developed a new network analysis tool to evaluate the supply sensitivity of each traded good.

As such, many scholars have attempted to provide an overall perspective of the features of disruptions by conducting empirical studies. The latest studies, however, are distinct from such

frameworks in that they analyze the vulnerability of one's supply chain by estimating import reliance and directly showing how sensitive imported goods are to one's economy.

Since "unpredictability" stimulates shocks in the value chain around the world, many studies have established new methodologies to diagnose how much supply chains are susceptible to such sudden changes. In that respect, Rogers et al. (2020) developed a new definition called "strategic dependency," which is defined as a level of reliance on imports from China. It determines whether five countries are overwhelmingly prone to certain products and industries. Three standards to identify 'specific products in strategic dependency' are as follows: (1) When a country is a net importer of a particular good, (2) When a country imports more than 50% of the good from China, (3) When China controls more than 30% of the global market of that particular good. The research findings suggested that understanding economic vulnerability must be preceded before taking definitive actions.

EU Commission (2021) also provided another methodological framework to acknowledge not only strategic dependencies but also whether this strategic nature could lead to a vulnerability of EU's core interests. First, it developed "Core Dependency Indicators" to find out the main foreign sources of the products of the most sensitive ecosystems within the EU. These indicators indicate three respective products, which are 'dependent products,' 'most dependent products,' and 'possible strategic dependencies' on each threshold. Second, it

further conducted comprehensive reviews regarding several areas considered strategic for Europe's interests. In addition, it provided context, the origin of vulnerabilities, and ongoing measures in each strategic industry.

Lastly, many researchers have estimated Korea's current trade dependence by modifying the aforementioned standards. Kim et al. (2021) evaluated Korea's dependence on imports subject to China's export control measures in 2021. This study modified the methodology of Rogers et al. (2020) and classified the items based on the level of import reliance on China. Furthermore, Shim & Hong (2022) applied the methodology of Kim et al. (2021) and expanded the scope of Korea's import vulnerability not only to China but also to the U.S. and Japan. This research also applied the indicator of TSI (Trade Specialization Index) to figure out which items are in 'export specialization' or 'import specialization.' Additionally, Min & Lee (2022) analyzed the global import supply chain and the Korean economic import supply chain based on the methodology of the IMF (2017) and the EU Commission (2021).

Since literature on Supply Chain Vulnerability (SCV) only has provided some conceptual frameworks but very few empirical studies (Sharma et al., 2021), the need for more research on SCV and resilience is highlighted in face of COVID-19. (Ivanov & Dolgui, 2021) In this regard, this study will focus on the newly developed analytical approach, which directly describes the current state of Sino-Korean trade.

Chapter III. Empirical Framework

3.1. Methodological Framework

As an empirical analysis to study Korea's asymmetric trade with China, this study will first provide an overall trend in how bilateral economic ties have taken place. Then, from each section, it complements previous studies in the following areas. First, it will provide new findings by expanding the scope of data and countries to diagnose past and present conditions of Korea's import supply chain. This finding will confirm the trends of its import dependence by industries with China, the U.S. and Japan. Also, this paper will find out how the reliance on major trading partners' items has changed for two decades. Therefore, it can contribute to the study of finding out the transition of Korea's dependence over time.

Next, by assessing which specific Chinese goods that Korea relies heavily on, this study aims to examine the possibility of the exporting country exercising influences over the importing country through the "import dependence" by analyzing external factors and Korea's competitiveness. This is important to avoid the analysis of import reliance just by numbers, which are limited interpretations described in previous studies.

3.2. Data

Pursuant to the objective of the research, the relevant data set is chosen based on the research methodology and data availability. Data sources of the study are from UN Comtrade and Korea Customs Service. Classification for the products is based on the HS Codes (Harmonized System Codes), SITC (Standard International Trade Classification), and Broad Economic Categories (BEC).

3.3. Empirical Model

3.3.1. Trade Interdependence: Trade share, Trade Intensity

Two representative indicators, trade share and trade intensity, are indices to demonstrate bilateral trade relations. Trade share, expressed as the proportion of Korea's export (import) to China in Korea's total export (import), indicates the importance of China in Korea's trade. However, there is a limitation to this indicator that it is affected by the size of the economy. To overcome this limit, trade intensity will provide us with more precise information by estimating the reciprocal importance of their respective trade to its weight in world trade. That is, it determines whether the trade ties between the two are greater than their respective trade with the rest of the world. If this figure is greater than 1, trade dependence is evaluated as greater than the global average. The indices for import and export intensity are illustrated in Table 3.1.

Table 3.1. Formula of Trade Interdependence

Export Share	$\frac{X_{ij}}{X_i}$
Import Share	$\frac{M_{ij}}{M_i}$
Export Intensity	$\frac{X_{ij}/X_i}{M_j/M_{world}}$
Import Intensity	$\frac{M_{ij}/M_i}{X_j/X_{world}}$

Note: X = export, M = import, i, j = country

- Export (Import) share of country A with respect to country B is country A's export(import) to(from) country B divided by total exports(import) of country A.
- The export(import) intensity of country A to country B is the ratio of B's share to A's total exports(import) to B's share of world total imports(exports).
- If export(import) intensity is higher than 1, it means that two countries' trade intensity is relatively higher than world trade intensity, which means their trade is complementary.

3.3.2. Import Reliance by Industry: Industrial Dependence

For estimating overall dependence on the U.S., China, and Japan by industry, it is necessary to collect data within the categorization system of Standard Industrial Classification system. However, this system is used differently in various countries, so the most detailed Harmonized System (HS) classification of imported goods will be used. (Rogers et al, 2020) These imported goods will be divided into 99 industries on the basis of two-digit level of HS Codes. Each industry will be expressed as the nomenclature of the HS Codes, elaborated in each section.

This indicator is modified from “strategic dependency”³ used in Rogers et al. (2020). The purpose of this assessment is to investigate the transition of industrial dependence over time. Table 3.2 defines how Korea is dependent on three trading partners out of its total imports in each industry categorized as Harmonized System (HS) Nomenclature.

Table 3.2. Formula of Import Reliance by Industry

Industrial Dependence	$\frac{M_{ijk}}{M_{i,world,k}} (\%)$
-----------------------	--------------------------------------

Note: M = import, i = Korea, j = China, U.S., Japan,

k = products (HS two – digit level), t = time (2000, 2010, 2020)

³ Rogers et al (2020) stated that “Strategic dependency is a level of reliance on the imports from another country that gives the exporting country the ability to significantly impact the overall domestic availability of that imported good.” The author used it to find out whether reliance on critical imports may let importing countries put in economic coercion or supply chain disruptions in the near future.

3.3.3. Import Reliance by Item: Interest Item, Vulnerable Item

The next methodology, which is ‘Items of Interest and Vulnerable’ used by Kim et al. (2021), provides a brief understanding of inherent vulnerabilities in Korea’s import structure. The main goal of this methodology is to investigate critical import items demonstrating one’s supply chain is too concentrated on the other. Table 3.3 summarizes the definitions and formulas of each item.

Table 3.3 Formula of Import Reliance by Interest and Vulnerable Item

Korea’s import dependence	Net Exports	
	Export Specialization (Trade Surplus)	Import Specialization (Trade Deficit)
Less than 50%	–	–
50~70%		Interest Item
More than 70%		Vulnerable Item

(1) Interest Item

- Two Criteria: (1) Country A imports more than it exports in certain items, which means global trade deficit. (2) Country A imports certain goods above 50% of its total imports from country B.
- 1st standard: $X_{ik} - M_{ik} < 0$
- 2nd standard: $0.5 \leq \frac{M_{ijk}}{M_{ik}} < 0.7$

(2) Vulnerable Item

- Two Criteria: (1) Country A imports more than it exports in certain items, which means global trade deficit. (2) Country A imports certain goods more than 70% of its total imports from country B.
- 1st standard: $X_{ik} - M_{ik} < 0$
- 2nd standard: $\frac{M_{ijk}}{M_{ik}} \geq 0.7$

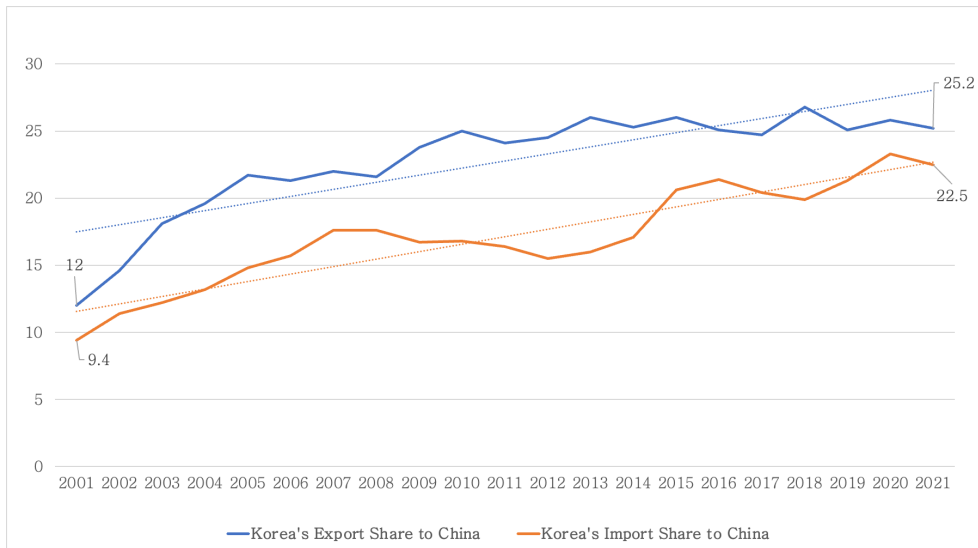
Note: $X = \text{export}$, $M = \text{import}$, $i, j = \text{country}$

Chapter IV. Results and Key Findings

4.1. Interdependence between Korea and China

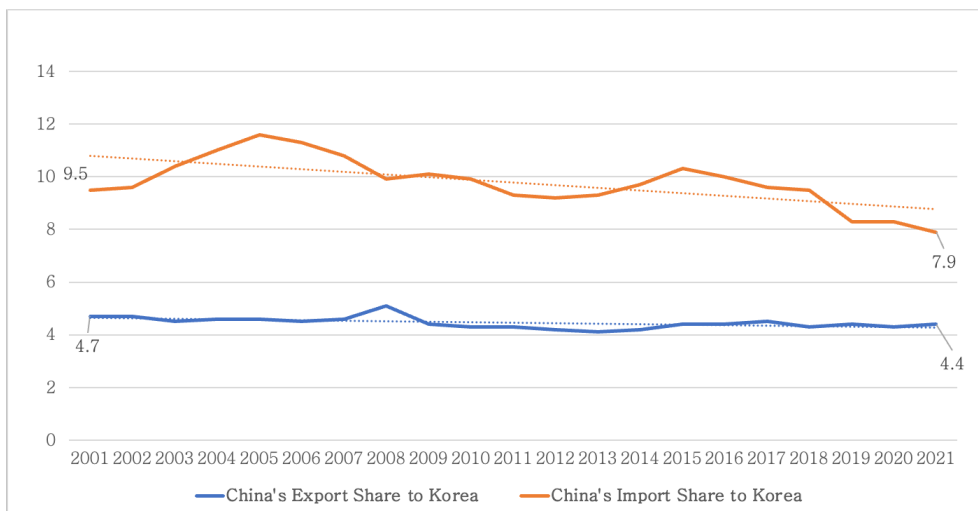
4.1.1. Trade Share

Graph 4.1. Korea's Trade Share to China



Source: Author's calculation using UN Comtrade database, Unit: (%)

Graph 4.2. China's Trade Share to Korea



Source: Author's calculation using UN Comtrade database, Unit: (%)

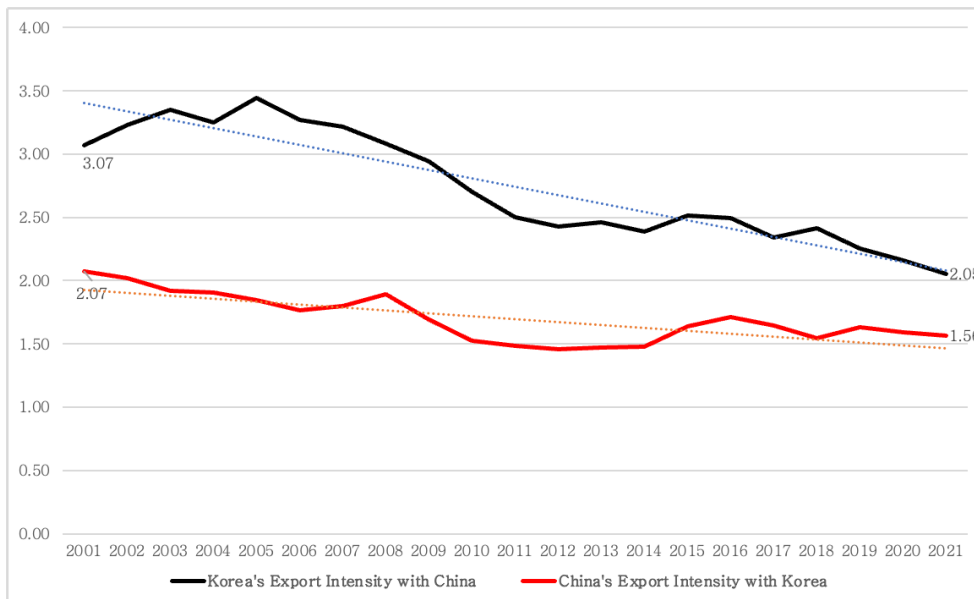
The findings above verify how the interdependence between Korea and China is biased. Graph 4.1 and Graph 4.2 confirm that Korea's trade share is much higher than that of China, both in terms of export and import. It means that China has gained greater significance in Korea's overall trade, whereas Korea has accounted for a relatively small portion of China's overall trade.

However, the findings cannot verify whether there are changes in trade volumes and significant structural changes, just demonstrating the outline of Korea's asymmetric trade dependence on China. Therefore, the trade intensity indicator will be provided with more information to understand the relative importance of their bilateral trade to its weight in world trade.

Next, the estimates of trade intensity are illustrated in Graph 4.3. and Graph 4.4. On the whole, Graph 4.3. and Graph 4.4. show the trade integration of the two economies is stronger than their respective trade to the global market. Not very surprisingly, the trade intensity of each side has a downward tendency, meaning declining significance in their trade relations compared to the past. In a nutshell, the nature of their trade changed from a "complementary" to a "competitive" relationship.

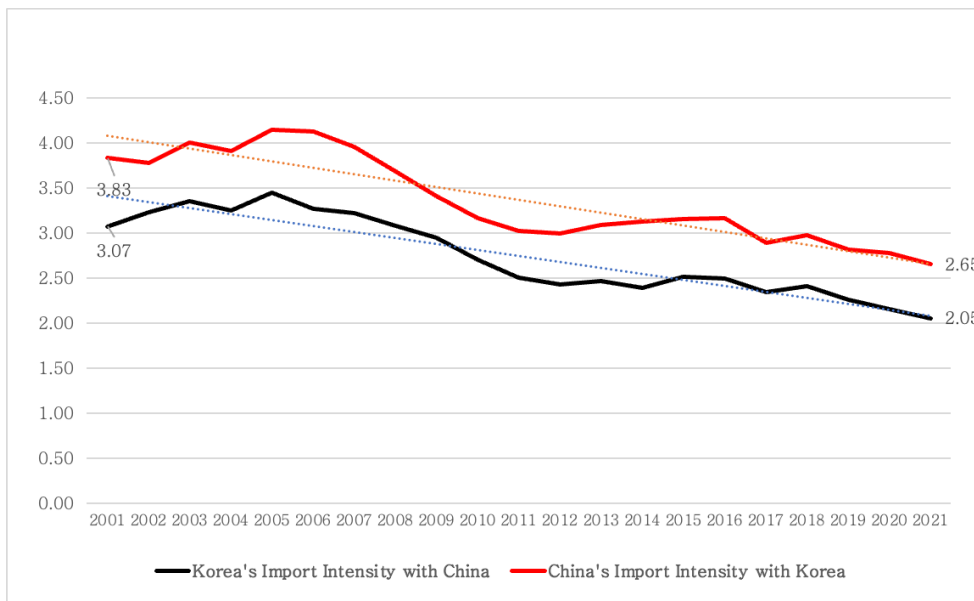
4.1.2. Trade Intensity

Graph 4.3. Export Intensity



Source: Author's calculation using UN Comtrade database, Unit: (%)

Graph 4.4. Import Intensity



Source: Author's calculation using UN Comtrade database, Unit: (%)

On closer inspection of Korea's export intensity with China, the finding confirms that efforts should be made to change Korea's exports of intermediate goods. In the past, Korea vigorously exported intermediate inputs, which have played a major role in China's processing trade. Nevertheless, the descending indicator reinforces the point that it becomes much harder for Korea to have competitiveness because of technological advancement and the self-sufficiency policy in China. In fact, as the rate of China's backward GVC (Global Value Chain) participation decreases, its dependence on imports of intermediate inputs for all countries decreases. It is estimated that China's import intensity with Taiwan and Korea has been greatly eased as well. (Kim & Jeong, 2018)

Second, the export behaviors of China are expected to be more independent from Korea. This is not only because of its high self-sufficiency but also its diversification of trading partners. This mainly resulted from China's expansion of the production capacity of intermediate goods, resulting in the diversification of exports to emerging countries. Since the 2010s, there has been an annual increase (6.6%) in the Chinese exports of intermediate goods and gradual expansion of intra-regional trade with ASEAN. (Kim & Jeong, 2018)

Furthermore, the complementarity of imports between the two countries is in a downturn. Kang (2019) pointed out several factors for a downturn of Korea's products to China by analyzing changes in China's import market. In a nutshell, the main reasons are the

structural changes in China's import market and decline in Korea's competitive advantage. Since China's industrial advancement, such as curbing processing trade and self-sufficiency, there is no necessity to import items which can be readily replaced by domestic production. Instead, the import demand for high-value-added intermediate goods increased, which can be obtained abroad. Therefore, it implies that existing imports with less competitive advantage are unnecessary, meaning that Korea should diversify its main export products and be independent of the structure concentrating on specific competitive items.

Finally, the rate of Korea's import intensity with China has also constantly declined, meaning that the importance of import trade with China is becoming smaller than the average of global trade. This is explained by the fact that China increasingly is exporting significant amount of trade in the intra-region, such as ASEAN. However, it cannot explain Korea's continuous trade deficits with China, which is partially attributed to the rapid increase in the imports of primary and intermediate goods into Korea⁴. Therefore, Graph 4.3. and Graph 4.4. can provide information explaining some changes in Korea-China trade partially. Thus, the following research will cover import reliance on a wide range of industries and items with more segmented data for a more precise diagnosis.

⁴ 3 개월 연속 對中 무역적자, 원인 보니...중간재 수입 증가·공급망 재편 (2022, August 9). KITA. <https://www.kita.net/cmmrcInfo/cmmrcNews/cmmrcNews/cmmrcNewsDetail.do?pageIndex=1&nIndex=69895&sSiteid=1>

4.2. Korea's Import Dependence by Industry

On a two-digit system of HS Codes, the trends of changes are divided into three types. The first type (Type A) and the second type (Type B) summarize consistent changes in industrial dependence over time. The third type (Type C) is described as an inconsistent change in the reliance rate of total imports. They will explain the overall trends of changes in Korea's import dependence by industry from China. They also imply that many Chinese imported goods have made great significance to the Korean economy.

Next, Table 5.2 and Table 5.3 summarize the category of Chinese products, which have had a profound rate of increase in Korea's import market for twenty years. From these findings, we can assume that some of the U.S. and Japanese products are substituted by those of others or Chinese competitive products, which eventually changes Korea's import behavior compared to the past. Such situations are somewhat plausible when considering China's industrial change in each period.

The changes in China's industrial structure can be understood through industrial policies before and after China's accession to WTO (World Trade Organization) and the economic policy of Xi Jinping's administration. Commonly, China selected "prioritized" industries to be encouraged by the country in each period, and this is also reflected in Korea's import market. From 1980 to 1990, the promotion of light

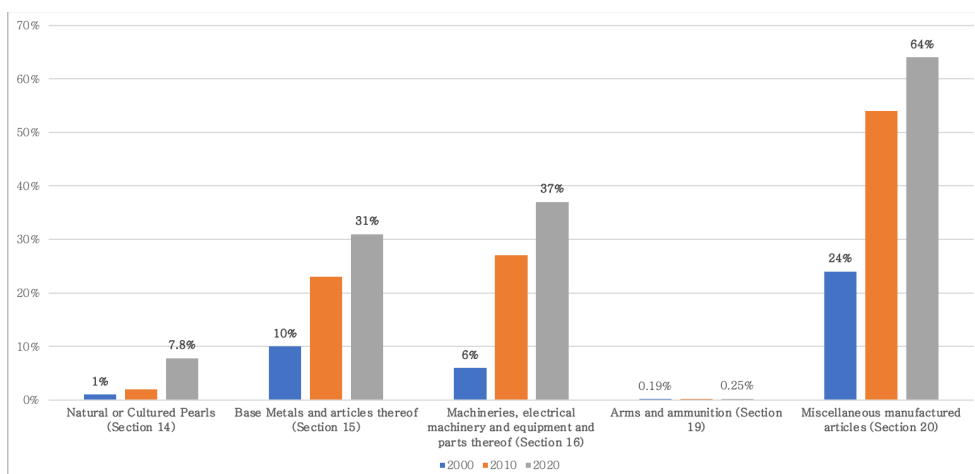
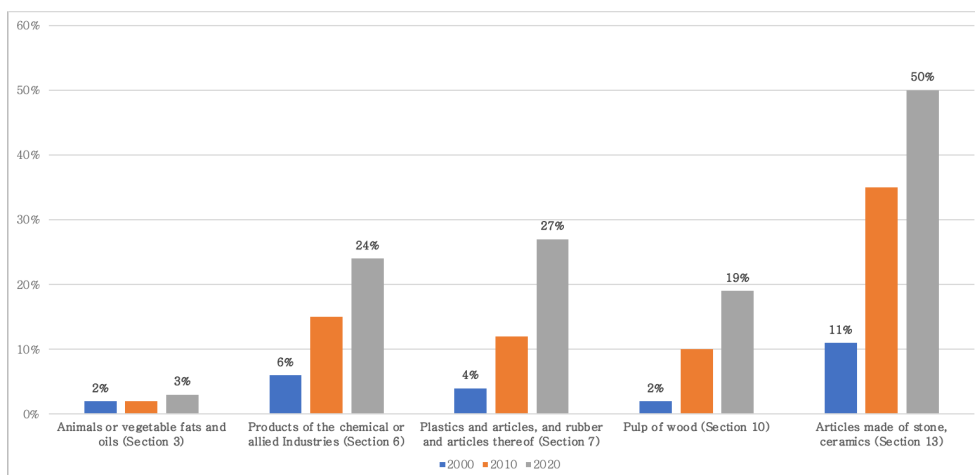
industry and national industrial policy(90 年代国家产业政策纲要⁵) were implemented to revive the overall domestic economy in China. Therefore, textiles, footwear, live animals, and vegetable mostly comprised the principal imports into Korea at the early stage.

In the wake of the 2008 financial crisis, however, fundamental changes in China's industrial policy occurred to overcome the limitation of low-value-added manufacturing-oriented development. 'Strategic Emerging Industries'⁶ were selected for sustainable growth, and the consistency of this policy made a great change in Korea's import market through China's industrial growth and development. As illustrated in Table 5- Type A and Table – Type C, the computer and communication-related parts and accessories (Section 16) and vehicles and associated transport equipment (Section 17) have achieved a considerable increase share of the total amount of imports in 2020, compared to 2000.

⁵ China's 'Pillar Industries', selected by the administration, refer to the key industries that will bring economic development and the selected five industries were as follows: Machinery, Electronics, Petrochemicals, Automobiles, and Architecture.

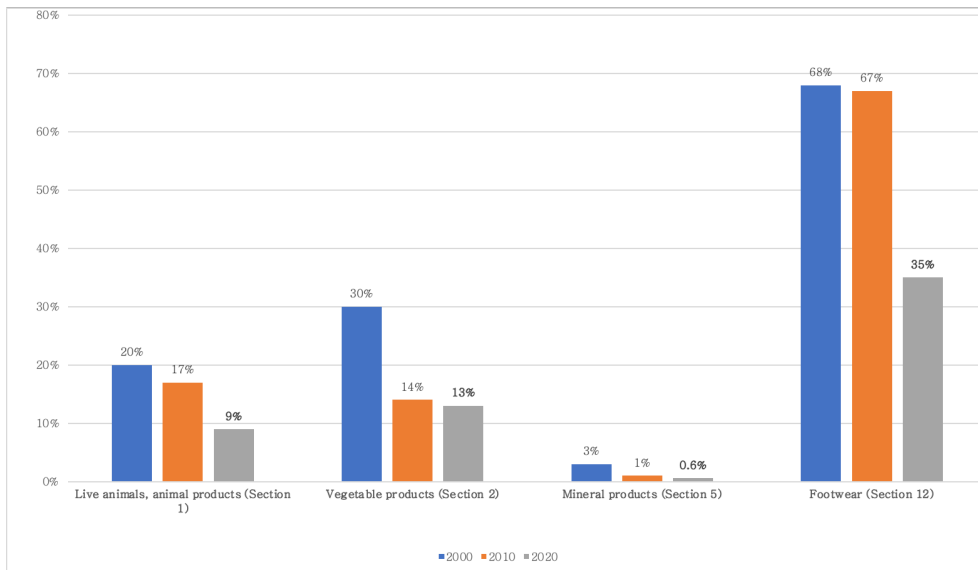
⁶ China's 'Seven Strategic Emerging Industries' are environment and sustainable growth-related industries such as biotechnology, new energy vehicle industry, and advanced equipment manufacture. This extends to 'Nine Strategic Emerging Industries' in 2020.

Table 5 – Type A. Korea's Dependence on China by Industry



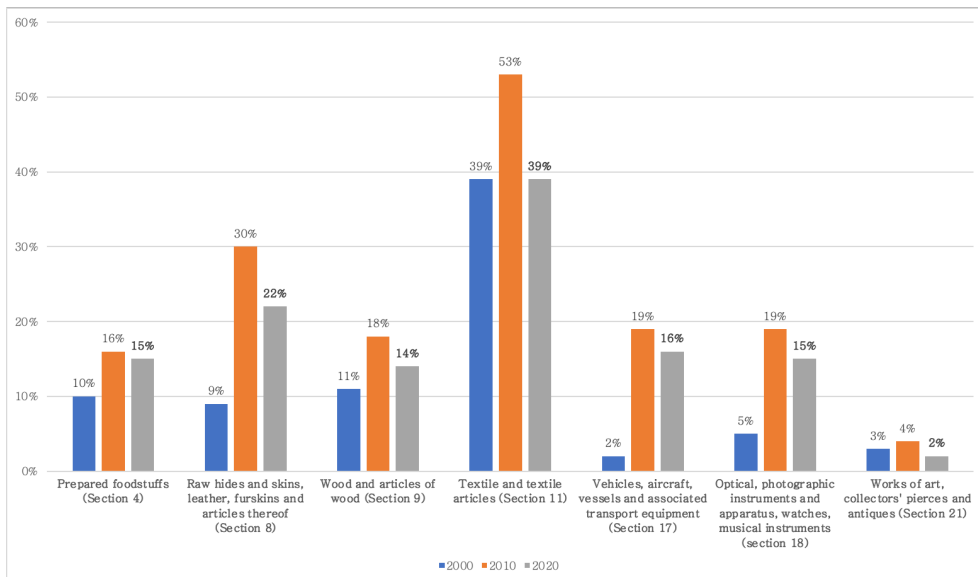
Source: Author's calculation using UN Comtrade database, Unit: (%)

Table 5 – Type B. Korea's Dependence on China by Industry



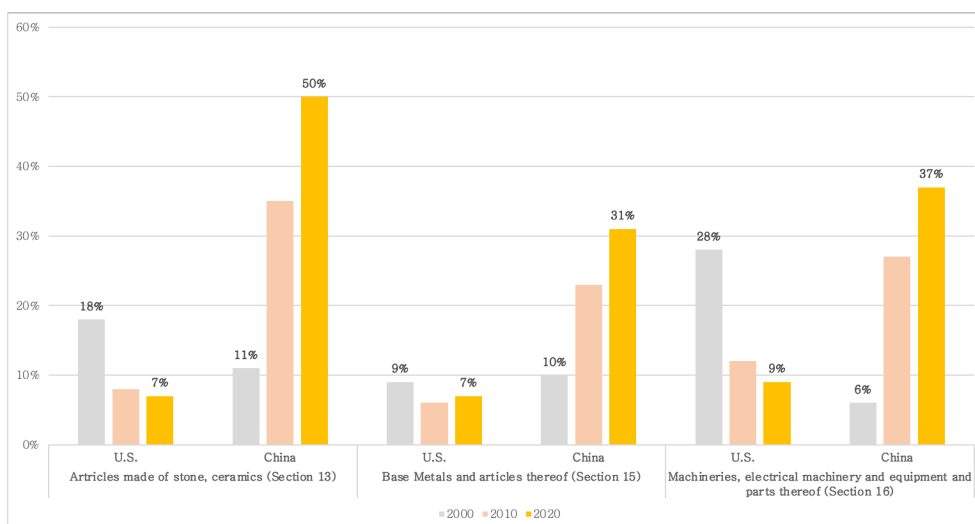
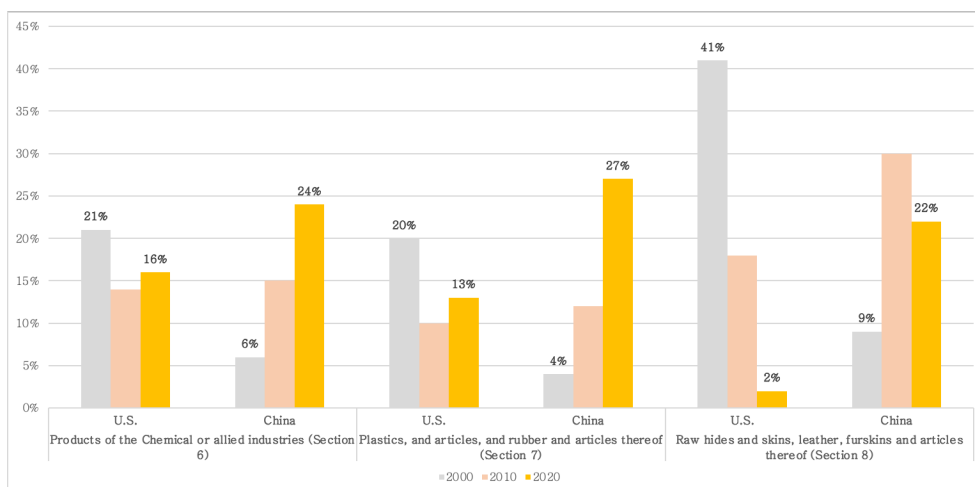
Source: Author's calculation using UN Comtrade database, Unit: (%)

Table 5 – Type C. Korea's Dependence on China by Industry



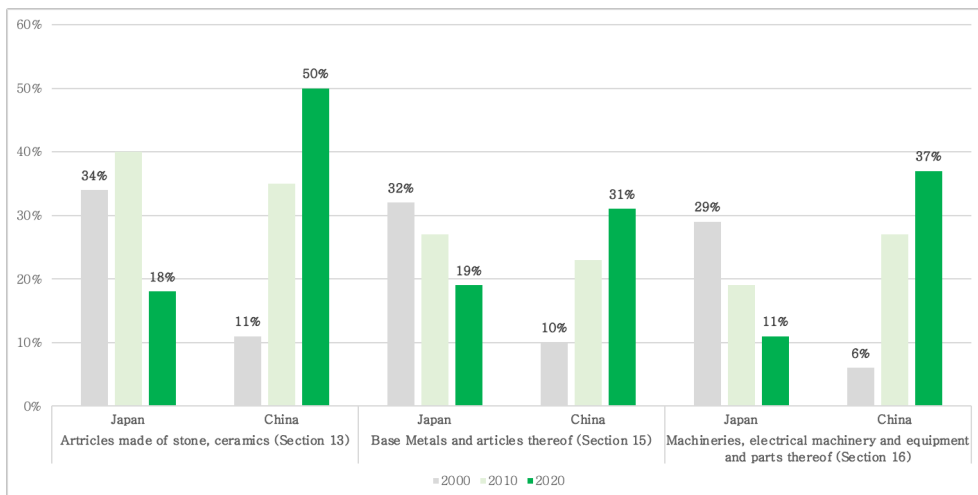
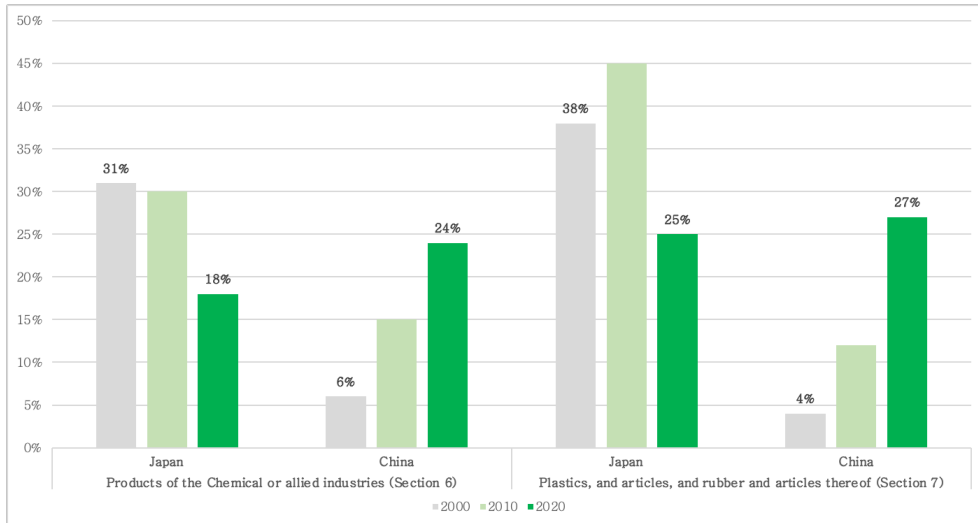
Source: Author's calculation using UN Comtrade database, Unit: (%)

Table 5.2. Transition of Korea's Dependence from the U.S. to China



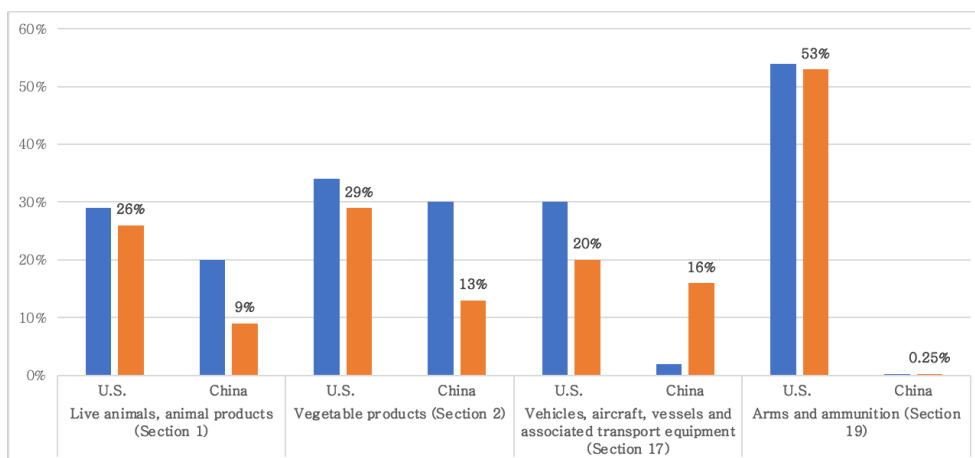
Source: Author's calculation using UN Comtrade database, Unit: (%)

Table 5.3. Transition of Korea's Dependence from Japan to China



Source: Author's calculation using UN Comtrade database, Unit: (%)

Table 5.4. Korea's Dependence on the U.S. compared to China



Source: Author's calculation using UN Comtrade database, Unit: (%)

Moreover, in Table 5.4., we can anticipate the U.S.-China fierce competition in the products associated with transport equipment in Korea's import market. Not only the competition in specific sectors but also, we can expect that security in various food products (Section 1 and 2) and arms and ammunition (Section 17) should be maintained. Considering the trends of making restrictions on domestic products for securing own interests, triggered by inflation (an increase in food price) and nuclear challenge, will make the dependent state more vulnerable to powerful nations. Also, the high import dependence on the arms and ammunition of the U.S, not China, can verify that a resolute choice in the conflict between two great powers could threaten Korea's security interests as well as its economic interests.

Despite all of these inherent vulnerabilities, this raises the question of the reliance indicating an imminent danger for Korean critical industries. Table 5.2. and Table 5.3. clearly imply the

expansion of China's power in the import market. However, Korea-China trade has long been an "intermediate goods" - oriented structure within the process of forming a global value chain centered on China since multiple Korean companies operating in China have been component suppliers by re-importing the assembled intermediate goods. This can partly explain Korea's dependence on Section 20 (Miscellaneous manufactured articles) of Table 5 - Type A. Thus, it is hasty to conclude that the products with high-import reliance can pose a threat to key industries considering the trade structure. At point of Korea being a major partner taking the lead in high-tech trade, the reliance on intermediate products related to high-technology with high-value-added will matter.

4.3. Korea's Import Dependence on China's Intermediate Goods

Intermediate products are the essence of the Korea-China trade. As followed in Table 6, it is “intermediate good” that Korea had most imported from major economies in 2020. Processed materials are semi-finished products being changed in the manufacturing process, comprising medium and low-tech products such as petrochemicals, steel, nonferrous metals, and textiles. Meanwhile, parts and accessories mainly consist of high-tech goods with high-value added, such as electronic products, semiconductors, automobiles, and mechanical components, which are the core of today's global value chain.⁷ Based on the BEC (Broad Economic Categories) classification representing three basic classes of goods (capital goods, intermediate goods, and consumption goods), this section investigates Korea's import dependence on China's intermediate goods, especially with regard to parts and accessories.

⁷ Jeong H.W., (2022, November 25). [중국 이해 키워드 30] <중간재 교역> 한중 무역에 대한 3 가지 우려, 모두 기우였да?. The JoongAng.
<https://www.joongang.co.kr/article/25069700#home>

Table 6. Korea's Import Structure with Major Countries by Processing Stage

	Year	Primary Goods	Intermediate Goods			Final Goods		
			Processed	Parts and Accessories	Subtotal	Capital	Consumption	Subtotal
China	2020	1.4	43.6	17.4	61	22.9	14	37
U.S.		17.3	34.9	10.5	45.5	18	18.8	36.7
Japan		3.2	47.7	17.4	65.1	25.5	6	31.5

Source: Author's calculation using UNComtrade Database (Unit: %)

This paper uses the BEC-SITC correspondence table to estimate interest and vulnerable items. Table 6.1., 6.2., and 6.3. provides Korea's vulnerable and interest items, which are categorized as parts and accessories, with China in 2022. Table 6.4, on the other hand, demonstrates China's dependence on Korea's parts and accessories.

From the following tables, the most interest and vulnerable items are from the machinery and transport equipment industry. Furthermore, not only China but also the U.S. can pose a significant threat to our supply chain resilience considering the items of vulnerable are more significant than those of China. Commonly, the interest and vulnerable items are concentrated on electrical machinery, apparatus, appliances, and parts thereof (SITC 77). In particular, Korea is significantly dependent on the items of power generating machines

(SITC 71) and cathodes, parts of the tubes and valves of television (SITC 776) made in the U.S.

On closer inspection, Table 6.5. summarizes the changes in the import share of OECD-defined “high-tech” imported goods in machinery and transport equipment. Considering the rate of increase in the import share of foreign goods in the Korean industry, it is found that significant products have already been imported since the 2010s as found in Table 6.6. Also, the import rate of the products has increased significantly in 2022, even compared to 2020. As a main supply channel for electronics-tele communications items, China provides a great volume of semiconductor devices (SITC 77631) and piezoelectric crystals (SITC 77688). Besides, the main resources, which are necessary for aerospace and electronics-telecommunications products, are from the United States.

Table 6.1. Korea's Interest and Vulnerable Items in SITC 6

	SITC 6 Manufactured goods classified chiefly by material	Number of products
China	65791 (81%), 69961 (84%)	2
	None	0
U.S.	None	0
	69555 (52%)	1
Japan	None	0
	None	0

Table 6.2. Korea's Interest and Vulnerable Items in SITC 7

	SITC 7 Machinery and transport equipment	Number of Products
China	74493 (81%), 75995 (92%), 76212 (74%), 77313 (71%), 77688 (82%), 78689 (76%)	6
	71899 (50%), 74172 (62%), 74491 (53%), 74519 (51%), 74597 (61%), 74691 (52%), 77231 (64%), 77235 (59%), 77323 (52%), 77579 (52%), 77631 (59%), 77822 (67%), 77829 (53%), 77885 (53%), 78536 (58%)	15
U.S.	71319 (93%), 71441 (91%), 71481 (87%), 71489 (73%), 71491 (72%), 77612 (100%), 79293 (84%)	7
	71311 (58%), 72851 (64%), 77621 (60%), 77627 (55%), 77629 (58%), 77689 (68%)	6
Japan	None	0
	None	0

Table 6.3. Korea's Interest and Vulnerable Items in SITC 8

	SITC 8 Miscellaneous manufactured articles	Number of Products
China	81219 (85%), 87319 (95%), 88124 (87%), 88134 (78%)	4
	87424 (55%), 88113 (56%)	2
U.S.	None	0
	82111 (69%)	1
Japan	None	0
	87149 (51%)	1

Note: Each represents SITC code of vulnerable, interest items which a certain level of import dependence is above 70% and 50% respectively.

Source: Author's calculation using Korea Customs Service database

Table 6.4. China's Interest and Vulnerable Items with Korea in SITC 6, 7, 8

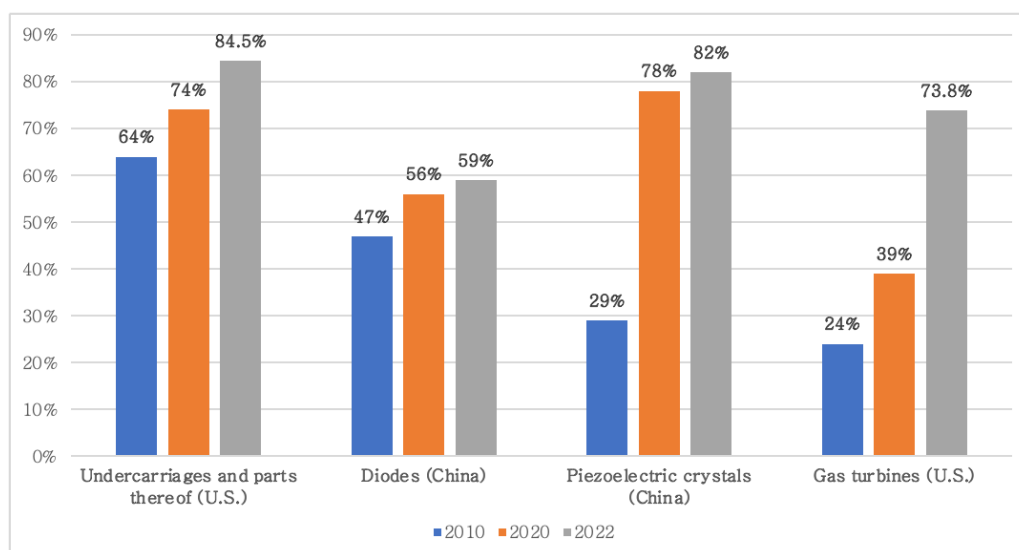
	Interest and Vulnerable Items in each SITC	Number of products
SITC 6	None	0
SITC 7	71333 (52%), 77629 (71%)	2
SITC 8	None	0

Source: UN Comtrade

Table 6.5. High-Tech products labeled as Interest and Vulnerable Items

Group	SITC (rev.4)	Products	Korea's Imports in 2022 (USD Million)	Origin	Import Dependence (%)
Aerospace	79293	Undercarriages and parts thereof	130.402	U.S.	84.5
Electronics- telecommunications	77631	Diodes , other than photosensitive or light- emitting diodes (LED)	336.246	China	59.3
Electronics- telecommunications	77688	Parts of the devices of subgroup 776.3 and of the mounted piezoelectric crystals of heading 776.81	173.089	China	82.7
Non-electrical machinery	71489	Other gas turbines	143.932	U.S.	73.8

Table 6.6. Change in Korea's Import Share of High-Tech Products



Gas turbines

Gas turbines are widely available for producing electricity to power ships, aircrafts, and other generators for carbon neutrality. In the midst of growing interests in clean and efficient energy, the U.S. Bureau of Industry and Security (BIS) announced ‘Export and Control Reform Act’ for certain “emerging and foundational technologies” that promote the production of gas turbine engine components or systems. For national security reasons, the policy is expected to restrict China’s capacity to design and attain high-end semiconductor devices. At the same time, however, these strategic concerns behind the BIS actions would call for allies and a number of companies to be engaged in a more effective multilateral control regime.⁸

Diodes

Also, diodes are the core material having a wide variety of uses, such as consumer electronic goods and emerging industries including cloud computing and smart manufacturing. After the 2018 U.S.– China trade war, China began a localization policy with diodes. Given its bargaining power of diodes at an affordable price and dominance in the display market, especially organic light emitting diodes (OLED), Korea is in a position on narrowing the technological gap with China through R&D support.

⁸ Shivakumar S., Wessner C., and Tomoshige H. (2023, January 10). Toward a New Multilateral Export Control Regime. *CSIS*. <https://www.csis.org/analysis/toward-new-multilateral-export-control-regime>

At the stage of heightened competition between hegemonic powers in critical minerals and products for emerging technologies, in particular semiconductor industries, it is wonder that China and the U.S. will pose threats through interest and vulnerable items. If there is or not, what are the reasons and how the threat can be removed?

4.4. The Possibility of Threats from Reliance on Imports

Unlike the initial stage of development of Korea-China trade, the current geopolitical environment reflects today's hegemonic competition between China and the United States, thereby the future conditions of Korea's supply chain should be brought into consideration. In that sense, previous studies consider a 'high level of import reliance on China' a valid indicator to expect Korea's future disruptions and determine it as supply chain vulnerability. This is because the trade of semiconductor industries, in particular, becomes more "politicized" with restrictive policies aiming at market dominance and blocking the other's technology supremacy. However, this section will touch upon strategies to avoid being vulnerable to shifts triggered by the competition.

There is a chance of Korea securing its interests through new customers and self-sufficiency. For instance, diplomatic conflict triggered the Korea-Japan trade dispute in 2019, leading to Japan's export restrictions on three key chemicals used for semiconductors and displays. The Korean administration had no choice but to encourage domestic production due to its heavy dependence on three materials. Makioka & Zhang (2023) found out how Japanese export controls have affected Korea's production, import, and export in the semiconductor

industry. First, the export restrictions propelled the reallocation of its sourcing from Japan to other locations, such as Taiwan, Belgium, and the U.S. Second, the export controls caused a large decline in Japanese exports to Korea of hydrogen fluoride, but not in the other two inputs. These results suggested that there is a limit to unilateral trade controls since they require changes in production locations and sourcing strategy. Moreover, Korea had actively started to accelerate the localization of the materials-components-equipment in the semiconductor industry and diversified its customers to deal with export regulations. As a result, there was notable progress in the localization and exports of hydrogen fluoride, which prompted independence from total dependence on specific imports. Also, on the other side of the perspective, this restriction caused Japan to lose the biggest buyer, Korea, which is also a risk element of export controls. The restriction of one important material or product can decide the counterpart's choice. However, it cannot result in permanent disruptions in one's supply chain, and 'high import reliance' can represent supply chain vulnerability for both countries since the restrictions have combined effects for either side.

Moreover, it is expected that the scope and degree of economic disconnection from China would be restricted. In 2023, the Group of Seven (G-7) partners officially declared and changed their economic approach to China from "de-coupling" to "de-risking". The common risks the U.S. government invokes are those related to national security, however, G-7 focused more on the ambiguity of the word "de-risking". They recognized economic approach not designed to harm China nor aim to impede its economic development. The decision of declaring an official approach

could mean that it is important to sustain economic relations with China for the U.S. and its allied partners and alleviate the backfire of future export controls. In addition, from the perspective of China, it is not sustainable to implement export controls on critical materials for the production of semiconductors considering its low rate of self-sufficiency. Because of the horizontal division of labor in the semiconductor ecosystem, each country has its advantages in the production process. For China, the reason for rapid growth in its semiconductor industry was its role as a global manufacturing plant, not its production capacity. An unexpected structural change in export policies would compromise the resilience of this ecosystem, so leveraging market dominance over rare materials for retaliation is not economical. Therefore, Chinese restrictions under the name of national security could be invoked but cannot be long-term strategy since technology and cooperation from other countries are essential to increase its global market share. In that sense, import reliance on inputs used for the critical industry can cause supply chain disruptions in the short term for the dependent state, whereas reliance itself cannot tell supply chain vulnerability for these reasons.

Chapter V. Conclusion

In accordance with one-sided interdependency, this study will make clear how Korea is more susceptible to China's specific industry by comparing Korea's supply chain vulnerability with other partners and China's trade vulnerability with Korea as well. It also provides with Korea's strategies to deal with unprecedented export controls by analyzing recent geopolitical circumstances and the precedent. This will supplement the limitation of previous studies, which only provided general information such as the number of interest and vulnerable items. Given the unexpected urea crisis in 2021, this index can be useful in determining Korea's import susceptibility across the classified traded goods to prevent future supply chains.

This study presents different implications from other analyses of how distortive Korea's trade vulnerability is with China. After looking into the research findings targeted at specific sectors and items, the reliance on parts and accessories for high-tech products already are underway, and it is not limited to only one country. Although the possibility of negative effects from the U.S.-China conflict on the Korean economy is high, there is a good chance of sustaining economic interests and the scope of economic separation from China cannot be sustainable.

In that sense, diversification of the supply chain out of China may not be the best option and should be carefully decided. Francoise (2009) emphasized that Korea can escape from the "intermediate goods-oriented" import structure by pursuing high value-added

activities, thereby reducing overwhelming reliance on intermediate inputs. Also, Chang (2017) suggested an alternative method to reduce economic dependence on China is third-country direct investment exported to China, such as ASEAN. However, unlike in the past, geopolitical issues are of growing importance in redefining the definition of global trade. Also, China is still of great importance as a major supplier even if Korea has achieved enormous growth in high-technology industries.

Therefore, this would be a good time to rearrange Korea's position in this fierce global trade competition. As the United States sought to deepen its cooperation with "like-minded" partners, Korea has also increasingly participated in building capacity and partnerships for resilient supply chains. Pursuant to this objective, the U.S. has come up with a multilateral framework, which indicates not only the intent to manage China's economic rise but also to bolster regional networks and partnerships. To cite one example, Indo-Pacific Economic Framework for Prosperity (IPEF) represents America's willingness to expand its economic leadership and reshape its influence in the Indo-Pacific through alignment. However, the agenda has challenges and potential risks. It is a wonder that new norms and standards can be effectively implemented considering the inherent limitation of IPEF and the diversity of participants. In that sense, IPEF can be a "strategical" method to gradually reduce dependence on critical items, but complete decoupling with China should be avoided. Given that Chinese economic leadership is pursuing self-sufficiency

and its interdependence with the U.S., it is now more crucial than ever for Korea's delicate stance of cooperation and competition with China and seeking to achieve consistent policies by clearly defining what our core interests are.

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국문초록

한국의 공급망 취약성에 관한 실증분석:

-대중국 수입의존도를 중심으로-

2020 년 이래로, 코로나 대유행으로 인한 전 세계적 공급망 대란이 발생하였으며 다른 지정학적 위기 요인들이 계속해서 가중되고 있다. 이후 한국에서는 예상치 못한 공급망 병목이 발생한바, 한국의 중국 제품에 관한 과도한 수입의존도가 동 현상의 핵심 요인으로 밝혀졌다. 그 이후, 공급망 안정성 및 회복탄력성 확보를 위해 특정국에 대한 공급망 취약성을 진단의 중요성이 부각되기 시작했다.

이러한 측면에서, 본 연구는 한국이 어떠한 중국 품목에 왜 취약하게 되었는지에 대한 이유를 제시하는 것을 목적으로 하며, 과연 수입의존성이 공급망의 취약성을 도래할 수 있는지 알아보고자 했다. ‘한-중 중간재 교역의 고착화’로 인해 단순한 수입품이 아닌 핵심품목에 대한 의존도의 변화를 살펴볼 필요가 있는바, ‘관심 및 취약품목’ 방법론을 활용함으로써 고위기술 산업에 사용되는 해외 부품 및 부속품에 대한 의존도가 공급망 취약성을 유발할 수 있는지 알아보고자 했다. 그 결과, 한국의 주요 무역 상대국에 관한 수입의존도를 살펴으로써 중국의 산업발전과 정책에 따라 한국의 공급망 구조가 미국중심의 수입에서 벗어남을 확인하였다. 두 번째, 주요 교역국인 중국, 미국, 일본으로부터의 전자기기 산업품목을 다수 수입하며 그

의존성이 높다는 것을 발견했다. 마지막으로, 동 고위기술 품목이 한국에 위협을 가할 수는 있으나 이전의 한-일 무역분쟁을 통해 갑작스러운 수입 중단에 대한 대비, 선진국들의 ‘디리스킹’ 대중 정책을 고려한바 장기적으로 ‘수입의존’ 자체는 위협이 될 수 없다고 분석하였다.

주제어: 무역, 공급망 취약성, 수입 의존도, 한중 무역, 공급망, 공급망 대란, 관심품목, 취약품목

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