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The Impacts of Bilateral Value Chains between Japan and Korea on Value-Added Creation of Manufacturing Firms

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Abstract

This study investigates the bilateral value chain participation between Japan and Korea and the impacts on their firms' value-added creation. We found a firm-level evidence that there exist mutual gains of Japanese and Korean firms when both firms belong to an industry that highly participates in a backward bilateral value chain of Korean with Japan, or equivalently say, a forward bilateral value chain of Japan with Korea. This evidence qualitatively remains the same in main manufacturing industries except for automobile and trailer industry. Our result may imply that a trade dispute between Japan and Korea hurts firms in both countries and a mutually beneficial trade relationship should be restored.

Key words: Bilateral Value Chain; Value-Added; Japan; Korea

JEL Classification: F1

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1. Introduction

In the past the Korean economy had grown in the assembly and processing industries of consumer products, and core materials, machines, parts and components were mainly procured from Japan. As the advanced technology of Japan was imported and greatly contributed to the industrialization process of Korean economy, the two countries have become naturally major trading partners. According to trade statistics of *Korea Customs Service* as of 2020 Korea is Japan's third-largest export destination and fourth-largest import destination, and Japan is Korea's fifth-largest export destination and third-largest import destination.

However, recently as historical, political and diplomatic frictions between the two countries increased, the trade dispute between Japan and Korea arose as well. Japanese government regulated the export of some materials that are essential in semiconductor and display industries of Korea. This measure was believed to give a disrupt of product developments and production ability in the semiconductor and display industries which are the main pillars of the Korean industry. Likewise, fatal crisis might have arisen for some Japanese firms who have exported as major suppliers to Korea. This paper aims to focus on the industrial relationship between the two countries in a view of bilateral value chains and empirically investigate how the industrial connections between the two countries are related to the firms' ability of creating value-added from their production and sales. We hope that this study can be used to derive a rational economic cooperation plan between the two countries.

The trade deficit of Korea with Japan was the main research subject in previous trade-related policy studies that were conducted in Korea.[1] This is because Korea is the net importer country from Japan and the trade deficit has chronically persisted for long time since the two countries

[1] For example, see Kim and No (2008), Oh and Park (2011), KISTEP (2013), Kim (2015) and Lee (2018) for Korea side. On the other hand, the effect of FTA between Japan and Korea was mainly analyzed for Japan side, for instance see Abe, Urata, and NIRA (2008).

started trade in 1965. The policy literature has analyzed causes of trade deficit and suggested industry and trade policies that may help reducing the size of total deficit. However, the trade structure between Japan and Korea is attracting attention of policy-oriented research group as well due to the recent trade dispute. The notion of trade structure between countries can be better captured by the concept of Global Value Chain (GVC). The GVC refers to a global production network in which net value-added is created at each stages of production that are specialized and distributed to several countries. The participations of a country in GVC can be divided into two types - forward and backward participation. The forward GVC participation of a country is an activity of producing and exporting intermediate goods used for production or export by importing partners. The backward GVC participation of a country is an activity of importing and reprocessing the intermediate goods used for production or export of the country. Using this concept, we will first define forward and backward BVC (Bilateral Value Chain) participation between Japan and Korea and then investigate the impact of BVC on the firms in both countries.

As one can notice, Korea's forward BVC with Japan is Japan's backward BVC with Korea, and Korea's backward BVC with Japan is Japan's forward BVC with Korea. So, precisely speaking, we are going to examine the following two sets of questions. The first set is for Korean firms: (1) Has the value-added of *Korean firms* increased when the firms belong to an industry that highly participated in *backward BVC with Japan*? (2) Has the value-added of *Korean firms* increased when the firms belong to an industry that highly participated in *forward BVC with Japan*? The second set is for Japanese firms. Likewise, (3) Has the value-added of *Japanese firms* increased when the firms belong to an industry that highly participated in *forward BVC with Korea*? (4) Has the value-added of Japanese firms increased when the firms belong to an industry that highly participated in *backward BVC with Japan*?

To conduct the empirical analysis, this paper uses two sources of databases. First, for firm-

level data, we use the *Survey of Business Activity* (SBA) from the Statistics Korea of the Korean government and the *Basic Survey of Japanese Business Structure and Activities* (BSJBSA) from the Ministry of Economy, Trade and Industry of the Japanese government. In particular, we will focus on the information on value-added of the manufacturing firms in order to verify whether a high degree of bilateral value chain participation creates high value-added for firms in both countries. In the empirical analysis, the real value-added variable will be used as normal value-added divided by industry price index. The industry price index is defined at 2-digit manufacturing industry and the data are available from the Bank of Korea for Korea, and JIP

Database for Japan. Second, we use World Input Output Database (WIOD) in order to construct the forward and backward BVC participations. The forward BVC participation of Korea with Japan at industry-level will be defined as for a given industry Korea's total export to the industry in Japan divided by the production or export of the industry in Japan. This will be the same definition for the backward BVC participation of Japan with Korea for that industry. To backward BVI participation of Korea with Japan at industry-level will be defined as for a given industry Korea's total import of the industry from Japan divided by the production or export of the industry in Korea. This will be the same definition for the forward BVC participation of Japan with Korea for that industry. In the empirical part, these BVC participation variables will be the main explanatory variable for explaining the effect on the firm-level value-added. We also control other firm characteristics such as capital, labor and R&D that may determine the value-added function for firms. Since we use panel data annually spanning from 2006 to 2014, we will also control year-specific effect together with firm-specific effect in our main regression models. The time period for our analysis is set from 2006 to 2014. This is because we used 2016 version of WIOD in which the data are available only up to 2014, and the SBA database in Korea are established in 2006.

Our empirical results reveal that the backward BVC participation of Korea with Japan or

equivalently the forward BVC participation of Japan with Korea increased *both* Korean and Japanese firms' value-added. However, the forward BVC participation of Korea with Japan or equivalently the backward BVC participation of Japan with Korea did not. This result implies that there exist the mutual benefits between Korean and Japanese firms when Korean firms imports intermediate inputs from Japanese firms. The implication can be further used to consider a possibility that the current trade dispute between Japan and Korea may hurt not only Korean firms but also Japanese firms as well.

2. Related Literature

In the past when the transportation and communication technology were not sufficiently developed, the production network or value chain was confined within a country. However, as the costs were reduced, new communication technologies were developed, and political and economic barriers to trade were lowered, the value chains have been expanded globally (Baldwin, 2013). The international division of labor was carried out efficiently in each stage of production through foreign direct investments by multinational firms, and finally the global value chain was established in the world economy.

The effect of participation in the global value chain has been analyzed in a context of expansion of input trade and the literature has shown that input trade contributes to growth of firm productivity. Amiti and Konings (2007) showed, using Indonesian manufacturing data, that the tariff cut for intermediate goods was more effective in improving productivity compared to the tariff cut for final goods. Grossman and Rossi-Hansberg (2008) theoretically showed that the increase in corporate offshoring contributes to productivity improvement through cost reduction. Halpern *et al*. (2015) used Hungarian firm-level data to show that an increase in import intermediate goods brings about productivity improvement. Criscuolo *et al*. (2015) summarized the three paths by which input trade can improve productivity; (1) the

efficiency gains through vertical specialization of production across countries; (2) the availability of high-quality inputs through intermediate goods trade; and (3) the cross-country spillover of new knowledge through input trade.

Related to our approach to GVC, Kummitriz (2016) defined global value chains using World Input-Output Table and found that a country's participation in GVC increases the domestic value-added. Particularly, GVC participation was divided into forward and backward participations. He found that forward GVC participation (i.e. input export) leads to a greater improvement in a domestic value-added than backward GVC participation (i.e. input import). As for recent studies on Korea, Kim and Choi (2020) examined the growth effect of GVC in Korea after 2008 global financial crisis. They found that the forward GVC participation of Korea to developing countries has had a positive impact on Korea's economic growth while the backward GVC participation with advanced countries has not. Regarding Japan, however, few similar studies have been conducted that so far as we know.

However, the GVC empirical literature has been relatively rare for firm-level studies. Actually, it is firms that has constructed and participated in the GVC through their foreign direct investment and trading activities across countries. So, we may want to know whether firms' participation in the GVC was a plus to themselves. In general, however, constructing GVC participation measure at firms-level is a difficult task. For instance, we need a firm-level information on input trade by country and by industry. If it were to be done, we could further investigate a question of how a firm's participation in input trade affect their economic performance and growth.

In order to overcome this data availability issue, the existing studies have defined variously the GVC participating firms as ones with foreign direct investment (Farole and Winkler, 2014); with two-way trades that do both import and export (Baldwin and Yan, 2014; Kasahara and Lapham, 2013); and with both the foreign direct investment and trade (Veugelers, 2013). In

this paper, since we are interested in trade relationship between Japan and Korea, we follow Baldwin and Yan (2014) and define a GVC firm as a firm whose import and export values are greater than zero. In Baldwin and Yan (2014), the GVC firms showed a relatively higher increase in real value-added than those that did not participate. This definition was also used in some of Korean literature. Kim *et al*., (2016) showed that Korean firms with the two-way trading perform better than non-two trading firms. Hur *et al*., (2018) pointed out that Baldwin and Yan (2014) neglected the fact that a manufacturing firm may produce multi-products and thus engage in multiple value chains in international trade. So, they investigated plant-level data and showed that the GVC participation could increase the plants' growth.

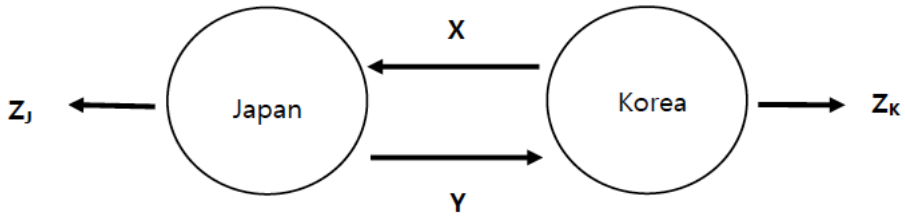
We notice that all of these papers at firm-level have focused on a case where a firm participate in global value chains as a whole. It has been paid relatively less attention to what happens to a bilateral value chain. More specifically speaking, if an importing firm in country A benefits from participating in backward value chain with country B, would the exporting firm in country B also benefit from participating forward value chain with country A? In short, our paper attempts to examine a possibility of mutual gains from bilateral value chain between a pair of countries. For this purpose, we investigate value-added of Japanese and Korean firms respectively when the firms in the two nations participate in a bilateral value chain simultaneously.

3. Bilateral Value Chain between Japan and Korea

As the production of goods and services became internationally divided due to globalization and technological progress, the concept of a global value chain emerged; meaning that the value-added inherent in a product is intertwined across borders. The value chain of a production is not limited to one country, but a global division of the chain is formed across countries based

on their comparative advantage in each stages of the production. A full-scale analysis of the international division of production and labor began with the introduction of the concept of vertical specialization in Hummels *et al*. (2001). Starting with Hummels *et al*. (2001), Fally (2012) and Koopman *et al*. (2010) sharpened the concept of GVC. According to their studies, the GVC participation methods are divided into two simple forms between a pair of countries. The first one is forward participation. This refers to an activity of a country's exporting domestic input used for production or export of an importing foreign country. The second is backward participation, which describes an activity of a country's importing foreign inputs used for production or re-export of the country. If these import and export activities are done by more than three countries, it is called as a complex GVC. Here is an illustration that simplifies a simple form of bilateral value chain between two countries.

Figure 1: Concept of Bilateral Value Chain between Japan and Korea

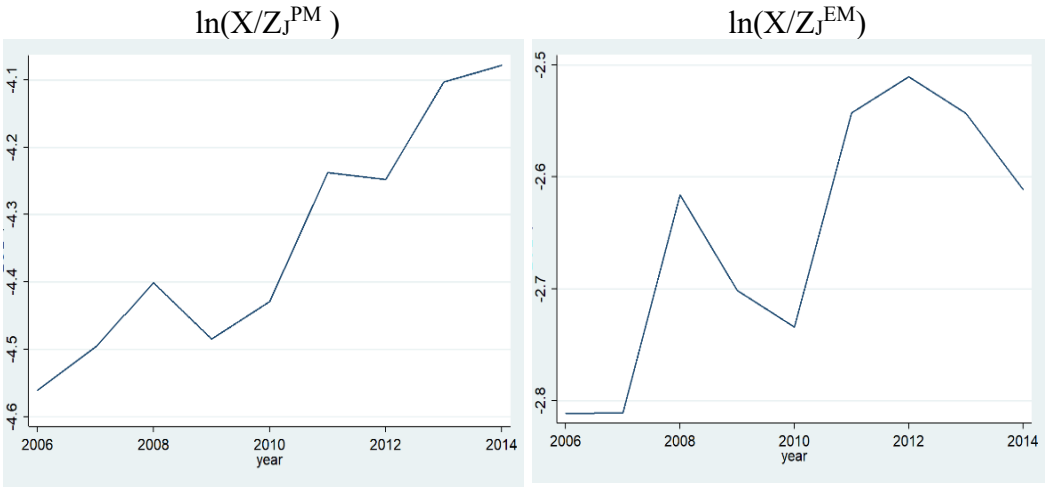


In Figure 1, X is the value-added of intermediate export by Korea to Japan and Z_J is the value-added of final good export of Japan to the rest of the world when Japan uses X as input for Z_J production. Likewise, Y is the value-added of intermediate export of Japan to Korea and Z_K is the value-added of final good export of Korea to the rest of the world when Korea uses Y as input for Z_K production. So, based on Hummels *et al*. (2001), we can define that Korea's backward participation of the bilateral value chain as Y/Z_K, and Korea's forward BVC participation as X/Z_J. From the perspective of Japan, Y/Z_K is the Japan's forward BVC

participation and X/Z_J is the Japan's backward BVC participation. For the variables of Z_i where i=J, K, we will consider production (Z_i^P) as well as exports (Z_i^E) since foreign input can be used for not just export but also total production including domestic sales. Also, following Wang *et al*. (2017), we will consider intermediate exports (Z_i^{EM}) and productions (Z_i^{PM}) for the variables of Z_i as well. These variations for the definition of backward and forward BVC is useful for us to examine a pair of countries who mainly engage in intermediate good trade.

In order to obtain the data for the X, Y, Z_i^P, Z_i^E, Z_i^{EM} and Z_i^{PM} we use the World Input-Output Database (WIOD) tables. The WIOD is an integrated world input-output table by country and industry. It interlinks to the input-output tables of each country who provides the information on the industrial structure of input demand and output supply including imported inputs and exported outputs. The World Input and Output Database used in this paper was published in 2016 with the support of the European Commission. It links the input-output tables of 43 countries (28 EU countries and other major 15 countries) by country and industry from the year of 2000 to 2014. The WIOD's industry classification follows International Standard Industry Classification (ISIC Rev.4) which is divided into 56 sectors.

[Figure 2: Share of Korea's Intermediate Exports to Japan's Outputs in Bilateral Value Chain]



For the period of 2006 to 2014, we calculate the BVCs between Japan and Korea and show in Figure 2 and Figure 3. Figure 2 shows for BVC variables, $\ln(X/Z_J^P)$, $\ln(X/Z_J^E)$, $\ln(X/Z_J^{PM})$ and $\ln(X/Z_J^{EM})$, which are the Korea's forward BVCs with Japan or equivalently the Japan's backward BVCs with Korea. The variables of X/Z_J^P and X/Z_J^{PM} are the shares of Korea's intermediate exports to Japan's total final goods' output and intermediate goods' output, respectively. Both variables have been increased for the period, except for the 2009 and the 2012 which seem to show temporary downturns. The overall trend implies that the role of Korea's industrial contribution to Japan's output production has been increased. We find a similar finding from the figures of $\ln(X/Z_J^E)$ and $\ln(X/Z_J^{EM})$ when we use the Japan's export. However, we notice that the trend seemed to change since 2013. This could be either a reduced export of Korea to Japan (X) or increased export of Japan to the world (Z_J^E and Z_J^{EM}). Nonetheless, Overall pictures of the four variables tell us that from 2006 to 2014 the Korea's forward BVCs with Japan or the Japan's backward BVCs with Korea has been intensified between Japan and Korea. Now what about the opposite BVCs between them?

[Figure 3: Share of Japan's Intermediate Exports to Korea's Outputs in Bilateral Value Chain]

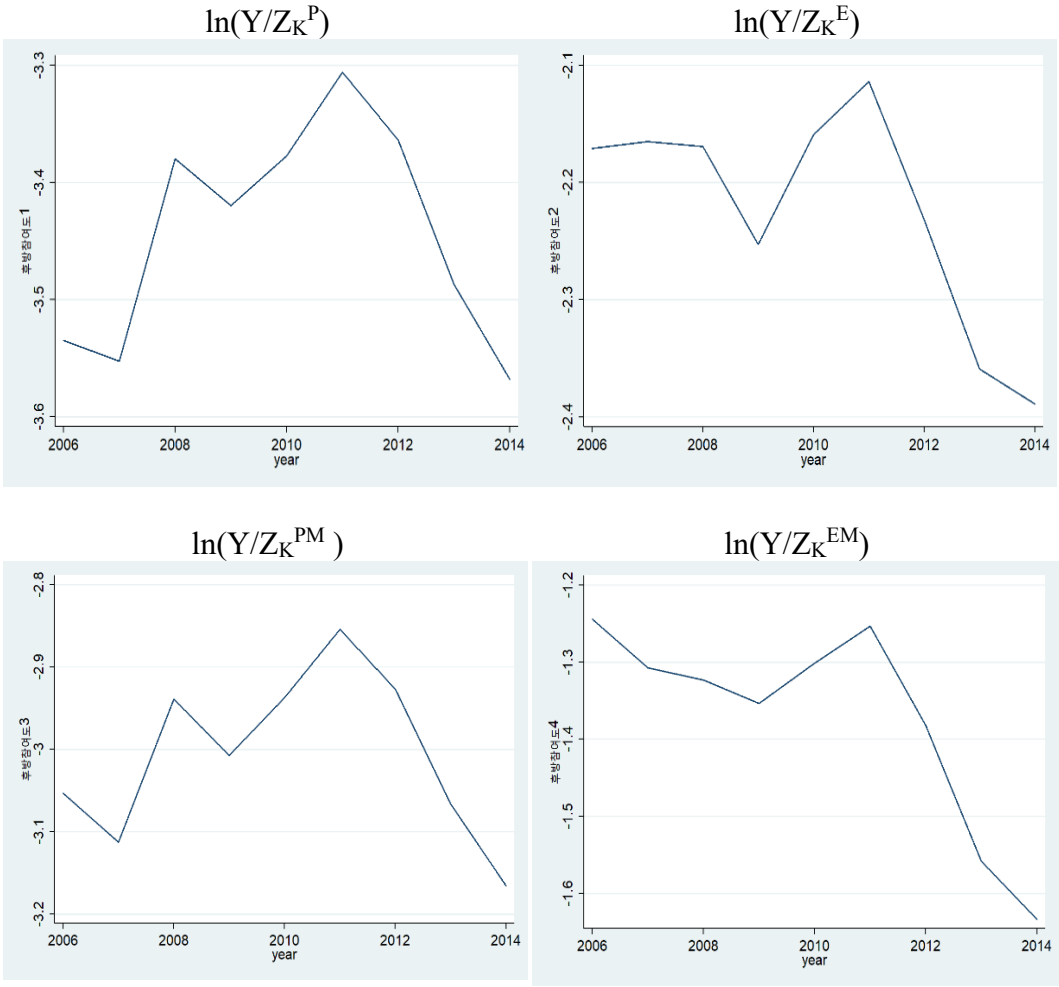


Figure 3 shows for the other side of BVC variables, $\ln(Y/Z_K^P)$, $\ln(Y/Z_K^E)$, $\ln(Y/Z_K^{PM})$ and $\ln(Y/Z_K^{EM})$, which are the Japan's forward BVCs with Korea or equivalently the Korea's backward BVCs with Japan. The trend of the BVC variables shows different patterns of those in Figure 2. The variables of Y/Z_K^P and Y/Z_K^{PM} are the shares of Japan's intermediate exports (Y) to Korea's total final goods' output (Z_K^P) and intermediate goods' output (Z_K^{PM}), respectively. Both variables have been increased for the periods of 2006 to 2010 and then began decreasing from 2011 to 2014. This implies that the role of Japan's industrial contribution to Korea's output production has been weakened since 2011. The weakened trend of Japan's contribution to Korea's industries are more clearly observed for the other BVC variables, Y/Z_K^E

and Y/Z_K^{EM}. These variables represent the Japan's industrial contribution to Korea's exports for final goods and intermediate goods. The two figures imply that Korea has been relatively using less of Japan's intermediate goods when Korea produces export products than domestic products. The Korea's backward linkage with Japan has been weakened. Understandably, as Korean economy has become industrialized, it seems to continue to increase its competitiveness in manufacturing intermediate goods domestically and hence rely on less Japanese inputs.

Our question in this paper is whether a firm in each country who engages in export and import in global markets would benefit from the these BVCs between Japan and Korea. For this purpose, we will provide a simple model of BVC and establish a testable hypothesis in next section.

4. Estimation Model and the Results

4.1 A Model of BVC participation and Value-Added

Suppose that a real value-added of a firm in Japan and Korea is determined by the following function.

$$VA = f(A, L, K)\,.$$

VA is the real value-added of a firm. It is a function of technology (A), labor (L) and capital (K) that the firm employs. VA increases in A, L and K, respectively. In particular, following the idea of Kim and Choi (2020), we will similarly assume that A is determined by a firm's Bilateral Value Chain participation (BVC) and R&D investment (RD); $A = A(BVC, RD)$ with $\frac{\partial A}{\partial RD}>0$.[2]

[2] Here we assume that there is no direct relationship between RD and BVC. However, Lee and Hur (2019) show

Then, we can find the path of how the BVC participation between Japan and Korea can affect the real value-added of the firms.

$$\frac{\partial VA}{\partial BVC} = \frac{\partial f}{\partial A} \times \frac{\partial A}{\partial BVC}$$

Since we assume $\frac{\partial f}{\partial A}>0$, the sign of $\frac{\partial VA}{\partial BVC}$ is determined by that of $\frac{\partial A}{\partial BVC}$. We may consider two paths how the BVC affects the firms' real value-added. First, if a firm engages in a vertically specialized bilateral value chain between two countries, we assume $\frac{\partial A}{\partial BVC}>0$ and thus we expect a result of $\frac{\partial VA}{\partial BVC} > 0$. The vertical specialization in a BVC between Japan and Korea may imply the following two situations. The first is that, for a given an industry firms in Japan efficiently reallocate their resources to become input producers who export intermediate goods to Korea (i.e., forward BVC participation of Japanese firms) *and* at the same time firms in Korea efficiently reallocate their resources to become output producers who import intermediate goods from Japan (i.e., backward BVC participation of Korean firms). The second situation is the opposite vertical specialization – backward BVC participation of Japanese firms and forward BVC participation of Korean firms. In both cases, we may expect the firms in the BVC between Japan and Korea will benefit each other by specializing in what they are relatively better at. Second, if they do not participate in the BVC at all or the vertical division of work between Japan and Korea is not efficient at all in a type of BVC (either forward or backward), then we may have $\frac{\partial A}{\partial BVC} = 0$ or $\frac{\partial A}{\partial BVC} < 0$.

Note that, in our empirical analysis, we will consider a sample of firms who actually engage in two-way trading – both import and export – in global markets. Our premise here is that a participation of a cross-country value chain – the two-way trading – is a result of firms' rational

a possible complementary relationship between R&D investment and two-way trading activities using a bivariate choice model. So, admittedly we may not rule out the indirect relationship between RD and BVC.

and optimal behavior. So, if our empirical analysis supports $\frac{\partial VA}{\partial BVC} > 0$, we may interpret as that the BVC between Japan and Korea affects two-way trading firms to enhance their technology and value-added. However, we need to be cautious in this interpretation. Due to the lack of firm-level data on export destinations or import countries, the two-way trading firms we use in our empirical analysis are those that are trading in a global market not just in Japan-and-Korea market. In order to get around the problem of lacking firm-level trading country information we define the BVCs between Japan and Korea using industry-level trade data. In this way, we may expect that a larger number of firms of both countries in a given industry are more likely to export and import between Japan and Korea, if the BVC participation rate between Japan and Korea in that industry is larger than that in other industries.

Another consideration should be given to a possibility that relative BVCs may matter in multi-country setting. Suppose that for a given industry, a vertical specialization between Korea and China is stronger than between Korea and Japan. Then, it would be possible that firms in the former BVCs may be more relevant to Korean firms than in the latter BVCs. For this reason, our empirical results should be interpreted as those only *within* a bilateral relationship between Japan and Korea. Our approach does not rule out a possibility that another competing BVCs may be more beneficial or detrimental than the Japan-and Korea BVC. In fact, our purpose of the current research is to focus on how the bilateral value chain between Japan and Korea affects the firms in both countries *within* the chain. It would be natural and interesting to examine relative effects across different BVCs and we will leave it for a future work.

4.2 Empirical Analysis and Results

Empirical Model

Here we offer the following regression model.

$$\ln VA_{i,j,t} = \alpha + \beta \cdot \ln BVC_{j,t} + \gamma_1 \cdot \ln L_{i,t} + \gamma_2 \cdot \ln K_{i,t} + \gamma_3 \cdot \ln R\&D_{i,t} + u_i + v_j + w_t + \varepsilon_{i,j.t}$$

$VA_{i,j,t}$ is a real value-added of firm *i* in industry *j* in year *t*. The value-added is calculated as the summation of total sales and labor costs after subtracting operating costs. We divide the nominal value-added by the price index of industry *j* in year *t*. In this way we can obtain the real value of the value-added of the firm. In the context of a vertical supply chain, we expect that the value-added of a firm tends to be higher when the firm is positioned at a point of a vertical industry where a higher value-added can be created, compared to the case where it is placed at other vertical industry with a lower value-added. We implicitly assume that this positioning strategy within a value chain can be optimally chosen by a firm when the firm allocates its resources efficiently and specializes one stage in a vertically fragmented production network between Japan and Korea. Also, as we addressed in subsection 4.1, note that we consider a sample of firm *i* who actually engage in two-way trading – import and export – in global markets. This is because our main focus is not a treatment effect for being a trading firm versus a non-trading firm. Instead, we are interested in investigating the effect of the bilateral value chains between the two countries on trading firms that are active in global markets.

$BVC_{j,t}$ is our main explanatory variable that measures for bilateral value chain participation rate between Japan and Korea for a given industry *j* in year *t*. As we did in section 3, we define it as follows. First, for a given industry *j* in year *t*, X/Z_J^P, X/Z_J^E, X/Z_J^{PM} and X/Z_J^{EM} present for the Korea's forward BVCs with Japan or equivalently for the Japan's backward BVCs with Korea. Here X are the intermediate exports of industry *j* of Korea to Japan in year *t*; Z_J^P is the industrial total production of Japan; Z_J^E is the industrial total exports of Japan; Z_J^{PM} is the industrial intermediate production of Japan; and Z_J^{EM} is the industrial intermediate

exports of Japan. Second, for a given industry j in year t, Y/Z_K^P, Y/Z_K^E, Y/Z_K^{PM} and Y/Z_K^{EM} indicate the Japan's forward BVCs with Korea or equivalently for the Korea's backward BVCs with Japan. Here Y are the intermediate exports of industry j of Japan to Korea in year t; Z_K^P is the industrial total production of Korea; Z_K^E is the industrial total exports of Korea; Z_K^{PM} is the industrial intermediate production of Korea; and Z_K^{EM} is the industrial intermediate exports of Korea.

Other firm-level control variables are included in the above regression model based on the production function we address in section 3. $L_{i,t}$, $K_{i,t}$ and $R\&D_{i,t}$ are the number of workers, the real value of fixed assets and the R&D intensity of firm i in year t. For the workers, we use regular workers and exclude temporarily employed workers. For real value of fixed assets, we divide the nominal value of fixed asset by fixed asset price index in year t. For the R&D intensity, we control the size of firms by defining as a ratio of R&D expenditure to total sales of a firm. We consider a firm-fixed effect model to estimate the above equation and include the dummy variable of u_i for firm i, which is time-invariant. Furthermore, we include industry dummy v_j and year dummy w_t to control some unobserved heterogeneity across industries and year-specific effect for some macroeconomic shocks. We use total 18 different industries based on World Input-Output Database. We match them to Korean and Japanese industry classifications.[3] Finally, we use the years from 2006 to 2014 in the empirical analysis for a simple reason; The starting year for Korean firm-level database is the 2006 and the WIOD 2016 provide the data up to the year 2014.

For the Japanese and Korean firm-level databases, we use two separate databases. First, for the Japanese firms we use the *Basic Survey of Japanese Business Structure and Activities* (BSJBSA) provided by the Ministry of Economy, Trade and Industry of the Japanese government. Second, for the Korean firms we use the *Survey of Business Activities* (SBA) provided by the Statistics Korea of the Korean government. They are similar in that they

[3] See Table A in Appendix for the 18 industries. The concordances from KSIC (Korean Standard Industry Classification) and JSIC (Japan Standard Industrial Classification) to the WIOD industry classification are available upon requests.

surveyed the firms that employ at least 50 regular workers and that invest at least 30 million of Japanese yen or 300 million of Korean won on equity capital. Also, the two sets of firm-level data include various firm-level information such as sales, fixed assets, workers, R&D expenditure, exports and imports. Also, the basic financial structure and operating cost items are available.

<Table 1> Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
Korea's forward BVCs with Japan Or equivalently, Japan's backward BVCs with Korea (2006-2014)					
X/Z_J^P	162	.0084357	.0038604	.0009141	.0208248
X/Z_J^E	162	.0424180	.0489265	.0069577	1.276392
X/Z_J^{PM}	162	.0153238	.0078005	.0017295	.0409901
X/Z_J^{EM}	162	.1041262	.1735424	.0210774	1.503758
Japan's forward BVCs with Korea Or equivalently, Korea's backward BVCs with Japan (2006-2014)					
Y/Z_K^P	162	.0350001	.0120294	.004362	.065071
Y/Z_K^E	162	.1482636	.2331083	.0128513	4.228206
Y/Z_K^{PM}	162	.0535754	.0206136	.0071527	.1880235
Y/Z_K^{EM}	162	.4156987	.5688423	.0233193	4.662663
Korean firms (2006-2014)					
VA	20,242	53915.89	526225.3	-1814487	33100000
L	20,242	467.7039	2732.141	9	101973
K	20,240	130439.5	1075915	0	43700000
Sales	20,242	382427.6	3116557	509	158000000
R&D	20,242	10042.9	3116557	0	13800000
Export	20,242	186610.4	1814605	1	95000000
Import	20,242	98067.51	1086837	1	49700000
Japanese firm (2006-2014)					
VA	115,330	3520.3	19587.5	0.8	1374457
L	115,330	400.7	1603.6	50	80840

K	115,330	7540.9	60181.5	0.2	3898650
Sales	115,330	22193.3	155801.0	33	12100000
R&D	115,330	748.3	9108.7	0.0	561147
Export	115,330	1444.8	46860.6	0.0	7848785
Import	115,330	535.0	19344.6	0.0	2216294

Note: The units of VA, K, S, R&D, Export and Import for Korean firms are Korean million won and unit of L is a number of workers. For Japanese firms, the units of VA, K, S, R&D, Export and Import Japanese million yen and unit of L is a number of workers. These values are before taking the natural logarithmic values.

The summary statistics reveal some interesting fact about BVC between Japan and Korea. First, on average, the Korea's backward BVC participations with Japan (3.5%~41.5%) is larger than the Japan's backward BVC participations with Korea (0.8%~10.4%). Or, equivalently say, the Japan's forward BVC participations with Korea is larger than the Korea's forward BVC participations with Korea. However, when we examined Figure 2 and 3 the trend of the Korea's backward BVC participations with Japan from 2006 to 2014 has been decreased, while that of the Japan's backward BVC participations with Korea has been increased. This may be natural from the perspective of economic development. As Korean economy has become industrialized, it may increase its competitiveness in producing intermediate goods domestically and hence decrease imports those inputs such as industrial materials, machines, and parts and components. Second, the BVC participation rates defined for exports (E) are larger than those for production (P). For example, the Korea's backward BVC rates with Japan for intermediate goods exports (Y/Z_K^{EM}) and for total exports (Y/Z_K^{E}) are 41.5% and 14.8% respectively, while that for intermediate goods production (Y/Z_K^{PM}) and for total productions (Y/Z_K^{P}) are 5.3% and 3.5% respectively. These are qualitatively true for Korea's forward BVC with Japan. That is, X/Z_J^{EM}=10.4% > X/Z_J^{PM} =1.5%; and X/Z_J^{E} =4.2% > X/Z_J^{P} = 0.8%. These imply that BVC participation appears clearer when the imported inputs are used for exports rather than for domestic productions.

As for the firms for our empirical analysis, we use firms with both export and import. Because of the selected firms with positive amount of trades, the employment size on average is about 467. This implies that our firm data are skewed toward large-scale firms. Their average

(nominal) value-added is 53 billion Korean won; the average value of capital stock is 130 billion Korean won; the total sales are 382 billion Korean won. The firms are also quite active in R&D investment and trade. The average expenditure on R&D is as large as 10 billion Korean won, which is 2.6% of total sales and 19% of value-added. Also, the total export amount on average is 186 billion Korean won (almost 49% of total sales) and the total import is 98 billion Korean won. Such active R&D investment and global trade are the key feature of our firm-sample. This may support our idea on the production function in section 3 where the R&D and trade are associated with the technology level and the value-added of firms.

As for sample of Japanese firms we use, we find that there are more numbers of firms with positive export and import compared to Korean firms. That is, the Japanese sample data are less skewed toward large-scale firms. So, as we observe in the data, the average values are smaller than those of Korean sample. The average value-added per firm is 3.3 billion Japanese yen; the average value of capital stock is 7.5 billion Japanese yen; the average sales are 20 billion Japanese yen. The average expenditure on R&D is about 0.7 billion Japanese yen, which is 10% of total sale and 21% of value-added. Also, the average export is 3.8 billion Japanese yen (18% of total sales) and the average import is1.4 billion Japanese yen. Similarly, the large scale of R&D and global trade are the main feature of the Japanese firm sample.

Main Results

Our main results are presented in Table 2-5 where we apply a firm-fixed effect model to our regression equation. To validate the model, we conducted the Hausman Specification test by comparing it with random effect model. We are able to reject the null hypothesis and support the fixed effect model with 1% significance level.

In Table 2 and 3, for Korean firms, all of the 4 kinds of Korea's forward BVC indices are negatively associated with their value-added, while all of the 4 kinds of Korea's backward BVCs are positively associated with them. From the Japan's perspective, Table 4 and Table 5 show that all of the 4 kinds of Japan's forward BVC indices are positively associated with their

value-added, while all of the 4 kinds of Japan's backward BVCs are negatively associated with them.

<Table 2: Fixed Effect Models for Korean firms in Forward BVC with Japan>

	(1)	(2)	(3)	(4)
Korea's forward BVC =	-0.302***			
Japan's backward BVC ($\mathbf{X/Z_J^P}$)	(0.045)			
Korea's forward BVC =		-0.279***		
Japan's backward BVC ($\mathbf{X/Z_J^E}$)		(0.040)		
Korea's forward BVC =			-0.261***	
Japan's backward BVC ($\mathbf{X/Z_J^{PM}}$)			(0.041)	
Korea's forward BVC =				-0.196***
Japan's backward BVC ($\mathbf{X/Z_J^{EM}}$)				(0.036)
ln(L)	0.685***	0.684***	0.685***	0.681***
	(0.030)	(0.030)	(0.030)	(0.030)
ln(K)	0.042**	0.041**	0.042**	0.042**
	(0.017)	(0.017)	(0.017)	(0.017)
ln(R&D)	-0.060***	-0.060***	-0.060***	-0.060***
	(0.006)	(0.006)	(0.006)	(0.006)
Firm-fixed effect	yes	yes	yes	yes
Industry-fixed effect	yes	yes	yes	yes
Year-fixed effect	yes	yes	yes	yes
Obs	16,142	16,142	16,142	16,142
No. of Firms	4,076	4,076	4,076	4,076
R-squared	0.171	0.170	0.170	0.168

Note: The numbers in parentheses are firm clustered robust standard errors. **, *** indicate 5%, and 1% significance level.

<Table 3: Fixed Effect Model for Korean firms in Backward BVC with Japan >

	(1)	(2)	(3)	(4)
Korea's backward BVC =	0.273***			
Japan's forward BVC ($\mathbf{Y/Z_K^P}$)	(0.076)			
Korea's backward BVC =		0.100***		
Japan's forward BVC ($\mathbf{Y/Z_K^E}$)		(0.047)		
Korea's backward BVC =			0.180***	
Japan's forward BVC ($\mathbf{Y/Z_K^{PM}}$)			(0.054)	
Korea's backward BVC =				0.076***
Japan's forward BVC ($\mathbf{Y/Z_K^{EM}}$)				(0.034)
ln(L)	0.683***	0.684***	0.683***	0.684***
	(0.030)	(0.030)	(0.030)	(0.030)

ln(K)	0.045***	0.045***	0.045***	0.044***
	(0.017)	(0.017)	(0.017)	(0.017)
ln(R&D)	-0.060***	-0.060***	-0.060***	-0.061***
	(0.006)	(0.006)	(0.006)	(0.006)
Firm-fixed effect	yes	yes	yes	yes
Industry-fixed effect	yes	yes	yes	yes
Year-fixed effect	yes	yes	yes	yes
Obs	16,142	16,142	16,142	16,142
No. of Firms	4,076	4,076	4,076	4,076
R-squared	0.165	0.164	0.165	0.165

Note: The numbers in parentheses are firm clustered robust standard errors. *** indicates 1% significance level.

<Table 4: Fixed Effect Models for Japanese firms in Forward BVC with Korea>

	(1)	(2)	(3)	(4)
Japan's forward BVC =	0.111***			
Korea's backward BVC ($\mathbf{Y/Z_K^P}$)	(0.017)			
Japan's forward BVC =		0.077***		
Korea's backward BVC ($\mathbf{Y/Z_K^E}$)		(0.011)		
Japan's forward BVC =			0.163***	
Korea's backward BVC ($\mathbf{Y/Z_K^{PM}}$)			(0.014)	
Japan's forward BVC =				0.076***
Korea's backward BVC ($\mathbf{Y/Z_K^{EM}}$)				(0.008)
ln(L)	0.701***	0.705***	0.703***	0.706***
	(0.016)	(0.016)	(0.016)	(0.016)
ln(K)	0.019***	0.019***	0.019***	0.019***
	(0.002)	(0.002)	(0.002)	(0.002)
ln(R&D)	-0.003***	-0.003***	-0.002**	-0.002**
	(0.001)	(0.001)	(0.001)	(0.001)
Firm-fixed effect	yes	yes	yes	yes
Industry-fixed effect	yes	yes	yes	yes
Year-fixed effect	yes	yes	yes	yes
Obs	112,714	112,714	112,714	112,714
No. of Firms	18,093	18,093	18,093	18,093
R-squared	0.135	0.135	0.136	0.135

Note: The numbers in parentheses are firm clustered robust standard errors. **, *** indicate 5%, and 1% significance level.

<Table 5: Fixed Effect Model for Japanese firms in Backward BVC with Korea >

	(1)	(2)	(3)	(4)
Japan's backward BVC =	-0.351***			
Korea's forward BVC ($\mathbf{X/Z_J^P}$)	(0.014)			
Japan's backward BVC =		-0.123***		
Korea's forward BVC ($\mathbf{X/Z_J^E}$)		(0.010)		
Japan's backward BVC =			-0.321***	
Korea's forward BVC ($\mathbf{X/Z_J^{PM}}$)			(0.013)	
Japan's backward BVC =				-0.087***
Korea's forward BVC ($\mathbf{X/Z_J^{EM}}$)				(0.008)
ln(L)	0.714***	0.704***	0.713***	0.702***
	(0.016)	(0.016)	(0.016)	(0.016)
ln(K)	0.020***	0.019***	0.019***	0.019***
	(0.002)	(0.002)	(0.002)	(0.002)
ln(R&D)	-0.002**	-0.003***	-0.002**	-0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Firm-fixed effect	yes	yes	yes	yes
Industry-fixed effect	yes	yes	yes	yes
Year-fixed effect	yes	yes	yes	yes
Obs	112,714	112,714	112,714	112,714
No. of Firms	18,093	18,093	18,093	18,093
R-squared	0.145	0.136	0.146	0.136

Note: The numbers in parentheses are firm clustered robust standard errors. **, *** indicate 5%, and 1% significance level.

These results imply that as the input import intensities of Korea from Japan get larger for a given industry the global trading firms in both countries can be more benefitted, compared to other industries where the import intensity of Korea from Japan is low. However, as the input export intensities of Korea toward Japan get larger for a given industry, the global trading firms in both countries are more adversely affected, compare to other industries where the export intensity of Korea toward Japan is low.

This suggests that it is important for the global trading firms' ability of creating value-added in both countries to engage in the backward bilateral value chains of Korea with Japan, or equivalently, the forward bilateral value chains of Japan with Korea. Since the bilateral value chains are a form of cross-border vertical specialization in an industry between Japan and

Korea, we may interpret that the results are from a fact that the backward BVC of Korea with Japan or the forward BVC of Japan with Korea has been more efficiently constructed between the countries, than the forward BVC of Korea with Japan or the backward BVC of Japan with Korea. That may result in a higher performance of a trading firm in those industries.

Now, we continue to ask whether the current results remain true for each individual industries. For this purpose, we run the regression model for each of the following 6 main industries: (1) Manufacture of chemicals and chemical products, (2) Manufacture of fabricated metal products, except machinery and equipment, (3) Manufacture of computer, electronic and optical products (4) Manufacture of machinery and equipment n.e.c., (5) Manufacture of motor vehicles, trailers and semi-trailers, (6) Manufacture of other transport equipment. Note that these six industries are as large as we can obtain enough numbers of observations for our empirical analysis. For example, the sample observation in industry (6) of Korea is 270 numbers of firms for the period of 2006 to 2014. Other than these six industries, however, we are not able to get statistically meaningful results, nor able to compare the results for Japan and Korea.

Here we provide the estimated results for Korea in Table 6 and Japan in Table 7. Then, we summarize them in Table 8 to see the results from the matched BVC structure between Japan and Korea.

<Table 6> Results for the 6 manufacturing Industries of Korea

Forward BVC	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbf{X/Z_J^P}$	-0.153**	-0.279*	-0.195*	0.084	0.349***	-0.626**
	(0.061)	(0.166)	(0.112)	(0.116)	(0.037)	(0.253)
$\mathbf{X/Z_J^E}$	-0.177***	-0.579**	-0.077	-0.279***	0.468***	-0.446**
	(0.063)	(0.249)	(0.083)	(0.101)	(0.050)	(0.181)
$\mathbf{X/Z_J^{PM}}$	-0.156**	-0.278**	-0.514***	0.042	0.319***	-0.412*
	(0.062)	(0.169)	(0.112)	(0.118)	(0.035)	(0.247)
$\mathbf{X/Z_J^{EM}}$	-0.174***	-0.670**	-0.142*	-0.395***	0.512***	0.161**
	(0.063)	(0.283)	(0.086)	(0.113)	(0.075)	(0.078)

Backward BVC	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbf{Y/Z_K^P}$	-0.217	0.116	0.633***	0.421***	-0.149*	0.529**
	(0.263)	(0.212)	(0.110)	(0.117)	(0.082)	(0.293)
$\mathbf{Y/Z_K^E}$	0.026	0.066	0.056	0.289***	-0.426***	-0.183
	(0.216)	(0.174)	(0.152)	(0.100)	(0.073)	(0.221)
$\mathbf{Y/Z_K^{PM}}$	-0.288	0.115	0.416***	0.375***	-0.099	0.344**
	(0.234)	(0.193)	(0.083)	(0.113)	(0.067)	(0.134)
$\mathbf{Y/Z_K^{EM}}$	0.018	0.080	-0.105	0.093	-0.327***	0.434*
	(0.228)	(0.147)	(0.094)	(0.068)	(0.042)	(0.26)
Observation	1,514	699	3,465	2,222	1,748	270

Note: (1) Manufacture of chemicals and chemical products, (2) Manufacture of fabricated metal products, except machinery and equipment, (3) Manufacture of computer, electronic and optical products (4) Manufacture of machinery and equipment n.e.c., (5) Manufacture of motor vehicles, trailers and semi-trailers, (6) Manufacture of other transport equipment. The estimation results for other variables are not summarized here. The numbers in parentheses are firm clustered standard errors. *, **, *** indicate 10%, 5%, and 1% significance level.

<Table 7> Results for the 6 manufacturing Industries of Japan

Backward BVC	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbf{X/Z_J^P}$	-0.008	-0.200***	8.313***	-0.140***	-0.003	-0.580***
	(0.036)	(0.025)	(0.345)	(0.033)	(0.016)	(0.074)
$\mathbf{X/Z_J^E}$	-0.012	-0.393***	-7.463***	-0.240***	-0.004	-0.579***
	(0.052)	(0.050)	(0.309)	(0.056)	(0.025)	(0.074)
$\mathbf{X/Z_J^{PM}}$	-0.008	-0.206***	-14.011***	-0.153***	-0.003	-0.662***
	(0.037)	(0.026)	(0.581)	(0.036)	(0.015)	(0.084)
$\mathbf{X/Z_J^{EM}}$	-0.012	-0.679***	-3.612***	0.287***	-0.007	-4.269***
	(0.053)	(0.086)	(0.150)	(0.067)	(0.040)	(0.543)
Forward BVC	(1)	(2)	(3)	(4)	(5)	(6)
$\mathbf{Y/Z_K^P}$	-0.208	0.903***	17.156***	1.059***	0.016	5.746***
	(0.906)	(0.115)	(0.711)	(0.246)	(0.086)	(0.730)
$\mathbf{Y/Z_K^E}$	0.023	0.775***	-5.489***	0.152***	0.009	0.894***
	(0.098)	(0.099)	(0.228)	(0.035)	(0.052)	(0.114)
$\mathbf{Y/Z_K^{PM}}$	-0.106	1.171***	-27.776***	0.427***	0.013	-5.381***
	(0.460)	(0.149)	(1.151)	(0.099)	(0.071)	(0.684)
$\mathbf{Y/Z_K^{EM}}$	0.024	2.373***	-1.891***	0.085***	0.004	0.424***

	(0.105)	(0.302)	(0.078)	(0.020)	(0.023)	(0.054)
Observation	6,035	11,977	9,364	17,281	8,485	2,420

Note: (1) Manufacture of chemicals and chemical products, (2) Manufacture of fabricated metal products, except machinery and equipment, (3) Manufacture of computer, electronic and optical products (4) Manufacture of machinery and equipment n.e.c., (5) Manufacture of motor vehicles, trailers and semi-trailers, (6) Manufacture of other transport equipment. The estimation results for other variables are not summarized here. The numbers in parentheses are firm clustered standard errors. *** indicate 1% significance level.

For Korean industries, see Table 6. The statistically significant coefficients for the forward BVC of Korea are negative for all industries except for (5) where the effect is positive. The estimation results for the backward BVC of Korea shows that there are positive effects for (3), (4) and (6) industries. However, for the industries of (1) and (2), we could not find out any statistically significant results. But, for (5), we find negative impact of backward BVC of Korea on the Korean firms' value-added.

For Japanese industries, see Table 7. The statistically significant coefficients for the backward BVC of Japan are negative for industries (2), (3), (4) and (6). The coefficients for the forward BVCs are positive for (2) and (4). However, for industries such as (3) and (6) the impacts of the forward BVCs of Japan are mixed. Also, for industry (1) and (5), both backward and forward BVCs of Japan with Korea do not affect the Japanese firms' value-added at all.

Here Table 8 summarizes the above results from Table 2 to Table 7 by indicating the signs of the BVCs between the two countries.

<Table 8> Summary of the Results

	Korea's Backward BVC with Japan = Japan's Forward BVC with Korea		Korea's Forward BVC with Japan = Japan's Backward BVC with Korea	
	Korean Firms	Japanese Firms	Korean firms	Japanese Firms
All Industries	+	+	−	−
Industry (1)	0	0	−	0
Industry (2)	0	+	−	−

Industry (3)	+	+, −	−	+, −
Industry (4)	+	+	−	−, +
Industry (5)	−	0	+	0
Industry (6)	+	+, −	−	−

Note: All Industries means all of the 18 industries we used in Table 2. (1) Manufacture of chemicals and chemical products, (2) Manufacture of fabricated metal products, except machinery and equipment, (3) Manufacture of computer, electronic and optical products (4) Manufacture of machinery and equipment n.e.c., (5) Manufacture of motor vehicles, trailers and semi-trailers, (6) Manufacture of other transport equipment. (+) and (−) indicates statistically at least 10% significant results from Table 2, 3 and 4. (+, −) indicates the mixed results. (0) indicates statistically insignificant results.

As you find in the table, Korean firms and Japanese firms in industry (4) - Manufacture of machinery and equipment n.e.c. - are mutually benefitted for their value-added as Korea imports from Japan. However, the firms in both countries experience mutual damages to their value-added as Korea exports to Japan in that industry.

The weakly similar results are found for industry (2), (3) and (6) as well. The mutual gains of Korean and Japanese firms are not clear for Korea's backward BVC with Japan or for Japan's forward BVC with Japan. But, we observe that Korean firms are benefitted in industry (3) - Manufacture of computer, electronic and optical products and (6) - Manufacture of other transport equipment, while Japanese firms are benefitted in industry (2) Manufacture of fabricated metal products. For the (3), the Japanese firms are benefitted only when their exports are used for Korea's total production in the two industries, but hurt when their exports are used for Korea's export and for Korea' intermediate productions and exports. For the (6), the Japanese firms are hurt only when their exports are used for Korea's intermediate production, but mostly benefitted when their exports are used for Korea's total production and export and for Korea's intermediate export. However, the firms in both countries are mutually hurt for Korea's forward BVC with Japan or for Japan's backward BVC with Korea for industries (2), (3) and (6). These results are weakly similar to those for all industries in Table 2.

For industry (1) - Manufacture of chemicals and chemical products, the results almost

disappear, except for the negative impact on Korean firms when Korea exports to Japan. Also, interestingly, for industry (5) - Manufacture of motor vehicles, trailers and semi-trailers, the results are weakly opposite to the other industries of (2), (3), (4), and (6). That is, as Korea imports from Japan (or Japan exports to Korea), Korean firms are hurt in their value-added, while they are benefitted as Korea exports to Japan (or Japan import from Korea). However, these BVCs do not have any statistically significant effects on Japanese firms at all.

5. Conclusion

For long time, Korea has had a trade structure in which intermediary goods are highly dependent on Japan. Judging from this fact, however, the recent trade dispute between Korea and Japan could adversely affect Korean firms and possibly Japanese firms as well. So, in this paper, we attempt to analyze the impacts of bilateral value chain between Japan and Korea on the firms in both countries.

In doing so, we construct the various bilateral value chain measures for the two countries and use both Japanese firm-level database (*BSJBSA* of METI) and Korean firm-level database (*SBA* of Statistics Korea) for the period of 2006 to 2014. Our main findings are as follows. First, there was a positive effect of Korea's backward BVC with Japan or Japan's forward BVC with Korea on the real value-added of firms in both countries simultaneously. Second, however, there was a negative effect of Korea's forward BVC with Japan or Japan's backward BVC with Korea on the real value-added of firms in both countries simultaneously. These results may imply a fact that the cross-border vertical specialization between Japan and Korea has been efficiently built up by mutually beneficial ways of Korea's importing intermediate goods from Japan. Third, this finding remains qualitatively more or less the same in 4 main industries - Manufacture of fabricated metal products; Manufacture of computer, electronic and optical

products; Manufacture of machinery and equipment n.e.c.; and Manufacture of other transport equipment. But, for the industry of Manufacture of motor vehicles, trailers and semi-trailers, the results are weakly opposite to these 4 industries: That is, in this industry Korean firms are hurt from Korea's backward BVC with Japan, while they are benefitted as Korea exports to Japan. However, these BVCs do not have any statistically significant effects on Japanese firms at all.

The main lesson from our research is that, the current vertical trading structure between Japan and Korea are mutually beneficial for firms in both countries in most main manufacturing industries. So, a trade dispute between the two countries would damage both countries, in particular, the trading firms engaging in global markets who are the main players for their economic development and successes. A further and deeper cooperation in manufacturing sectors between the two countries would be harmless.

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Appendix

<Table A: WIOD's manufacturing industry classification>

Manufacture of food products, beverages and tobacco products
Manufacture of textiles, wearing apparel and leather products
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials
Manufacture of paper and paper products
Printing and reproduction of recorded media
Manufacture of coke and refined petroleum products
Manufacture of chemicals and chemical products
Manufacture of basic pharmaceutical products and pharmaceutical preparations
Manufacture of rubber and plastic products
Manufacture of other non-metallic mineral products
Manufacture of basic metals
Manufacture of fabricated metal products, except machinery and equipment
Manufacture of computer, electronic and optical products
Manufacture of electrical equipment
Manufacture of machinery and equipment n.e.c
Manufacture of motor vehicles, trailers and semi-trailers
Manufacture of other transport equipment
Manufacture of furniture; other manufacturing