The Korea-Japan trade dispute: non-tariff barriers

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Abstract

In mid-2019, a new major trade war started to heat up in east Asia, while the U.S.-China trade war held the spotlight. This article documents the recent Korea-Japan trade dispute and quantifies economic impacts. We calibrate the GTAP version 10 database to the GTAPinGAMS model, imposing the non-tariff barriers—the export controls by the Japanese government and boycotts by Koreans—in the form of bilateral trade shocks. With the Korea Customs Service data, we control for the shocks on Korea's import values across associated sectors. We find that the welfare loss would be 0.144% ($1033.71 million) for Korea and 0.013% ($345.69 million) for Japan, and also that the trade dispute between the two countries creates slight trade diversion with their major trading partners. We analyze the sectoral output changes as well. Due to the export barriers to Korea, trade impacts Japanese industries. The production of chemical goods is reduced by 0.25%, while the impacts on other sectors are relatively light. For Korea, the reduction in imports from Japan is regained either with domestic production or imports from other countries by sector.

Keywords: Applied economic analysis, Non-tariff barriers, Trade wars

JEL Classification: F11, F13, F17, C68

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1. Introduction

In mid-2019, the new major trade war started to heat up in east Asia, while the U.S.-China trade war held the spotlight. On July 1, the Japanese Ministry of Economy, Trade, and Industry (METI) suddenly announced that exports on chemicals and other materials that are essential to the production of semiconductors, Korea's top export industry, would be restricted. With export controls, exporters in Japan have to apply for an individual export license for the export of three goods: fluorinated polyimide, hydrogen fluoride, and photoresist. The export process under this new regulation takes up to 90 days. The Japanese government has justified the action with a reason for national security based on the Foreign Exchange and Foreign Trade Act, while Korea has questioned the political reason behind it. The Korean government requested the withdrawal of Japan's export controls to the World Trade Organization (WTO). Furthermore, Korea removed Japan's preferred trade partner status, creating a new low-tier category to isolate the country from future-benefits in response to the export controls. A more surprising feature was the Korean public's response in the form of boycotts. Given the complicated history between the two countries, Koreans were furious at Japan, displaying their anger by boycotting Japanese brands as well as travel to the country. In December, Korea and Japan have agreed to resume talks to solve the trade dispute, but it seems hard to reduce the gap between them.

The trade dispute is expected to bring negative impacts on the world, although they are concentered primarily in Korea and Japan. With the tension rising from the export controls, the global supply network could be directly affected. Japan supplies a large portion of intermediate goods for semiconductors to the world.[1] For its part, Korea produces most of the world's memory chips and has a significant market share in TV and smartphone screens. Countries relying on Korea's high-tech products such as the U.S., China, and even Japan would adversely be affected, and a ripple effect on the global chain in the electronic device industry might be even more profound. The im-

[1] Export data from the Japanese Ministry of Finance. From January to April 2019, Japan exports $618.3 million of fluorinated polyimide, $28.9 million of hydrogen fluoride, and $950.2 million of photoresist to the world. For fluorinated polyimide, China, Korea and Taiwan take 36.3%, 22.5%, and 19.5%, respectively. For hydrogen fluoride, Korea take 85.9%, and Taiwan, the U.S., and China are followed with 7.8%, 3.3%, and 2.6%, severally. For photoresist, the U.S., China, Taiwan, and Korea take 21.8%, 16.7%, 17.9%, and 11.6%, respectively.

pacts could reverberate in other industries, in which electronic components are highly demanded. Along with the phase, the boycott movements in Korea cause another economic damage to both Korea and Japan, and they lead to trade disruptions. Although the boycotts target Japanese brands and services, the production origins are not limited to Japan. For example, the famous Japanese apparel brand, Uniqlo, is made in China. Therefore, the boycotts could harm China, having an unintended outcome. We present the data from the Korea Customs Service for the affected products in Section 2.

We adapt general equilibrium simulation models to analyze the trade dispute. These methods have been a powerful and standard tool for evaluating the impacts of important economic events. The assessment of free trade agreements is an epitome of the models: Ianchovichina and Martin (2003) show the impact of China's accession to WTO, and Kehoe (2005) analyzes the effect of the North America Free Trade Agreement (NAFTA). More recently, these models are applied to Brexit (e.g., Jafari and Britz, 2020) and the trade wars. Li et al. (2020); Carvalho et al. (2019); Guo et al. (2018) document the U.S.-China trade war showing how an increase in tariffs will impact export and welfare. Contrary to the high volume of studies on the U.S.-China's case, little attention is paid to the trade dispute between Korea and Japan. Hosoe (2020) quantifies the impacts of export controls on Korea and predicts welfare loss by from -\$2144.54 million to -\$98.76 million for Korea, and from -\$1562.62 million to no loss for Japan.

This paper is the first comprehensive evaluation of the recent Korea-Japan trade dispute by imposing non-tariff barriers (NTBs). Given the presence of NTBs caused by the export controls and changes on consumer preferences (*i.e.*, boycott on Japanese products), we control for shocks to change the bilateral trade share on Korea, reflecting the ongoing impact of imports. With the Lanz and Rutherford (2016) GTAPinGAMS model that is the workhorse of trade policy analysis, we calibrate the Global Trade Analysis Project (GTAP) version 10 account as our benchmark point. Then, using the monthly export-import data provided by the Korea Customs Service as of December 2019, we analyze the impacts of the trade dispute on welfare, sectoral outputs, and trade patterns. Our analysis is different from the previous study in the literature. First, we incorporate the whole event in the trade dispute, both the export controls triggered by the Japanese government and the boycott movement by Koreans. Hosoe (2020) forecasts the potential impacts of the export controls in the early stage of the trade dispute, but his analysis is not complete in the sense that it includes only the partial scenario. We will cover complete and factual impacts, even including the U.S.-China's tariff increases and showing how the global economy has been affected by the trade disruption.

Second, our analysis does not rely on Ad-Valorem Equivalent (AVE) of NTBs. When NTBs exist, an export tax equivalent is a common and straightforward practice in Computable General Equilibrium (CGE) analysis. Although AVE is an easy tool for generating an instant trade barrier, the interpretation of the result should be cautious.[2] Fundamentally, it is uncertain what percent of tariffs would be valid and equivalent for NTBs underlying the trade barriers. Kee et al. (2009) suggest a specification scheme of NTBs, but it demands the massive scale of data and estimation. Our method of imposing trade shocks on bilateral trade links that directly matches the value of import is still straightforward, enabling the quantifiable simulation precisely without hurdles of NTBs.

Our result shows that the welfare falls by -0.144% for Korea while Japan's welfare falls by -0.013%. They are equivalent to that Korea loses about $1033.71 million, and Japan loses about $345.69 million. The Welfare losses we estimated would be close to the actual damage from the trade dispute.[3] The magnitudes of welfare loss are far less than the U.S.-China trade war, but it is not negligible. With trade diversion, the trade volume shifts to the EU, China, and Mideast Asian countries, resulting in overall welfare gain in these regions. Moreover, the Korea-Japan trade dispute has substantial effects on the sectoral outputs, both on the targeted and related sectors. Japan's export controls on chemical intermediates bring about the reduction of production. The sectors targeted by boycotts such as food, beverage, and motor vehicles would suffer a loss as well. For Korea, some of the chemical goods are substituted locally, so that the production of it increases. However, with trade diverted from Japan to the EU, the motor vehicles and parts sector would be damaged the most.

[2]See Fugazza and Maur (2008). They imply that AVE of NTBs can create rent-seeking behaviors of the government so that, in the context of a general equilibrium approach, the result of welfare impacts should be interpreted carefully.

[3]Hosoe (2020) evaluates the export control by either imposing a TFP shock or an export tax (AVE of NTBs) on the chemical product sector. A TFP approach reveals that the welfare loss of Japan would be trivial, but Korea would only lose $98.76 million. Given the high trade interdependency between two countries, this estimated welfare loss would be unlikely. On the other hand, with imposing an additional 50% increase in export tax, the potential loss for Korea would be $2.14 billion and $1.56 billion for Japan. As discussed, however, the general equilibrium models might provide unreliable results without the precise level of NTBs.

The remainder of this paper takes the following form: Section 2 offers a description of the methodology and data. Section 3 represents the result of welfare impacts, sectoral output changes, and trade diversion. Finally, Section 4 concludes and summarizes the implications of the model and discusses directions for future research.

2. Methodology

2.1. Model

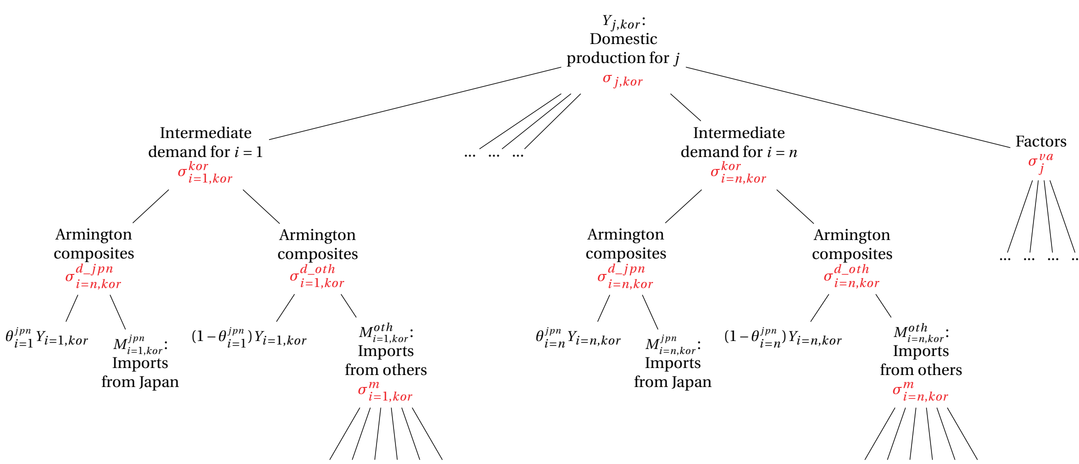
We employ the canonical GTAPinGAMS model by Lanz and Rutherford (2016) and calibrate it to the latest GTAP 10 dataset for the 2014 benchmark year.[4] With a generic neoclassical economic structure, this model provides an established benchmark point where we initiate our analyses. The international trade structure of the model is based on the Armington (1969) assumption, of which goods are differentiated by country of origin. Under this type of setup, goods from different countries are considered as imperfect substitutes, and the elasticity of substitution—the Armington elasticity—determines the degrees of substitution in demand between nationally differentiated products. The imports from different sources are aggregated to composite imports, so they can be used as an intermediate input or directly consumed by the representative agents. When the composite imports are used an an intermediate input, they are combined with domestic goods in a nested Constant Elasticity of Substitution (CES) structure.

Figure 1 shows CES nesting structures for production in Korea and other regions, and the elasticity in each nest is denoted with σ.[5] We modify the nesting structure of imports in Korea to accommodate our targeted sectors described in Section 2.2. The conventional nesting structure would only conceive a first-order effect: a decrease in import from one country must bring a decrease in overall composite imports. However,

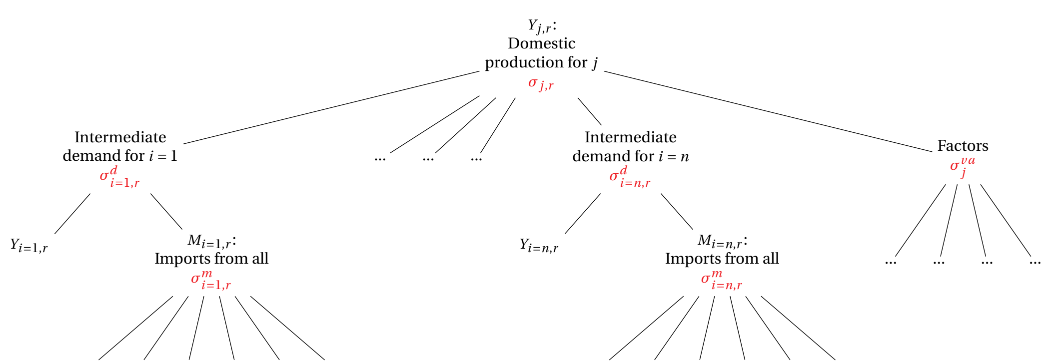
[4]The key difference between the GATPinGAMS and the Standard GTAP Model frameworks has laid in the final demand system. While GTAPinGAMS uses Cobb-Douglas preferences on final demand, the Standard GTAP Model represents them with a constant difference of elasticities (CDE) demand system. Although Lanz and Rutherford (2016) introduce CDE implementations in GTAPinGAMS for alternative representations of final demand, we use the model with Cobb-Douglas preferences in our analysis.

[5]The rationale for the trade elasticities of sectors and factors in these regions comes from Hertel (1997). The elasticity (σ^d) between domestic and composite import goods is half of the elasticity (σ^m) between foreign sources of import goods (*i.e.*, $\sigma^m = 2\sigma^d$). However, the values are generally unknown with precision, and the magnitude is debatable as well. Feenstra et al. (2018) indicate that there is no significant difference between two parameters for one-half of goods they estimated, while for the other half, σ^d is significantly smaller than σ^m.

we find that the first order effect is not sufficient for such sectors as Motor vehicles and parts; Other food products. These sectors experience an increase in overall composite imports, despite a sharp decrease in import from Japan. We need to impose a more complex nest to understand the change behind the trade dispute. Thus, it is inevitable that Korea's nesting structure would be subdivided. In Korean industries, the import from Japan is separated from other foreign sources of imports, while the rest of them are still merged into the composite imports. Our new structure leads to the different Armington composite goods based on origin, of which they are combined with domestic intermediates by weights θ_i^{jpn} for associated sectors. Except Korea, Other regions including Japan follow the conventional nesting structure of the GTAPinGAMS model.



(a) Korea



(b) Other regions

Figure 1: Nesting structure of the CES production function in Korea and Other regions

Given the altered CES nesting structure of production in Korea, we impose bilateral trade shocks on Korea's imports from Japan. Since the model uses the calibrated share form of the production function, we can consider the absolute reference level of outputs at all times. Consequently, it enables us to control the shocks, aiming the precise targets. The shocks in our model are essentially embodied in a non-linear system of equations, which is formulated as in a Mixed Complementarity Problem (MCP) setting. The two key variables, import quantity ($M^{jpn}_{i,kor}$) and price ($P^{M\_jpn}_{i,kor}$) from Japan in Korea, are associated with zero profit and market clearance conditions, respectively.[6] We characterize a new set of MCP setting of Korea's imports with integrated shocks as follows; the zero profit conditions are:

$$m^{jpn\_0}_{i,kor}(P^{M\_jpn}_{i,kor} - CIM^{jpn}_{i,jpn,kor}) \geq 0 \quad \perp \quad M^{jpn}_{i,kor} \geq 0 \tag{1}$$

In Equation (1), the benchmark of import from Japan for sector i is given by $m^{jpn\_0}_{i,kor}$, and $CIM^{jpn}_{i,jpn,kor}$ is the unit cost of imports from Japan in sector i. To define these terms, we need to utilize a Social Accounting Matrix (SAM) in the GTAP 10 database. The GTAPinGAMS model illustrates the accounting identities of import with the following notations: the benchmark bilateral export of i from region s to r ($vxmd_{i,s,r}$) and its price ($p^{vxmd}_{i,s,r}$) along with the margins for transport service ($vtwr_{j,i,s,r}$) and its price ($p^{vtwr}_{i,s,r}$). The trade shock (τ_i) for sector i is integrated on the benchmark values of bilateral trade (*i.e.*, $vxmd_{i,s,r}$ and $p^{vxmd}_{i,s,r}$). We multiply the benchmark quantity by $1-\tau_i$ and divide the benchmark price by $1-\tau_i$, in which τ_i can be considered as a negative shock if the sign is minus. A negative trade shock causes the benchmark import price to decrease, and the benchmark import quantity to increase. Overall, the shocks are canceled out entirely; however, the benchmark point is stable:

$$\begin{aligned} m^{jpn\_0}_{i,kor} &= \left[\frac{p^{vxmd}_{i,jpn,kor}}{(1-\tau_i)}\right]\left[(1-\tau_i)\, vxmd_{i,jpn,kor}\right] + p^{vtwr}_{i,jpn,kor}\sum_j vtwr_{j,i,jpn,kor} \\ &= p^{vxmd}_{i,jpn,kor}\; vxmd_{i,jpn,kor} \; + \; p^{vtwr}_{i,jpn,kor}\sum_j vtwr_{j,i,jpn,kor} \end{aligned}$$

[6] The full description of the MCP setting of the GTAPinGAMS model is found in Lanz and Rutherford (2016).

The trade shock comes into effect by price channel on $CIM^{jpn}_{i,jpn,kor}$, which is given by:

$$CIM^{jpn}_{i,jpn,kor} = \overbrace{\underbrace{\theta^{vxmd}_{i,jpn,kor}}_{\text{value share of imports}} \underbrace{P_{i,jpn}}_{\text{price of } Y_{i,jpn}} \underbrace{\left(1 - t^{xs}_{i,jpn,kor}\right)}_{\text{export tax}} \underbrace{\left(1 + t^{ms}_{i,jpn,kor}\right)}_{\text{import tax}} \underbrace{\frac{(1-\tau_i)}{p^{vxmd}_{i,jpn,kor}}}_{\text{trade shock integrated}}}^{\text{the producer supply prices in Japan}} + \overbrace{\sum_j \underbrace{\theta^{vtwr}_{j,i,jpn,kor}}_{\text{value share of transport}} \underbrace{P^T_j}_{\text{price of transport}} \frac{\left(1 + t^{ms}_{i,jpn,kor}\right)}{p^{vtwr}_{i,jpn,kor}}}^{\text{the unit price of transportation}} \tag{2}$$

Equation (2) has two parts: the producer supply price in Japan and the cost incurred by the transportation of goods. A negative shock would impact the production costs in Japan, eventually causing an increase in the import price ($P^{M\_jpn}_{i,kor}$) of Japanese products in Korea via the market clearance conditions:

$$(m^{jpn\_0}_{i,kor} M^{jpn}_{i,kor} - \sum_j DIFM^{jpn}_{i,j,kor}) \geq 0 \quad \perp \quad P^{M\_jpn}_{i,kor} \geq 0 \tag{3}$$

$DIFM^{jpn}_{i,j,kor}$ in Equation (3) represents a compensated demand function for the Japanese intermediate inputs in Korea, which is a function of domestic productions ($Y_{j,kor}$), domestic prices ($P_{i,kor}$), and import prices ($P^{M\_jpn}_{i,kor}$). Equation (1) and (3), along with the other sets of non-linear equations, would pin down the optimal import price and quantity in Korea. Throughout the process, the Armington elasticities play an essential role determining the optimal import quantity, given changes in the price. The transmission of shock can be seen not only in the bilateral trade link between Korea and Japan, but it brings a global trade disruption through general equilibrium channels.

We aggregate the original 141 GTAP countries and regions to 17, and Table 1 shows the full description of the country set used in the analysis. Based on the UN Comtrade export-import data for Korea and Japan, we choose leading trade partners for both countries. For Korea, trade with Asian countries accounts for from 58.9% (export) to 64.6% (import), from 13.1% to 14.9% with North America, and from 9.6% to 11.6% with European countries. Japan has a similar trade pattern as most of the trade occurs with Asian countries. Thus, we maintain the essential Asian countries that have a high trade volume with Korea and Japan, while we merge the 28 members of the EU into one region. Other Asian countries that have relatively small trade values are aggregated to a Rest of Asia (XXB). For the countries out of our interest, they are aggregated to a Rest of the World (ROW). Moreover, we include 57 sectors instead of 65 in GTAP 10. Some commodities, such as in chemical and electronic industries, in GTAP 10 are subdivided, so it provides more detailed sectors than the previously released.[7] However, it might be not necessary to have more segmented sectors. Accordingly, the 57 sectors in our analysis are consistent with GTAP 9. Finally, we leave the eight factors as they appear in the original model.

[7] See Aguiar et al. (2019).

Table 1: Trade volume of Korea and Japan with countries and regions in the model

Regions		Korea		Japan	
		exports to ($604.8 billion)	imports from ($535.2 billion)	exports to ($738.2 billion)	imports from ($748.2 billion)
KOR	*Korea*	-	-	7.1%	4.3%
JPN	*Japan*	5.0%	10.2%	-	-
USA	*United States*	12.1%	11.0%	19.1%	11.2%
CHN*	*China*	34.4%	20.3%	24.2%	23.5%
EU**	*European Union*	9.6%	11.6%	11.3%	11.7%
MYS	*Malaysia*	1.5%	1.9%	1.9%	2.5%
VNM	*Vietnam*	8.0%	3.7%	2.2%	2.8%
TWN⋄	*Taiwan*	3.4%	3.1%	5.7%	3.6%
THA	*Thailand*	1.4%	1.0%	4.4%	3.3%
MID†	*Mideast Asia*	2.1%	13.0%	2.2%	11.8%
CAN	*Canada*	0.9%	1.1%	1.3%	1.6%
MEX	*Mexico*	1.9%	1.0%	1.6%	0.8%
BRA	*Brazil*	0.8%	0.7%	0.5%	0.9%
RUS	*Russia*	1.2%	3.3%	1.0%	2.1%
AUS	*Australia*	1.6%	3.9%	2.3%	6.1%
XXB	*Rest of Asia*	8.7%	5.7%	9.3%	7.0%
ROW	*Rest of the World*	7.3%	8.6%	5.8%	6.7%

Source: Author's calculation from UN Comtrade (2018)
* China includes mainland China and Hong Kong SAR.
** 28 members of the European Union
⋄ Although UN Comtrade does not provide the trade data for Taiwan officially, Taiwan is included in "other Asia, nec."
† Countries in MID are Saudi Arabia, United Arab Emirates, Iran, Qatar, Kuwait, and Bahrain.

2.2. Data

Korea Customs Service presents monthly export-import trade data based on the Harmonized System (HS) code. We use the data from January to December 2019 and process them to show the impacts on bilateral trade before and after the trade dispute. Given the fact that the trade dispute began to be tense around late July, we average out the monthly data as of August. The monthly average of January to July is labeled as "before," and that of the rest of the month be as "after" the trade dispute.

The boycott movement in Korea targets all Japanese brand products and services. However, the production site of multinational firms is not always consistent with the brand's country of origin. For instance, the Japanese brand apparel is produced either in China or Vietnam, in which goods are exported to Korea. Though the boycotts damage Japan in the end, it would harm those countries first. Unfortunately, it is beyond our scope to include multiple production sites and export schemes of multinational firms in our model. We exclude the products of these sorts and maintain only the ones whose production originated in Japan. A portion of consumer goods such as automobiles, beverages, cigarettes, cosmetics, and processed foods are included. Table 2 shows the impacts of the trade feud over 2019. It seems that the campaign to boycott Japanese goods has led to severe decreases in demands for associated goods.[8] The import value on automobiles declines the most (-$40.58 million) as an absolute value, but the percent difference in beer & cigarettes is far sharper than others (-97.14%). The import data from other countries are not shown here, but we find that considerable trade diversion occurred during this period. For instance, automobile imports from Germany and the U.S. have increased by 52.55% and 32.57%, respectively.

To incorporate the impacts in our model, we assign the Korea Customs Service data at the 6-digit HS code level to the GTAP sectors. Table 3 reports the affected GTAP sectors and percent difference before and after the trade dispute by origin of imports. Import dependency from Japan is the highest in the sector of Chemical, Rubber, and Plastic products (21.74%), while it is the lowest in the sector of Other food products (2.42%). These findings imply that Korea is highly dependent upon Japan's intermediate goods, given the demands for Chemical, Rubber, and Plastic products in most industries. In Motor vehicle and Parts, imports from Japan declined by almost 20%, but the overall import value increased by 14.88%, indicating that trade diversion occurs. We also find that trade is diverted in Other food products sector, although the percent change is small.

[8] See Appendix. The import weight from Japan has significantly decreased along with the import value, whereas the import price has been stable given the period of our analysis. We provide the data for import weight and import price indexes (IPIs) for selected categories of goods in the Appendix section. Even though the unit import price could be directly calculated from the Korea Customs Service data that we used, there are potentially significant biases in using customs unit value to measure import price changes. For this reason, IPIs are the preferred alternative for import price (e.g., Export and Import Price Index Manual: Theory and Practice, 2009).

Table 2: Changes in import value for affected products by origin over the trade dispute

Affected products	Origin of imports	"Before" (Million USD)	"After" (Million USD)	Value difference (Million USD)	Percent difference (%)
Boycotts					
Automobiles	Japan	115.62	75.04	−40.58	−35.10
	All	853.75	1027.11	173.35	20.30
		[13.54%]	[7.31%]		
Beer & Cigarettes	Japan	5.73	0.16	−5.56	−97.14
	All	29.42	26.32	−3.11	−10.56
		[19.46%]	[0.62%]		
Cosmetics	Japan	19.31	14.24	−5.07	−26.27
	All	145.10	139.55	−5.55	−3.83
		[13.31%]	[10.20%]		
Processed Foods	Japan	15.25	9.40	−5.86	−38.39
	All	273.24	281.51	8.27	3.02
		[5.58%]	[3.34%]		
Export controls					
Fluorinated Polyimide	Japan	33.70	31.56	−2.14	−6.36
	All	42.04	42.44	0.41	0.97
		[80.16%]	[74.34%]		
Hydrogen Fluoride	Japan	5.94	0.68	−5.27	−88.61
	All	18.19	14.48	−3.71	−20.38
		[32.67%]	[4.67%]		
Photoresist	Japan	32.65	27.36	−5.23	−16.18
	All	36.96	33.96	−3.00	−8.13
		[88.33%]	[80.59%]		

Source: Author's calculation from Korea Customs Service (January to December 2019)
Notes: "Before"—monthly average of January to July. "After"—monthly average of August to December. We process the data from the following HS code: automobiles (4-digit level 8703), beer (6-digit level 220300), cigarettes (4-digit level 2402), cosmetics (4-digit level 3303, 3304, 3305, 3306, and 3307), processed foods (2-digit level 18, 19, and 21), fluorinated polyimide (6-digit level 392099), hydrogen fluoride (6-digit level 281111), and photoresist (6-digit level 370790). Ratio of Japanese imports to all in square brackets.

Table 3: Changes in import value by origin in the GTAP sectors

GTAP sectors	Origin of imports	"Before" (Million USD)	"After" (Million USD)	Percent difference (%)
Chemical, Rubber, and Plastic products	Japan	1122.90	1059.32	−5.66
	All	5102.50	4957.93	−2.83
		[22.01%]	[21.37%]	
Motor vehicles and Parts	Japan	210.55	169.06	−19.70
	All	1392.91	1600.20	14.88
		[15.12%]	[10.57%]	
Beverages and Tobacco products	Japan	8.92	1.30	−85.49
	All	146.47	138.38	−5.53
		[6.09%]	[0.94%]	
Other food products	Japan	24.08	14.66	−39.14
	All	828.87	836.87	0.97
		[2.91%]	[1.75%]	

Source: Author's calculation from Korea Customs Service (January to December 2019)
Notes: "Before"—monthly average of January to July. "After"—monthly average of August to December. GTAP sectors are defined broader than the HS classification of Korea Customs Service. For example, Motor vehicles and Parts sector includes not only 4-digit level 8703 HS code, but also other 4-digit levels such as 8704 and 8705 HS codes. Ratio of Japanese imports to all in square brackets.

2.3. Scenarios

We experiment with two scenarios in our analysis—first, the comprehensive trade dispute between Korea and Japan as of December 2019.[9] We recalibrate our model from the initial benchmark to the data point reflecting the impact of imports in Korea by imposing the bilateral trade shocks and shifting the Armington elasticities. Specifically, we have two moments reported in the percent difference column in Table 3: one is the imports from Japan, and the other is the imports from all. For identifying these moments, we use a numerical method: find the trade shocks (τ) that match the percent change in the imports from Japan, then change the Armington elasticities (σ^{d_oth}) that

[9] It is infeasible to separate two events (*i.e.*, the export controls triggered by the Japanese government and boycotts by Koreans) and estimate welfare loss of each impact. Foremost, the timeline of the two events is too close to identify the data point at our best knowledge. Second, the chemical products affected by Japan's export controls and Japanese cosmetics boycotted by Koreans are in the same sector of GTAP: Chemical, Rubber, and Plastic products.

match the percent change in the import from all. Thus, the first scenario would analyze the full impact of the trade dispute.

Second, we incorporate the tariff increase data archived by Li (2018) from the U.S.-China trade war. This database provides not only a tariff increase between the U.S. and China, but also between the U.S. and other countries such as the EU, Korea, Japan, and others.[10] The global impacts of two trade wars can be found in this scenario.

3. Results

3.1. Welfare impacts

We first report, in Figure 2, welfare impacts across regions and countries for the scenario of Korea-Japan's trade dispute. Welfare impacts are calculated based on equivalent variation (EV), and they are displayed both by percentage changes and with million US dollar values in total household income. In this trade dispute, Korea loses the most, and Japan is followed. Welfare in Korea decreases by 0.144%, and in Japan welfare decreases by 0.013%. When it is translated to dollar notation, the gap would be much reduced, given that Japan's economy is three times bigger than Korea. The welfare loss in Korea is equivalent to $1033.71 million, and Japan's loss is $345.69 million. While Korea and Japan lose, most other major trade partners to both countries gain from the feud. The biggest winners under the scenario are the EU, China, Mideast Asian countries, and Russia, gaining $217.91 million, $116.29 million, $89.98 million, and $32.11 million, respectively. In percentage change, the welfare of Mideast Asian countries (0.011%) and Vietnam (0.010%) increases the most. Other countries such as the United States, Australia, Canada, Thailand, and Brazil gain slightly with trade diversion.

3.2. Output changes by sector in Korea and Japan

In Figure 3, we plot the sectoral impacts in Korea and Japan. Bilateral trade shock affects economies in important and predictable ways. Foremost, it decreases outputs across targeted sectors in Japan. Among the four targeted sectors presented in Table 3, the chemical, rubber, and plastic products sector suffers the most harm from the trade dis-

[10] Li et al. (2020) quantify the impacts on the recent trade war between the U.S. and China with the same tariff increase database we use.

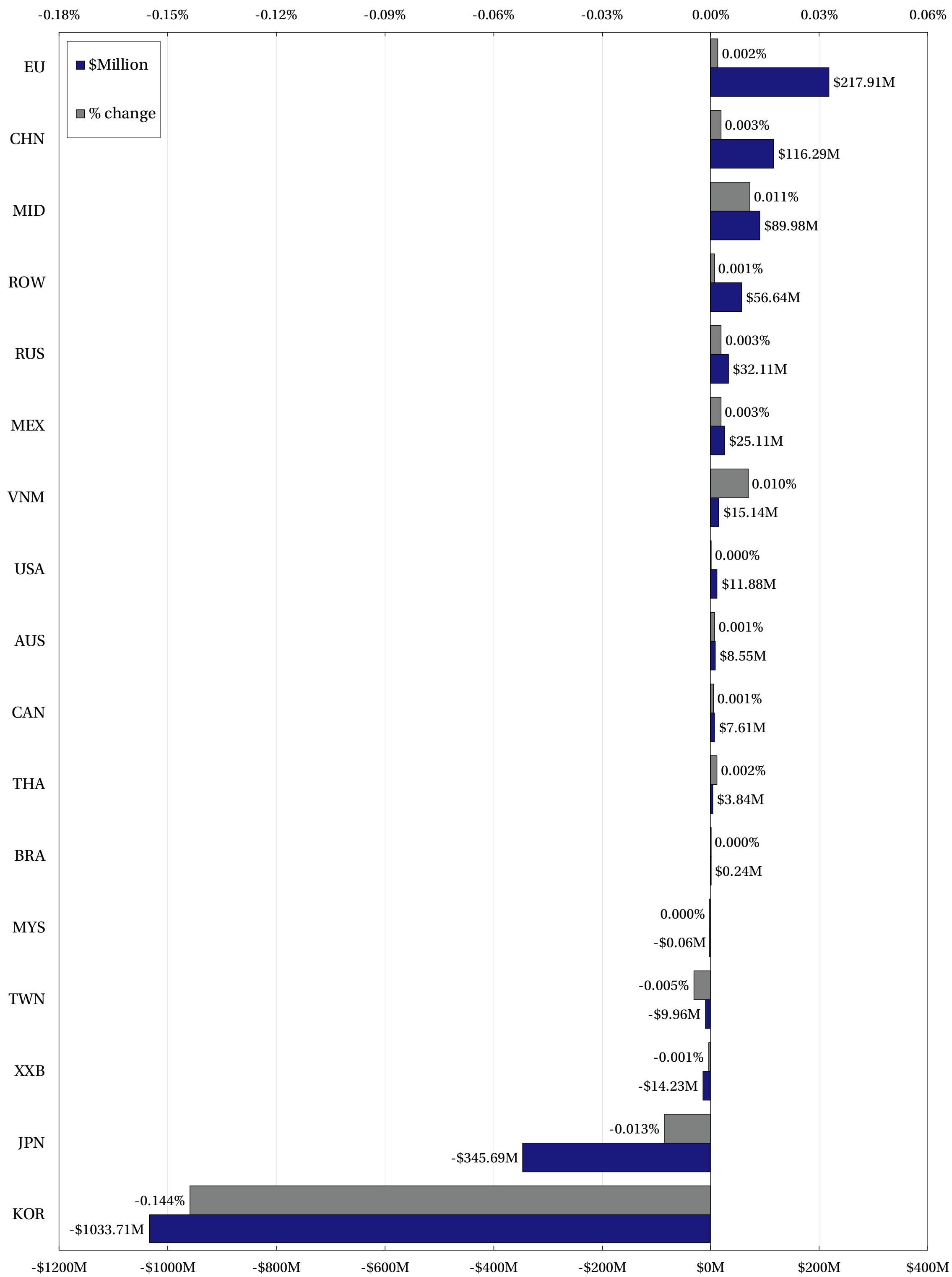


Figure 2: Welfare impacts across countries and regions: % change and $Million

pute. Due to the export controls on chemical goods to Korea, which creates non-tariff barriers, the production of chemical goods has decreased by 0.25% in Japan. Compared to the output change in chemicals, trade has impacted other Japanese industries relatively lightly. For instance, the output of beverages and tobacco products decrease by 0.09%, motor vehicles and parts decrease by 0.07%, and the other food products sector suffers a 0.07% drop in output. Given the size of these industries, the damage to the chemical, rubber, and plastic products sector would be modest, but other sectors should be minimal.

In Korea, the production changes differ from Japan across targeted sectors. Given the period of the trade dispute, the imports from Japan have decreased and been substituted with others. For some sectors in which the total imports increased, the demand for Japanese products is diverted to other countries, leading to a decrease in domestic production. For example, the output in motor vehicles and parts sectors drops by 2.29%, and other food products drop by 0.31%. The boycotts and import depressions occur at the same time, implying trade diversion. It is not reported here, but we find that trade diversion occurred in the motor vehicles and parts sector from Japan to Germany and the United States. For other sectors in which the total imports decreased, the demands are covered by domestic goods. For example, some of the chemical goods are locally substituted, boosting domestic productions in Korea by 0.99%. This result might be consistent with the new direction of Korean firms, diversifying new sources of chemicals other than Japan, and starting to invest in local facilities. Moreover, the output of beverages and tobacco products increases slightly by 0.64%. Although the output change in the sector is small, it reflects the shift in consumer preferences from Japanese to domestic products.

3.3. Trade diversion

This section highlights how Korea's import and Japan's export would be diverted with the trade dispute. The percent change in trade flows of Korea and Japan with their trading partners is reported in Table 4. First of all, with the impacts of the export controls and boycotts, Korea's import is shifted from Japan to others. While the inflow from Japan falls by 2.46%, the trade with other major partners such as the EU (2.10%), China (0.19%), the U.S. (0.34%), and Mideast Asian countries (0.24%) rises. Given that Korea's

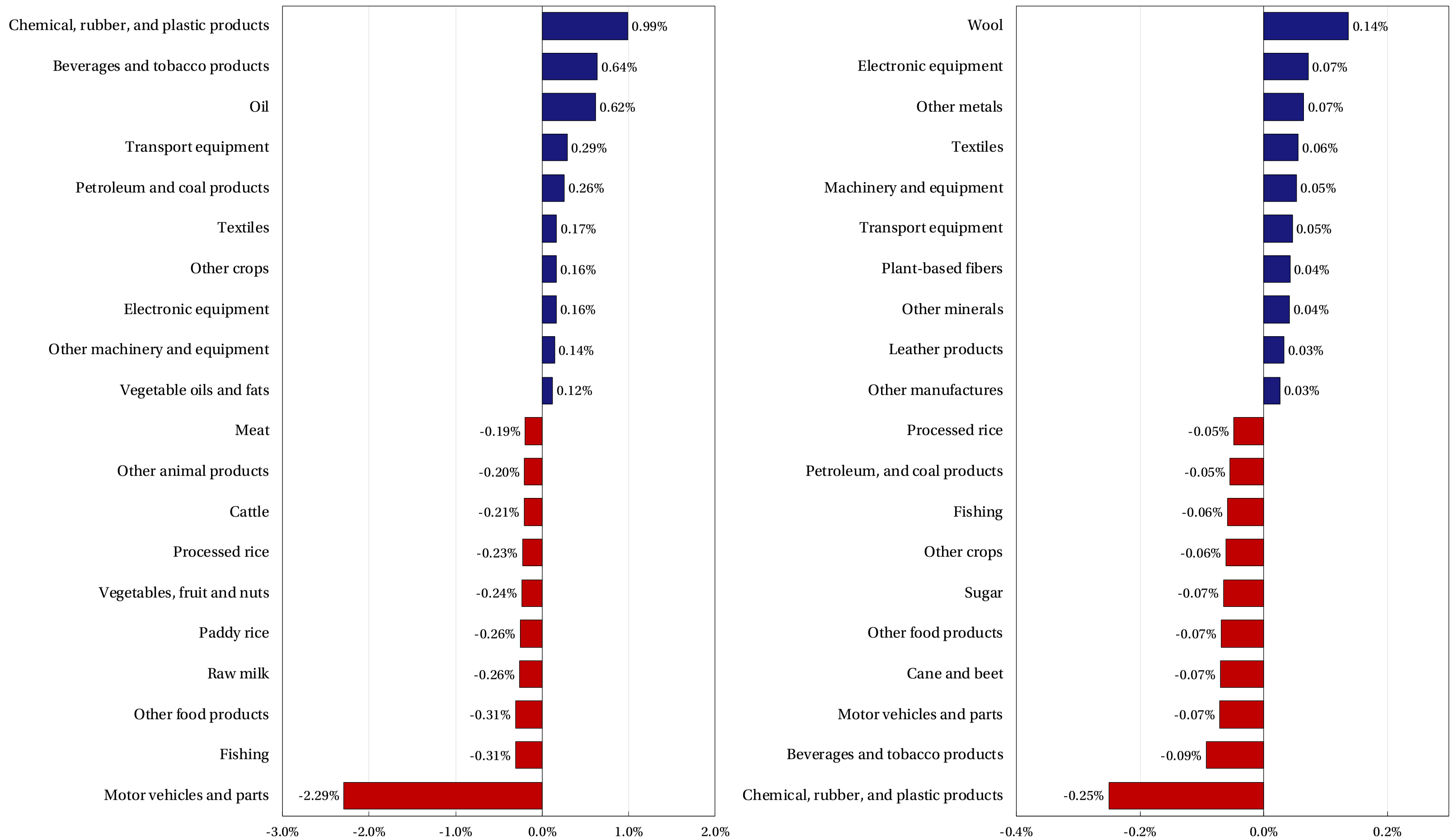


Figure 3: Percent changes for sectoral output—top 10 rising and falling: Korea (left) and Japan (right)

primary partners have over 70% of import shares, the trade diversion is sizable as the overall imports in Korea increase by 0.18%. Second, we find that Japan loses the export market in Korea but expands others slightly. The gains from other markets, however, are too small to offset the loss from Korea. Overall, the net exports from Japan decrease by 0.06%.

Table 4: Percent changes in trade flows of Korea and Japan with the trading partners

	(1)	(2)	(3)	(4)
	Exporter to Korea	% change	Importer from Japan	% change
1	*China*	0.19	*China*	0.08
2	*Mideast Asia*	0.24	*United States*	0.13
3	*European Union*	2.10	*European Union*	0.16
4	*United States*	0.34	*Rest of Asia*	0.10
5	*Japan*	−2.46	*Korea*	−2.46
6	*Rest of the World*	0.09	*Rest of the World*	0.12
7	*Rest of Asia*	−0.04	*Taiwan*	0.08
8	*Australia*	0.15	*Thailand*	0.09
9	*Vietnam*	0.18	*Australia*	0.09
10	*Russia*	0.22	*Vietnam*	0.07
11	*Taiwan*	−0.05	*Mideast Asia*	0.12
12	*Malaysia*	0.02	*Malaysia*	0.10
13	*Canada*	0.13	*Mexico*	0.13
14	*Mexico*	2.00	*Canada*	0.14
15	*Thailand*	−0.09	*Russia*	0.13
16	*Brazil*	−0.09	*Brazil*	0.13
Total		0.18		−0.06

Notes: The countries and regions in Column (1) and (3) are sorted in descending order by the trade shares of Korea's import and Japan's export, which are reported in Table 1.

3.4. The consequence of global trade wars

In this section, we incorporate the tariff increase database of Li (2018) into our model and report the consequence of global trade wars. The database includes not only the tariff increase between the U.S. and China but also other countries conflicting with the U.S. We believe that this analysis can present the most comprehensive welfare impacts. Table 5 reports the welfare impacts on percent change and billion-dollar value by scenario. In Column (1), two trade wars are included: the cases on Korea-Japan and the U.S.-China. The unprecedented scale of the global trade war causes the welfare of the U.S. and China solely to fall by 0.242% and 1.657%, respectively, while others would benefit from it. The EU gains the most with over $10 billion, and the countries in North America (*i.e.*, Mexico and Canada) gains fairly. Korea and Japan would gain as well. While Korea and Japan would experience the most losses in their trade war, the significant trade diversion brought from the U.S.-China trade war will balance their welfare losses entirely. Column (3) captures the net change from the scenario of Korea-Japan's case (see Column (2)) to the global trade wars (see Column (1)), which shows the exclusive impact of the U.S.-China trade war.

Table 5: Welfare impacts by scenario

Regions	(1)		(2)		(3)	
	(KOR-JPN) + (USA-CHN)		(KOR-JPN)		Net change from (2) to (1)	
	% change	Million USD	% change	Million USD	% change	Million USD
Vietnam	0.881	1299.85	0.010	15.14	0.871	1284.71
Malaysia	0.751	1277.74	0.000	−0.06	0.751	1277.80
Mexico	0.725	6487.36	0.003	25.11	0.723	6462.25
Taiwan	0.574	1231.05	−0.005	−9.96	0.579	1241.01
Korea	0.509	3660.22	−0.144	−1033.71	0.653	4693.93
Thailand	0.459	996.21	0.002	3.84	0.457	992.37
Canada	0.335	3430.51	0.001	7.61	0.334	3422.90
Japan	0.162	4391.42	−0.013	−345.69	0.175	4737.11
Brazil	0.153	2305.49	0.000	0.24	0.153	2305.26
Rest of Asia	0.116	3047.88	−0.001	−14.23	0.117	3062.11
European Union	0.099	10699.20	0.002	217.91	0.097	10481.29
Mideast Asia	0.094	776.47	0.011	89.98	0.083	686.49
Rest of the World	0.068	3857.20	0.001	56.64	0.067	3800.56
Australia	0.062	491.72	0.001	8.55	0.061	483.17
Russia	0.055	592.83	0.003	32.11	0.052	560.71
United States	−0.242	−29056.08	0.000	11.88	−0.242	−29067.97
China	−1.657	−68460.80	0.003	116.29	−1.660	−68577.09
World	−0.116	−52971.74	−0.002	−818.35	−0.114	−52153.39

Notes: (KOR-JPN)—the scenario of Korea and Japan. (USA-CHN)—the scenario of the U.S. and China.

4. Conclusions

This paper documents the recent Korea-Japan trade dispute using a standard general-equilibrium simulation model, in which we impose the non-tariff barriers caused by the export controls and boycotts. Using a data source that resulted from the dispute, we control for the shocks on Korea and Japan's bilateral trade of associated goods, calibrating the model from a transparent reference point. We find that the welfare loss estimated by this study is 0.144% ($1033.71 million) for Korea and 0.013% ($345.69 million) for Japan, and also that the trade dispute between the two countries brings slight trade diversion with their major trading partners.

Our model, however, is limited in the features of foreign direct investment (FDI) and outsourcing that could distort the trade structure. One obvious caveat in our analysis due to this limitation is the origin of the sourced country. We are unable to encompass the full list of boycotted products that are produced other than in Japan. Given the activity of multinational firms on the FDI and outsourcing, the actual welfare impacts of the dispute would permeate further to China, Vietnam, and other low-income countries, which are popular destinations for manufacturing industries. While the recent work of Lakatos and Fukui (2014) suggests a new structure of demand and supply for the extension to FDI and foreign affiliates, the firm-level activity should be incorporated for further applications.

Appendix

Table A.1: Changes in import weight for affected products by origin over the trade dispute

Affected products	Origin of imports	"Before" (Metric ton (1000kg))	"After" (Metric ton (1000kg))	Value difference (Metric ton (1000kg))	Percent difference (%)
Boycotts					
Automobiles	Japan	8699.16	5764.60	−2934.56	−33.73
	All	42471.74	50625.26	8153.52	19.20
Beer & Cigarettes	Japan	6670.39	133.72	−6536.67	−98.00
	All	32428.21	27412.06	−5016.15	−15.47
Cosmetics	Japan	811.91	615.06	−196.85	−24.25
	All	8328.39	8193.20	−135.19	−1.62
Processed Foods	Japan	2353.41	1569.40	−784.01	−33.31
	All	55629.51	53047.90	−2581.61	−4.64
Export controls					
Fluorinated Polyimide	Japan	787.53	773.84	−13.69	−1.74
	All	1193.14	1161.26	−31.38	−2.67
Hydrogen Fluoride	Japan	3096.47	442.60	−2653.87	−85.71
	All	10140.63	8364.54	−1776.09	−17.51
Photoresist	Japan	222.17	208.24	−13.93	−6.27
	All	703.31	546.56	−156.75	−22.29

Source: Author's calculation from Korea Customs Service (January to December 2019)
Notes: "Before"—monthly average of January to July. "After"—monthly average of August to December. We process the data from the following HS code: automobiles (4-digit level 8703), beer (6-digit level 220300), cigarettes (4-digit level 2402), cosmetics (4-digit level 3303, 3304, 3305, 3306, and 3307), processed foods (2-digit level 18, 19, and 21), fluorinated polyimide (6-digit level 392099), hydrogen fluoride (6-digit level 281111), and photoresist (6-digit level 370790).

Table A.2: Import price indexes and percent changes for selected categories of goods: January to December 2019

Description	Index											
[2015=100]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
All commodities	105.89	108.18	109.20	110.13	108.45	105.11	105.97	103.76	104.49	103.19	103.67	104.58
	(-)	(2.16%)	(0.94%)	(0.85%)	(-1.53%)	(-3.08%)	(0.82%)	(-2.09%)	(0.70%)	(-1.24%)	(0.47%)	(0.88%)
Consumer goods												
Automotive	105.24	105.15	104.29	104.19	101.95	101.96	101.79	99.93	100.26	101.23	101.84	102.00
vehicles	(-)	(-0.09%)	(-0.82%)	(-0.10%)	(-2.15%)	(0.01%)	(-0.17%)	(-1.83%)	(0.33%)	(0.97%)	(0.60%)	(0.16%)
Foods, feeds, &	83.51	84.64	84.26	83.88	83.10	82.95	83.83	82.71	83.76	84.57	85.11	85.15
beverages	(-)	(1.35%)	(-0.45%)	(-0.45%)	(-0.93%)	(-0.18%)	(-0.14%)	(-0.14%)	(1.27%)	(0.97%)	(0.64%)	(0.05%)
Cosmetics	100.65	100.41	99.80	98.99	96.32	97.03	98.02	95.81	96.18	97.07	98.06	97.70
products	(-)	(-0.24%)	(-0.61%)	(-0.81%)	(-2.70%)	(0.74%)	(1.02%)	(-2.25%)	(0.39%)	(0.93%)	(1.02%)	(-0.37%)
Manufacturing												
Chemical	100.57	100.39	101.62	102.19	101.66	101.12	100.90	98.48	99.74	98.99	98.40	98.62
intermediates	(-)	(-0.18%)	(1.23%)	(0.56%)	(-0.52%)	(-0.53%)	(-0.22%)	(-2.40%)	(1.28%)	(-0.75%)	(-0.60%)	(0.22%)

Source: Bank of Korea (January to December 2019)
Notes: USD basis. Monthly percent changes (from the previous month) in parentheses.

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