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China Shocks to Korea's ICT Exports

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Abstract

Purpose – This paper examines China's impact on Korea's ICT exports considering the direct competition channel, the production shift channel, and the indirect demand channel at once. This paper also takes China's economic rebalancing into account and discusses whether it makes any differences in the effect of the three channels.

Design/methodology – To quantify the effect of the three channels, I constructed a linear panel regression model and estimated it with various estimation methods including the system GMM. China's exports toward the same destination as Korea's exports, Korea's exports toward China, and the third countries' exports toward China respectively reflect the three channels. China's GVC indicators are included as well to evaluate the effect of further China's economic rebalancing. Since the present paper has a greater interest in the effect of China rather than the determinant of bilateral trade, a (fixed effect) panel model becomes more appropriate than the gravity model because time-invariant variables in the gravity model, such as the distance and the language, are eliminated during the estimation process.

Findings – The estimation results indicate that Chinese ICT exports are complementary to Korea's ICT exports in general. However, when markets are considered in subgroups, China's ICT exports could have a negative effect in the long run, especially for SITC75 and SITC76 markets, implying a possible competitive threat of China. The production shift effect turns significant during China's economic rebalancing in the markets for the advanced economies and the SITC76 product. China's indirect demand channel is also in effect significantly for the advanced economy and SITC75 commodities during China's economic rebalancing periods. In addition, this paper shows that China's transition toward upstream in the global value chain could have a positive impact on Korea's ICT exports, especially at the Asian market.

Originality/value – The contribution of this paper is threefold. First, it focuses on the ICT industry for which Korea increasingly depends on China and China becomes a global hub of the GVC. Second, this paper quantitatively studies three channels in a model in contrast to the literature which mostly examines those channels separately and pays less attention to the GVC aspect. Third, by utilizing relatively recent data from the period of 2001-2017, this paper discusses whether China's economic rebalancing affects the three channels.

Keywords: Dynamic Panel Regression, Global Value Chains, Korea's ICT Exports
JEL Classifications: C13, C23, F14, F62

1. Introduction

1.1. China's Growth in the Export market and its Spillover Effect on the ICT Sector

Since it acceded to the WTO, China's exports have shown astonishing growth, now accounting for 12.8% of global merchandise exports and 29.5% of global ICT exports in 2017 compared to merely 4.3% and 6.1%, respectively, in 2001 (UN Comtrade Data).[1] Such im-

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pressive export growth has occurred not only in terms of trade volume (and market share) but also in variety (and sophistication), such that Chinese export similarity with OECD countries has grown substantially.[2]

China is exceptional in light of the empirical evidence of a strong positive relationship between export sophistication and income-per-capita (Schott, 2004; Rodrik, 2006; Hummels and Klenow, 2005; Hausmann et al., 2007; Henn et al., 2017). The growing similarity and sophistication of Chinese exports may imply that China can compete with more advanced economies mimicking Korea.[3] Edwards and Lawrence (2010) also noted that newly industrialized Asian economies (NIEs) including Korea face a rising similarity with China in terms of both export variety and value to the US in that their export prices are significantly discounted as those of China. Korea's market share of global ICT export has been very stagnant growing from 4.5% in 2001, which is almost the same as China's share, to 6.9% in 2017 which is merely about one-fifth of China's share.

Accordingly, many researchers and policymakers have concerned themselves with the competitive threat of China in third markets and a large body of research has studied the displacement effect of China's exports on its competitors. Most studies found that the Chinese exports have negatively affected the exports of other developing countries (Hanson and Robertson, 2008; Giovannetti and Sanfilippo, 2009; Wood and Mayer, 2011; Edwards and Jenkins, 2014; Busse et al., 2016).

The literature also shows that countries specialized in high-tech products can still be considered relatively safe from the competition with China despite China's impressive export specialization (Schott, 2008; Hallak and Schott, 2011). This is because China's exports are mostly performed by foreign-funded enterprises and most domestic firms just assemble the imported parts and components from advanced economies (Xing, 2014; Lovely and Huang, 2018). Many industrialized countries were shifting their manufacturing and assembly facilities to China via their FDI to China (Dollar, 2019).[4]

As Haddad (2007) noted, China has quickly become a hub of production networks in East Asia since 2001, and this gives rise to a triangular trade in the area. For instance, East Asian countries export a high share of parts for the ICT product to China and China exports the finished products to the EU and US. This trade pattern has thus contributed to the complementarity between the production structures and the development paths of countries in the region. Accordingly, the share of intra-regional GVC activities increased in Asia from 2000 to 2017 so that the East Asian countries' dependency on China has grown more and more (Dollar, 2019). On the other hand, in North America and Europe, the share of inter-regional production sharing activities increased, especially their GVC linkages with "Factory Asia" reflecting inter-connectedness with China.[5] Consequently, China became an increa-

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[1] Aslam et al. (2017) also shows that China′s value-added contribution of world output also has increased substantially from 0.3% in 1990 to 2.0% in 2013, representing a 5-fold increase.

[2] China's export similarity with the OECD increases substantially, and far more than for any other US trading partner, over the period of 1972-2005. The export similarity index (ESI) of Schott (2008) increases from 0.05 to 0.21 for China and 0.11 to 0.33 for Korea over the sample period.

[3] Korea competed with other developing countries during the 1980s and 1990s (Faini et al., 1992; Muscatelli et al., 1994) and it currently competes with industrialized economies especially in high-tech products.

[4] China was the world's second-largest source and second-largest recipient of FDI between 2015 and 2017.

[5] China replaced Japan and part of the US position and became the second-largest supply hub in terms of both the magnitude of its value-added exports and the number of strong linkages to other countries.

singly important supply and demand hub in GVC, and thus production and final demand from third countries have had a significant impact on trade with China.

Even in the ICT sector, China became the largest regional hub for the traditional trade and GVC networks in 2017 reflecting the so-called industrial hollowing out in the US and Japan's ICT sectors, accompanied by large-scale FDI from these countries to China (Dollar, 2019). This implies multinational firms in these countries have shifted their production stages or facilities to China, and consequently their direct exports to third countries decrease when other things being equal. Two-thirds of all ICT intermediate imports of China, coming from other countries in Factory Asia, are used as inputs into Chinese exports.

Therefore, even as it has fostered rivalries for market share abroad, ICT exports of East Asian countries could be positively affected by China's development in export volume and variety.

1.2. China's Economic Rebalancing and Its Spillover Effect

On the other hand, China has suffered from the high investment share of GDP and large current account surplus, so-called 'twin surpluses.' To prevent from potential negative consequences of the imbalances[6] and to achieve sustainable growth, the Chinese government is striving to transform its economy from an 'export'- and 'investment'-oriented economy toward a 'domestic'- and 'consumption'- driven economy (Dieppe et al., 2018; Mano, 2016; Kelly, 2014).[7] China's such economic rebalancing would result in slower but sustainable growth, and thus lower import demand, especially for the intermediate goods. It also would lead to a larger services sector compared to the manufacturing sector and faster growth of the high-tech industry. In addition, the lower demand for imported intermediate goods and greater demand for domestically produced intermediate goods in China may also reduce backward GVC activities due to the deepening of the domestic division of labor and the lengthening of domestic value chains. In fact, as Mano (2016) noted, the investment and manufacturing share of China's gross value-added decreased since 2011, and the high-tech industry value-added share increased.[8] Moreover, the Global Value Chain (GVC) indicators reveal the changes in GVC activities of China as in Figure 1. China's foreign value-added share of its gross export (hereafter FVA) began to decrease in 2011[9], while its indirect value-added share of its gross exports (hereafter DVX) continued to increase; consequently, the GVC position (GVCPO) begins to sharply increase since then; the magnitude of decrease in FVA is larger and thus GVC participation rate (GVCPA) decrease significantly.[10]

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[6] The heightened investment share induced by rising indebtedness raised concerns of financial vulnerabilities, especially for State-owned enterprises.

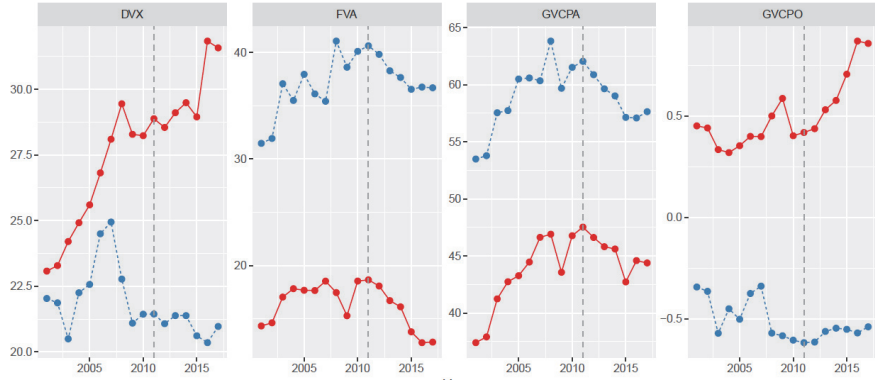
[7] The National People's Congress of the People's Republic of China in 2011 and the Third Plenum of the Chinese Communist Party in 2013 clearly emphasized their need for structural reforms.

[8] The Chinese government has announced a plan to expand domestic supply for semiconductors to 80 percent of domestic demand by 2030 from 33 percent in 2016. However, despite soared R&D expenditure, China still depends on imports of some core technologies, such as semiconductors and optical devices, as well as intellectual property (IP) from abroad. (Woetzel, 2019).

[9] According to OECD 2018 TiVA analysis, China's FVA has declined to lower than OECD and G20 averages even in the ICT sector, which is not only the largest export industry but also the highest imported intermediate use sector for exports.

[10] Countries with a larger GVC position index are relatively more upstream, i.e., they contribute more value-added to other countries' exports than other counties contribute to theirs.

Fig. 1. Trends in Global Value Chain for Korea (dashed blue) and China (red)



Note: FVA is also referred to as a measure of 'backward participation', given that it measures imported intermediate inputs that are used to generate output for export. DVX is a measure of 'forward participation', i.e. it measures exports of intermediate goods that are used as inputs for the production of exports of other countries. (Aslam et al., 2017).

Source: Author's calculation based on Eora MRIO tables following Koopman et al. (2014).

This implies that China's role as a hub in the global production network is shrinking, and its demand for domestic intermediate goods is growing as it moves up the value chain. The lower import demand and change in import demand composition could negatively affect East Asian countries, which are deeply involved in the triangular trade with China.[11] In that sense, Korea's ICT exports must be largely affected by China's economic rebalancing. This is because China's economic transformation is most pronounced in the ICT-relevant sectors and Korea is one of the top ICT trading partners for China.[12] For Korea, the share of China in its ICT export was only 9.2% in 2001 and reached 48.1% in 2017.

As for the topic of China's development in the export market, a lot of papers have tried to analyze the effect of China's economic rebalancing. Those researches investigate the effect concerning changes in industrial composition and lower GDP growth of China, based on various models.[13] Taken together, these studies showed that the consequences of China's economic rebalancing vary over countries and sectors depending on the degree of trade, financial, commodity linkages, and policy response and that the successful transition of China could have a positive effect in the long run by reduced uncertainty and sustainable growth trajectory. However, Hong et al. (2017) and Mano (2016) found that Korea's income and

[11] Hong et al. (2017) and Bussière et al. (2013) showed that China's economic rebalancing induced changes in China's import demand composition and the changes significantly affect world trade dynamics respectively.

[12] The TiVA 2018 reports by country indicate that China is the top trading partner for Korea and Korea is a top 5 trading partner for China in terms of both gross and value-added exports and imports. In addition, 'ICT and electronics' is the industry for both Korea and China with the highest imported intermediate inputs used for exports and the greatest source of domestic value added content of exports.

[13] Among others, Sznajdersak and Kapuscinski (2020) and Blagrave and Vesperoni (2018) used the (G)VAR model, Aasaavari et al. (2020) used the CGE model, Dieppe et al., 2018 used the ECB-Global model, Mano 2016 used calibrated the Ricardian trade model, Dizioli et al. (2016) and Anderson et al. (2015) used IMF's Flexible System of Global Models, and Hong et al. (2017) used the VAR and panel regressions model.

exports would be negatively affected both cases when China's preference moves for consumption away from investment and when China moves up the value chain into higher-tech industries in the short-run. However, their analysis is performed on a country level and is thus silent on how Korea's ICT exports are affected. As noted above, despite government efforts, China still heavily depends on imports of core technologies such as semiconductors, and hence, China's economic rebalancing could have differently affected the ICT industry.

1.3. Three Channels through which China can Affect Korea's ICT Exports

While investigating how China's rapid export growth and its recent economic rebalancing affect Korea's ICT exports to third countries, this paper focuses on the trade channel considering their influence on global value chains. This is because, as the literature noted (Sznajdersak and Kapuscinski, 2020; Dieppe et al., 2018 among others), not only is the trade linkage the most significant and powerful transmission channel of China's development and economic rebalancing, but the financial and commodity prices link between Korea's ICT industry and China is very limited.[14]

Even in the trade channel, there could be many different propagation mechanisms. However, the literature mostly has focused on the competition between China and the countries interested. I derive three channels among others from the literature mentioned above: 1) the direct competition channel, 2) the production shift (or capacity) channel, 3) the indirect demand channel.

The first channel is supposed to capture the competition between Korea and China in a certain market. China's ICT exports of the same product category to the same destination can either crowd out (or complement) Korea's ICT exports depending on its quality and partners' industrial structure. When China's ICT exports have negatively associated with Korea's ICT exports holding other factors being equal, we can take the results as evidence of competition between the two countries. In the opposite case, ICT exports of the two countries could be complementary.

The second channel is related to China's position in the global value chain and its internal restructuring.[15] As China became a hub of the production network, Korean multinational firms may have relocated some of their production stages to China from third-world countries, or the opposite could be the case because of increased wages and the recent economic rebalancing of China. If China is alike any other countries, not having any special role in the GVC, then Korea's ICT exports to China should move along with its exports to third-world countries reflecting Korea's ICT production capacity. However, when Korea's ICT exports to third-world countries are negatively related to its exports to China, it could be evidence of a production shift.

The third channel is related to complex global value chains and captures the case; for example, when a greater import demand due to China's economic growth or stronger connectivity of the third-world countries with China raises third countries' exports. Hence, the demand of these countries for Korea's ICT intermediates increases as well. Thus, when

[14] I also do not directly consider the government policy response to China's economic rebalancing because government policy reactions could hardly be identified and because those effects, if existing, would appear with many year lags.

[15] Hong et al. (2017) estimates the spillover effect of China's rebalancing and argues that countries closely integrated into China through the GVC such as Korea and Taiwan, that are, therefore, exposed heavily to China's investment demand will be most adversely affected. However, they also mentioned that the spillover effect would be positive as China's economic growth becomes more sustainable in the medium term.

Korea's ICT exports to third-world countries increase while the destination country's exports to China increase, it is considered as the 'indirect demand effect'.

This paper examines China's impact on Korea's ICT exports considering all three of these channels. It also investigates whether there are any changes in the effect of the three channels during the period of China's economic rebalancing. The research utilizes relatively recent data compared to the literature covering the period of 2001-2017, which allows for a discussion of the role of China's economic rebalancing on the three channels. This is the first paper that quantitatively studies the effect of all three channels in a model considering China's economic rebalancing.

To this end, a dynamic panel model is constructed and estimated using various estimation methods including the system GMM method. Only the data of the top 20 importing countries of Korea's ICT products for each year is considered. There are 29 countries in total accounting for about 90% of Korea's total ICT exports, on average, over the sample periods.

The results show that China's ICT exports have been complementary to Korea's ICT exports in general as is in the literature. However, when markets are considered in subgroups, China's ICT exports could have a negative effect in the long run.[16] The production shift effect turns significant during China's economic rebalancing only in the markets for the advanced economies and SITC76 product (such as telecommunication apparatus) in that the relationship between Korea's ICT exports to third-world countries and China is negative and significant. Although for the other markets and periods, Korea's ICT exports to China have a positive relationship with its exports to third-world countries in general, this relationship has loosened during the CER periods. China's indirect demand channel is in effect significantly for the advanced economy and SITC75 (such as office machines) commodities during China's economic transition periods. Furthermore, China's forward GVC participation (DVX) and backward GVC participation (FVA) are positively and negatively associated with Korea's ICT exports to third-world countries respectively during the rebalancing periods. Therefore, China's transition toward further upstream in the value chain could support Korea's ICT exports to third-world countries.[17] The main findings described above emphasize that China's economic rebalancing induces significant changes in the relationship between China and Korea's ICT exports.

The remainder of the paper is structured as follows. Section 2 explains the model and variables employed in the empirical analysis. The main results as well as various robustness checks and limitations are discussed in Section 3. In section 4, selective papers close to the present paper are discussed and the contribution is emphasized. Finally, Section 5 concludes the paper.

2. Model and Estimation

2.1. Model and Variables

Most empirical studies on China's competitive threat used an augmented gravity model and OLS estimation because of its strong empirical performance and theoretical derivation. However, given the substantial heterogeneity of trading partners and export products, OLS estimates are easily biased due to omitted variables (individual effect). Moreover, given that

[16] As I explained later, China's ICT exports can crowd out Korea's ICT exports for the Middle East and late-joining EU countries and markets for office machines, automatic data processing machines (SITC75), and telecommunication and sound recording apparatus (SITC76).

[17] Considering again that China's economic rebalancing induces greater DVX and lower FVA.

the present paper has a greater interest in the effect of China rather than the determinant of bilateral trade, a (fixed effect) panel model becomes more appropriate because time-invariant variables in the gravity model, such as the distance and the language, are eliminated during the estimation process. This paper considers a dynamic model for three reasons. First, the paper examines not only the contemporaneous impact but also the long-run (permanent) impact of China, and second, the static versions of the model tend not to pass diagnostic tests for 'cross-sectional dependency', 'serial correlation', and 'heteroskedasticity'. Finally, the omitted variables problem can be solved by using a dynamic model, as a lagged dependent variable is used as an instrument.

Therefore, to quantify the effect of the three channels described above, the paper constructs a linear panel regression model, as follows.

$$RXK_{ijt} \sim RXK_{ijt-1} + \Upsilon_{ijt} + CER \times \Upsilon_{ijt} + \mu_t \tag{1}$$

where CER is a dummy variable for the period of China's economic rebalancing, and it is assigned one for the year 2011 and after. $RXK_{\{i,j,t\}}$ is Korea's ICT exports of 'j' sector to country 'i' at time 't'. The variable μ_t is time dummies and $\Gamma_{i,j,t}$ are explanatory variables defined as follows.

$$\begin{aligned}\Upsilon_{ijt} = & \underbrace{RXC_{ijt} + RXC_{ijt-1}}_{\text{Direct Competition}} + \underbrace{RXK2C_{jt}}_{\text{Production Capacity}} + \underbrace{RX2C_{jt} + RX2CT_t}_{\text{Indirect Demand}} + \\ & \underbrace{LCDVX_t + LCFVA_t}_{\text{China's Transition}} + \underbrace{EndUse.I_{it} + EndUse.K_{it} + EndUse.C_{it}}_{\text{Import Demand Composition}} + \\ & \underbrace{RFD_{ijt} + ODI_{it} + ODI.ict_{it} + ER_{it} + WTV_t}_{\text{Traditional Variables}}\end{aligned} \tag{2}$$

China's ICT export to third-world countries (RXC), Korea's ICT export to China (RXK2C), and third countries' ICT export to China (RX2C) are included to capture the first, the second, and the third channel, respectively. If there is a crowding-out effect of China's exports, the coefficient of RXC would have a negative sign. RXK2C captures the ICT production capacity of Korea (if positive), or it would reflect the production shift effect (if negative). The negative coefficient of this variable would imply that Korean firms relocate some of their production stages from third-world countries to China; thus, even with greater production capacity, Korea's ICT exports to third-world markets might decrease. LCDVX and LCFVA are a log of indicators of China's forward (DVX) and backward (FVA) linkages in global value chains, respectively, and accordingly reflect China's transition towards upstream in GVC. The end-use share of total imports of the destination country is considered to capture the industrial structure of Korea's trading partner. These variables are considered because, as mentioned earlier, the composition of demand affects a country's import demand, and thus partners' exports. In addition, total and ICT overseas direct investment of Korea to third countries (ODI and ODI.ICT) are considered to investigate the intrafirm trade of multinational firms. Multinational firms have invested in local subsidiaries, especially in Asia, to procure intermediate inputs that lower production costs. Therefore, exports tend to increase in this case as (ICT) ODI increases. Finally, conventional variables are included such as exchange rate (ER), Real Foreign demand (RFD), and world trade volume (WTV), into the model to control for price competitiveness, import demand, and global trade environment, respectively. The detailed explanations of the variables are in Table 1.

Table 1. DATA Description and Sources

Variables	Description	Source
$RXK_{i,j,t}$	Log of Real Korea's Exports of commodity j to country i at year t	UN Comtrade[a]
$RXC_{i,j,t}$	Log of Real China's Exports of commodity j to country i at year t	UN Comtrade
$RX2C_{i,j,t}$	Log of Real Country i's exports to China for commodity i at year t	UN Comtrade
$RX2CT_{i,t}$	Log of Real Country i's total ICT exports to China at year t	UN Comtrade
$RXK2C_{j,t}$	Log of Real Korea's Exports to China for commodity j at year t	UN Comtrade
$LCDVX_t$[1]	Log of China's Indirect Value Added ratio to total Exports at year t	Eora MRIO Tables[b]
$LCFVA_t$	Log of China's Foreign Value Added Share in total Exports at year t	Eora MRIO Tables
$RFD_{i,j,t}$	Log of Real ICT imports from World for Country i's, commodity j at year t	UN Comtrade
$EndUse.TI_{i,t}$	Log of Intermediate End-use share of country i at year t	OECD[c]
$EndUse.TK_{i,t}$	Log of Capital Goods End-use share of country i at year t	OECD
$EndUse.TC_{i,t}$	Log of Final Consumption Goods End-use share of country i at year t	OECD
$ODIT_{i,t}$	Log of Korea's real cumulative Total Oversea Direct Investment to Country i at year t	Korea Open DATA Portal[d]
$ODI.ICT_{i,t}$	Log of Korea's real cumulative ICT Oversea Direct Investment to Country i at year t	Korea Open DATA Portal
$ER_{i,t}$	Log of scaled exchange rate for country i in terms of Korea won at year t	IMF[e]
WTV_t	Log of World Trade Volume index(2010=100) at year t	CPB World Trade Monitor[f]

[1] DVX(indirect value added exports), i.e., the share of a country's value added exports embodied as intermediate inputs in other countries' exports, which captures the contribution of the domestic sector to the exports of other countries, thus indicating the extent of GVC participation for relatively upstream sectors.
[b] Eora MRIO database(https://worldmrio.com/eora/)
[c] OECD.Stat Bilateral Trade in Goods by Industry and End-use (BTDIxE), ISIC Rev.4 (https://stats.oecd.org/index.aspx?queryid=64755)
[d] The Export-Import Bank of Korea collects the Oversea Direct Investment(ODI) data and reports via Korea Open DATA potal (https://www.data.go.kr/dataset/3040164/fileData.do)
[e] IMF Exchange Rate Archives by Month (https://www.imf.org/external/np/fin/data/param_rms_mth.aspx)
[f] CPB World Trade Monitor (https://www.cpb.nl/en/worldtrademonitor)

2.2. DATA

First, ICT is defined as exports such as the 3-digit SITC of the UN Comtrade database under SITC75 (Office machine and automatic data processing machine), SITC76 (Telecommunication and sound recording apparatus), and SITC77 (Electrical machinery, apparatus, and appliances, n.e.s) categories. [18] Data only after 2001 is considered because China's WTO membership and consequently Information Technology Agreement (ITA) is in effect as of 2001. Based on the ITA, members are allowed to trade ICT goods with practically no tariffs and regulations. As mentioned above, only the top 20 export destinations for each year over the sample period are considered, which total 29 countries. The sum of those countries' ICT imports accounts, on average, for approximately 92% of the total ICT exports of Korea when exports to China are included, and approximately 61% when it is excluded. In addition, the value of global import of a country for each commodity is referred as the country's import demand.

Eora Multi-Region Input-Output (MRIO) tables are used to obtain GVC indicators for China, such as DVX and FVA. Data for each of the end-use share (intermediate goods, final consumption goods, and capital goods) of the importing country is obtained from the OECD STAN Bilateral trade database. Exchange rates of importing countries in Korean won are computed based on Domestic Currency per U.S. Dollar (period average) of the IMF Exchange Rate Archives by month. The annual average of the exchange rate is taken and normalized by its standard deviation. The world trade volume index is obtained from the CPB world trade monitor. The data for Korea's total and ICT overseas direct investment from the export-import bank of Korea is collected. All the nominal variables except for the exchange rate are transformed into real variables using the GDP implicit price deflator in the United States.

Finally, the natural log is taken for all the variables so that the estimated coefficient can be interpreted as an elasticity.

[18] ICT exports thus cover 12 commodity codes which are SITC 751, 752, 759, 761, 762, 763, 764, 772, 773, 775, 776, 778

2.3. Estimation Methodology

As mentioned above, the OLS estimates of a gravity model are susceptible to endogeneity problems. Accordingly, many papers adopt instrument variables (IVs) and estimate the corresponding model using a two-stage least squares method to attain consistency. For example, Eichengreen et al. (2007), Greenaway et al. (2008), and more recently Pham et al. (2017) used the distance between China and the importing country and/or China's GDP to avoid the potential endogeneity of China's exports. However, this distance seems not to be a good IV to discuss China's impact on Korea's ICT exports. This is because the distance between Korea and China is not far enough to explain the difference in exports of the two countries to third-world countries; moreover, the constant distance cannot capture the variations in exports over time. China's GDP could also be endogenous considering global value chains. For example, an increase in China's GDP implies a rise in demand for third countries' ICT exports, which can in turn raise ICT imports from Korea as intermediate inputs. Given the lack of external instruments, the only available instrumental variable is often the lagged dependent one. However, a lagged dependent variable is not an efficient instrument for two reasons. First, this variable does not account for the correlation introduced into the errors by first-differencing, and second, there are further valid instruments available. Therefore, the (two-step) system GMM method is considered to estimate equation (1), a dynamic linear panel model.[19] The Sargan-Hansen test and the second-order error serial correlation test are conducted to determine the validity of instruments and consistency, respectively.[20]

3. Estimation Results

Tables 2 and 3 report the estimation results with robust errors.[21] The second column shows estimation results on the full sample, and the third through the sixth columns are the estimation results on the regional subsamples, and the seventh through ninth column shows the estimation results by product category.[22] Table 2 mostly describes the variables related to the three channels and China's economic rebalancing, and Table 3 mostly describes the variables usually considered in the literature.

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[19] I prefer the system GMM to the first-differenced GMM in light of Bond et al. (2001). He pointed out that when the first-differenced GMM estimate for the lagged dependent variable lies below the corresponding 'within group' estimate, the GMM estimates are seriously biased due to weak instruments. The estimation results of all considered models are reported in Table 6. Various diagnostic tests support the system GMM.

[20] For the validity of instruments, the Sargan-Hansen test should not be rejected. However, the Sargan-Hansen test is sensitive to the number of instruments so the p-value of this test with instruments that are too large tends to be very high, leading to non-rejection of the validity of moment conditions, when the same test is performed on models that are more parsimonious in terms of the instruments; thus, this situation can potentially lead to opposite conclusions. Hence, I considered collapsed instruments (a much lower number of moments of conditions) as well. For consistency, innovations should not be serially correlated. This consequently means that the first-order covariance between $\Delta\varepsilon_{i,t}$ and $\Delta\varepsilon_{i,t-1}$ should be negative and statistically significant and the second-order covariance should be insignificant.

[21] I report the estimation results only if the estimated coefficients are significant in at least one of the eight estimations

[22] In GMM estimation, if the innovations are heteroskedastic and/or correlated, the variance-covariance matrix of coefficients is inconsistent. Thus, I use the robust estimation of the Coefficients' covariance

Table 2. System GMM Estimation by Market and Commodity Code

Dependent variable:RXK	ALL	Advanced	ASIA	Emerging	ME+EU28	SITC75	SITC76	SITC77
lag(RXK, 1)	0.807***	0.802***	0.590***	0.815***	0.813***	0.456***	0.849***	0.840***
	(0.026)	(0.049)	(0.098)	(0.114)	(0.087)	(0.085)	(0.054)	(0.053)
RXC	0.871***	0.968***	0.572*	1.015***	0.648**	0.322	0.538	0.940***
	(0.098)	(0.158)	(0.305)	(0.271)	(0.303)	(0.219)	(0.349)	(0.147)
lag(RXC,1)	−0.800***	−0.855***	−0.440**	−0.889***	−0.694***	−0.489***	−0.696***	−0.801***
	(0.084)	(0.164)	(0.207)	(0.255)	(0.252)	(0.147)	(0.239)	(0.104)
RXK2C	0.052***	0.049**	0.085**	0.105***	0.024	0.014	0.057***	0.043**
	(0.010)	(0.021)	(0.034)	(0.023)	(0.018)	(0.047)	(0.019)	(0.019)
RX2CT	−0.003	0.070	−0.042	0.036	−0.065*	0.072*	0.013	−0.009
	(0.012)	(0.045)	(0.061)	(0.138)	(0.038)	(0.037)	(0.022)	(0.021)
CER:lag(RXC, 1)	0.159	0.294	−0.580	0.014	−0.262	0.008	0.491*	0.142
	(0.117)	(0.187)	(0.360)	(0.416)	(0.370)	(0.153)	(0.254)	(0.252)
CER:RXK2C	−0.042***	−0.052**	−0.066	−0.101***	0.004	−0.021	−0.075***	0.008
	(0.011)	(0.021)	(0.041)	(0.032)	(0.028)	(0.058)	(0.021)	(0.025)
CER:RX2C	0.017	0.062**	0.065	−0.015	0.013	0.069*	0.003	0.012
	(0.012)	(0.026)	(0.043)	(0.032)	(0.042)	(0.036)	(0.026)	(0.018)
CER:RX2CT	−0.018	−0.065	−0.067	0.100	0.089	−0.096*	−0.026	−0.017
	(0.015)	(0.052)	(0.150)	(0.253)	(0.080)	(0.050)	(0.036)	(0.032)
LCFVA	0.265	0.583	−0.264	−0.440	0.772	0.244	1.269**	0.221
	(0.274)	(0.485)	(0.449)	(0.984)	(0.767)	(0.550)	(0.559)	(0.376)
CER:LCDVX	1.234*	0.635	2.796*	2.675	−1.249	3.509**	−0.145	0.673
	(0.714)	(1.121)	(1.665)	(2.131)	(2.030)	(1.403)	(1.372)	(1.225)
CER:LCFVA	−0.006	−0.133	−1.497*	−0.767	−0.353	0.940	−1.198*	−0.234
	(0.385)	(0.581)	(0.772)	(1.854)	(0.967)	(0.859)	(0.627)	(0.556)
EndUse.TI	0.095	−0.070	0.541*	0.119	−0.427	0.103	−0.079	−0.058
	(0.097)	(0.287)	(0.326)	(0.454)	(0.480)	(0.295)	(0.223)	(0.168)
EndUse.TK	0.097	0.378**	−0.401	−0.365	0.018	0.435	0.280*	0.002
	(0.066)	(0.154)	(0.257)	(0.623)	(0.332)	(0.270)	(0.153)	(0.077)
CER:EndUse.TI	−0.153	−0.063	−1.907*	0.107	0.393	−0.278	−0.006	0.145
	(0.102)	(0.375)	(1.022)	(1.290)	(0.575)	(0.309)	(0.260)	(0.172)
CER:EndUse.TK	−0.040	−0.359**	0.534	−0.301	0.022	−0.329	−0.167	0.051
	(0.072)	(0.177)	(0.407)	(1.447)	(0.689)	(0.302)	(0.172)	(0.099)
CER:EndUse.TC	−0.143***	0.142	−0.789	0.240	−0.198	−0.078	−0.112	0.026
	(0.050)	(0.244)	(0.493)	(0.975)	(0.303)	(0.220)	(0.127)	(0.106)
Observations	360	156	72	48	84	90	120	150
Sargan Test	300.7898	61.63304	37.85583	13.39164	42.06652	63.7471	59.88199	66.95485
AR(1) Test	−5.783***	−3.772***	−2.508**	−3.139***	−3.025***	−2.781***	−3.579***	−6.440***
AR(2) Test	0.901	−0.045	0.883	0.713	0.670	0.784	0.812	-1.031
Wald χ^2	1594280***	1036767***	260035.2***	949883.3***	458770.9***	219597.1***	875225.8***	1903313***

Note: *p<0.1; **p<0.05; ***p<0.01

3.1. Full Sample Estimation Results

The estimation results indicate that there is no crowding-out effect of Chinese exports as RXC is positively associated with RXK but this complementary relationship becomes much weaker in the long run. More specifically, a 10% increase in RXC leads to an 8.71% increase of RXK contemporaneously and 3.68% permanently. The positive coefficient to RXC might imply that ICT products produced in China and Korea were used jointly in assembly operations in third countries. In addition, there is no strong evidence on the production shift channel. Korea's ICT exports to China are positively related to its export to third countries

implying that RXK2C captures the export capacity of Korea. When Korea's exports to China increase by 10%, Korea's exports to third-world countries rises by 0.52% contemporaneously, and 2.69% permanently. The third-world countries export to China is negatively related to Korea's ICT exports but the coefficient is very small and statistically insignificant. Therefore, the indirect demand channel is not in effect on average over all sample periods.

Surprisingly, China's GVC indicators, such as the foreign value-added share of China's gross exports (LCFVA) and China's forward GVC participation (LCDVX), do not have a significant effect on Korea's ICT export on average over all the sample periods.

The end-use of imported goods of the importing country reflects their import demand composition. Intermediate goods share, capital goods share, and final consumption goods share are considered, but none of those variables are statistically significant in general.

The foreign import demand has a positive effect on exports as in the literature of the gravity model although the magnitude is much smaller. A 10% increase in foreign import demand results in a 1.05% and 5.44% increase of Korea's ICT exports in the short-run and long-run respectively. Korea's total overseas direct investment also has a positive relationship with Korea's ICT exports to the corresponding countries even though its magnitude is very small. On the other hand, Korea's overseas direct investment in ICT industry does not have a significant effect on its exports.

As mentioned earlier, China's economic rebalancing (CER) may change the relationship between Korea's ICT exports to third-world countries and the variables considered. To identify the change, the CER dummy and the intersection term are introduced with major variables.

Among the three channels, only the second channel is significantly affected by China's economic rebalancing, that is production shift (production capacity) channels become very weak as a 10% increase in RXK2C leads to a 0.1% increase in Korea's ICT exports to third-world countries contemporaneously, and a 0.5% increase permanently.

China's forward GVC participation also becomes significant during the CER period, and a 10% increase in China's DVX ratio (LCDVX) is associated with 12.34% greater Korea's ICT exports to third-world countries. Therefore, China's economic rebalancing seems to positively affect Korea's ICT exports to third-world countries on average, because it is associated with higher LCDVX and lower LCFVA as shown in Fig. 1. In addition, the final consumption goods end-use share of importing country becomes significant with a negative sign during the CER period, although it is very inelastic; the corresponding elasticity is -0.143.

The exchange rate turns significant as well during the CER periods and negative; when the Korean won cheaper, Korea exports more ICT products.[23] This may imply that Korea's ICT exports are in price competition during the CER period, in contrast to the previous period. The effect of Korea's total overseas direct investment (ODIT) remains positive but a little bit weaker during the CER as the corresponding coefficient decreases from 0.013 to 0.0105. Korea's ICT overseas direct investment (ODI.ICT) to destination countries has positively affected Korea's ICT exports and is statistically significant during the CER, even though it is very inelastic. Thus, we can conjecture, since 2011, Korea's ICT multinational firms are more vertically integrated on average and their investments have a positive spillover effect on Korea's domestic exporting firms.[24]

[23] The exchange rates are normalized by the corresponding standard deviations, the estimated elasticity should be interpreted with caution.

[24] At the firm-level decision-making problem, there is a trade-off between foreign investment (fixed costs) and exports (variable costs). Foreign investment tends to be complementary to exports if multinational enterprises are vertically integrated.

Table 3. System GMM Estimation by Market and Commodity Code (Continued)

Dependent variable:RXK	ALL	Advanced	ASIA	Emerging	ME+EU28	SITC75	SITC76	SITC77
RFD	0.105*	0.079	0.343	−0.094	0.301*	0.722***	0.303*	0.047
	(0.056)	(0.089)	(0.214)	(0.218)	(0.174)	(0.195)	(0.173)	(0.098)
ODIT	0.013*	0.018	0.087	0.028	0.009	0.003	0.022	0.014
	(0.007)	(0.012)	(0.068)	(0.029)	(0.032)	(0.022)	(0.014)	(0.011)
ER	−0.051	0.104	−0.730***	−0.879	0.046	−0.096	−0.113	−0.001
	(0.078)	(0.154)	(0.252)	(0.600)	(0.200)	(0.199)	(0.185)	(0.122)
CER:ODIT	−0.025*	−0.013	−0.152*	−0.017	0.033	−0.046	−0.041	−0.020
	(0.013)	(0.025)	(0.085)	(0.186)	(0.104)	(0.035)	(0.030)	(0.021)
CER:ODI.ICT	0.014*	0.009	0.120**	0.060	−0.060	0.036	0.013	0.008
	(0.007)	(0.014)	(0.059)	(0.308)	(0.051)	(0.031)	(0.017)	(0.011)
CER:ER	−0.164*	−0.476	1.920**	0.206	−0.357*	−0.151	−0.154	−0.281**
	(0.100)	(0.292)	(0.780)	(1.023)	(0.194)	(0.410)	(0.207)	(0.122)
CER:WTV	0.432	1.273	−5.242***	−3.221	1.732	2.897	−0.856	0.330
	(0.905)	(1.161)	(1.906)	(3.162)	(2.836)	(2.388)	(1.595)	(1.329)
CER	−5.212	−7.214	41.828***	13.393	−7.807	−29.822*	13.208	−4.423
	(6.676)	(8.555)	(15.528)	(24.999)	(18.517)	(17.467)	(11.313)	(9.739)
Observations	360	156	72	48	84	90	120	150
Sargan Test	300.7898	61.63304	37.85583	13.39164	42.06652	63.7471	59.88199	66.95485
AR(1) Test	−5.783***	−3.772***	−2.508**	−3.139***	−3.025***	−2.781***	−3.579***	−6.440***
AR(2) Test	0.901	−0.045	0.883	0.713	0.670	0.784	0.812	-1.031
Wald χ^2	1594280***	1036767***	260035.2***	949883.3***	458770.9***	219597.1***	875225.8***	1903313***

Note: *p<0.1; **p<0.05; ***p<0.01

3.2. Estimation Results by Market and Product Category

Next, the impact of China on Korea's ICT exports varies across major markets and product categories are identified. In doing so, the same model is estimated separately for four groups of countries (Advanced, Asia, Emerging, and the Middle East plus relatively late-joining EU countries (hereafter ME+EU28)) and three groups of production categories (SITC 75, 76, and 77).[25]

The estimation results show that ICT exports of China and Korea are complementary for all regional submarkets in both the short run and long run. The contemporaneous complementary effect is the strongest (1.015) in markets for emerging economies and the weakest (0.572) for Asian countries and those effects are substantially decrease in the long-run. Exceptionally, in the markets for Middle East countries and lately joined member states of EU (ME+EU28), China's ICT exports crowd out Korea's ICT exports in the long run. A 10% increase in China's ICT exports induces about 2.5% lower Korea's ICT exports permanently.

When considering markets by product, the complementarity exists only in the market for SITC 77 (electrical machinery, apparatus, and appliances) products and the estimated contemporaneous (and permanent) elasticity of Korea's ICT export regarding China's ICT

[25] Advanced countries consist of Australia, Canada, Japan, USA, Germany, Spain, Finland, France, United Kingdom, Ireland, Italy, Sweden; Asian countries consist of Hong Kong, Malaysia, Philippines, Thailand, Vietnam, Singapore; emerging countries consist of Brazil, India, Russia, Mexico; and Middle East & EU28 countries consist of United Arab Emirates, Turkey, Saudi Arabia, Czech Republic, Hungary, Poland, and Slovak Republic.

export for this market is 0.94 (0.867). However, in the markets for SITC 75 (office machines and automatic data processing machines) and SITC76 (telecommunications and sound-recording and reproducing apparatus and equipment), China's ICT exports are negatively associated with Korea's ICT exports in the long run, implying a possible competitive threat of China. The competition with China is quite intense in the market for SITC 76 products. Specifically, a 10% increase in China's ICT exports induces a permanent decrease in Korea's ICT export by 3.1% and 10.4% in markets for SITC 75 and SITC 76 products respectively. Given expanding market share of Chinese smartphone producers especially in the EURO area, the estimation results can easily be accepted.

The production capacity channel is statistically significant for all regional and commodity subgroups except for markets for ME+EU28 and SITC75, and oppositely, the indirect demand channel is in effect only in those markets. However, importing countries' exports to China is negatively related to Korea's ICT exports in ME+EU28 and the ASIA market even though it is statistically significant only for the former market. Although many factors including their role in the supply chain of the ICT industry could explain the negative relationship, I would leave the further discussion for the following research.

China's backward GVC participation has a positive effect on Korea's ICT export to third-world countries in SITC 76 market. A 10% higher foreign value-added share in gross ICT export of China (LCFVA) leads to a 12.7% greater Korea's ICT exports contemporaneously. On the other hand, the demand composition of importing country turns into a significant factor for Korea's ICT exports in advanced economies and the Asian market regionally, and SITC 76 product market. For advanced economies and SITC 76 commodity markets, a greater capital good end-use share leads to a higher Korea's ICT exports, and, for Asian markets, the intermediate good end-use share is positively associated with Korea's ICT exports. Interestingly, foreign demand has a positive effect only in the markets for ME+EU28, SITC75, and SITC76. Total overseas direct investment is statistically not significant for all submarkets in contrast to the results of full sample estimation.

Again, China's economic rebalancing induces a structural change in the three channels through which China affects Korea's ICT exports for the regional and commodity sub-markets. The complementarity of ICT export between China and Korea has become much stronger in the market for SITC76 products. Specifically, a 10% increase in China's ICT exports for this market permanently reduces Korea's ICT exports by 10.4% before the CER period, but it increases by about 22% during the CER. Moreover, the production shift effect takes place in the markets for advanced economies and SITC76 during the CER period. For instance, a 10% increase in Korea's ICT exports to China (RXK2C) leads to a 0.03% (0.25% in the long-run) decrease of its exports to third countries during the CER period in the advanced economy market. Even though the effect of RXK2C remains positive for other markets, they are substantially reduced in magnitude. During the CER period, the indirect demand channel becomes in effect for the advanced economies. This implies that the advanced economies procure Korea's ICT products for their exports to China. In other words, when China's import demand for the ICT products of advanced economies increases, Korea's ICT exports increase because of complex global value chains. The indirect demand effect of China exists only for SITC 75 again in the CER periods.

Furthermore, China's forward GVC participation becomes significant during the CER period for the Asia and SITC75 markets. The estimation results for the Asian market show that Korea's ICT exports have been positively related to China's DVX share and negatively related to its FVA share of China's exports. Noting again that China's FVA share of total exports has fallen, and its DVX share has risen since 2011, the estimation results, in turn, imply that China's transition towards upstream in the global value chain could have a positive

effect on Korea's ICT exports, especially in the Asian market. Such a positive effect might also exist for SITC 75 products, for which China's DVX share elasticity of Korean ICT exports is 3.509 since 2011. On the other hand, for SITC 76 products, the effect of China's FVA share remains positive (0.071) and significant (at 10%) even since 2011; thus, Korea's ICT exports could be negatively affected by China's structural change for SITC 76 product market.

The effect of the demand composition also changed during the CER period in the Asian market. The intermediate goods end-use share of the importing countries had a positive effect, but its effect turns negative (-0.649) during CER periods. This result may indicate that either the comparative advantage of Korea's ICT products in the Asian markets is not present for intermediate goods or that Korea's intermediate goods are mainly heading to China and assembled into final goods. Even though the effect of capital goods end-use share remains positive for advanced markets, it becomes very small (0.019) in the CER period. Additionally, the coefficient of exchange rate changes its sign into positive for the Asian market during the CER period. This might imply that price competitiveness becomes an unimportant factor for Korea's ICT exports in the Asian market during the CER periods. The effect of total and ICT overseas direct investment has become significant for the Asian market. The elasticity of Korea's ICT export regarding ICT ODI to the corresponding country is 0.12 and statistically significant, and which would again imply that Korea's ICT industry is vertically integrated during the CER period.

4. Discussion

There is a relatively smaller number of studies from which we can draw some empirical evidence for the impact of China on Korea. In this section, we consider the estimation results from the selected studies which used similar empirical method for Korea's ICT industry and discuss what causes the difference between the results obtained in this paper and the results of these other studies.

First, Eichengreen et al. (2007) discuss the direct competition effect and the indirect demand effect separately using data covering the period of 1990-2003. Their model is a gravity model with country-pair and time-fixed effects. They found that China's exports did not crowd out the exports of other Asian countries for technology-intensive consumer goods and capital goods. In addition, China's exports of intermediates continue to be positively associated with other Asian countries' exports of intermediates. Therefore, China's competitive threat does not exist on Korea's ICT exports. On the other hand, Greenaway et al. (2008) estimated almost the same model as Eichengreen et al. (2007) based on the data from the same period. However, they found evidence of a displacement effect, which is more pronounced for high-income Asian exporters such as Korea, Singapore, and Japan. This discrepancy can be attributed to the individual- and time-fixed effects which are not considered in Greenaway et al. (2008). However, both studies concluded that, because of China's import demand, the net effect of China would be positive for high-income Asian countries, including Korea.

Both studies, however, have limitations in comparison to this paper. First, they consider only the direct competition channel and not the global value chains and, thus, exclude the triangular trade of Asian countries. At best, they discussed the effect of the production shift channel separately and combine it with the direct competition channel in a counterfactual experiment. Second, as mentioned above, utilizing the distance between China and the importing countries would not be a good choice, as noted by Eichengreen et al. (2007), thus the GMM method would be a more appropriate estimation strategy. Third, their data spans

the period of 1990-2003; hence, it does not reflect structural changes in domestic and the global trade environment arising from China's economic rebalancing.

Recently, Pham et al. (2017) studied the competition effects of Chinese high-tech exports from the demand side with relatively recent data spanning the period of 1992-2013. Their model is a static gravity model with exporter fixed effects that adopts the same IVs to mitigate the biases induced by the endogeneity of China's exports. According to their estimation results, for the East Asian country group, which includes Korea, and ICT relevant products (computer-office machinery and electronics-telecommunications), Chinese exports are complementary to their exports. They also found that the complementarity in ICT exports for EA countries becomes stronger after 2009. This result is inconsistent with the results of the present paper in which such complementarity is mostly not changed before and after the CER period. A plausible explanation for this discrepancy is that their model did not consider some structural breaks arising from China's accession to the WTO in 2001 and the trade collapse in 2009. They also did not consider the global value chains and, hence, the production shift effects and China's economic rebalancing since 2011.

The three channels discussed in previous sections are also mentioned in Haddad (2007), among others. She showed that China's export growth negatively affected Korea's ICT export growth based on OLS estimation results. She also articulated that because Korea's ICT exports to China have grown substantially during the same sample periods, the negative effect should be attributed to the triangular trade among East Asian countries, rather than the competition between the two countries. However, she did not quantify China's competitive threats controlling the production shift effect in a model. To the best of my knowledge, this is the first paper that incorporates the variables capturing three channels within a model and discusses the effect of China's economic restructuring.

5. Conclusion

In this paper, we examine China's impact on Korea's ICT exports with a dynamic panel regression model considering the direct competition effect, the production shift effect, and finally, the indirect demand effect simultaneously. The first channel investigates whether China's ICT exports crowd out or complement Korea's ICT exports to third-world countries. The second channel evaluates indirectly whether Korean multinational firms relocated some of their production stages to China from third-world countries and, thus, whether they reduce their exports to third-world countries. Finally, the third channel tests the indirect impact of China's demand through complex global value chains.

To estimate the model, we utilize relatively recent data for the period of 2001-2017, and this allows a discussion of a possible structural break arising from China's economic rebalancing. The paper only considers the data for the top 20 importing countries of Korea's ICT products for each year, which cover approximately 90% of Korea's total ICT exports.

The system GMM results using a full sample show that China's ICT exports have been complementary to Korea's ICT exports contemporaneously, as indicated in the literature, but this complementary relationship becomes much weaker in the long-run. In addition, there is no strong evidence on the production shift channel. Korea's ICT exports to China are positively related to its export to third-world countries, however, the link becomes very loose during China's economic rebalancing. The indirect demand channel is not significant over all the sample periods. Surprisingly, China's FVA share does not have a significant effect on Korea's ICT export. Instead, Korea's ICT exports are more associated with China's DVX ratio in the CER period.

We also estimate the model with subsamples classified by region and product category. China's ICT exports are again complementary for all regional markets considered contemporaneously. The complementary effect is the strongest in emerging economies and the weakest in Asian countries regionally. Surprisingly, however, the positive relationship exists only in the market for STIC 77 among production categories. However, the permanent effect of China's ICT exports is negative in the markets for ME+EU28 countries and SITC75 and SITC76 implying a possible competitive threat of China. Korea's ICT exports are positively related to its exports to third-world countries except for ME+EU28 (production capacity), and its relationship has become much weaker since 2011 for the advanced and the emerging economy. For SITC 76 product, the relationship turns negative during the CER periods implying a production shift effect. The indirect demand channel is in effect only for the advanced economies during the CER periods. This means that when China's import demand for the ICT products of advanced economies increases, Korea's ICT exports increase because of complex global value chains. The indirect demand effect of China exists only for SITC 75 again in the CER periods.

Furthermore, the paper finds that Korea's ICT exports have been positively related to China's transition towards upstream in the global value chain, especially for the Asian market during the CER periods. On the other hand, for SITC 76 products, the effect of China's FVA share remains positive and significant even since 2011; thus, Korea's ICT exports could be negatively affected by China's structural change.

In sum, the paper finds that the three channels described above are valid, and China's economic rebalancing induces significant changes in the effectiveness of the channels. This is hardly identified in the empirical literature.

This paper also has some limitations in that the three channels are not exhaustive and the present paper does not discuss the interactive effect of the channels. As mentioned above, importing countries of Korea's ICT exports could respond to China's economic rebalancing so that endogenous effects of the variables could be important. In addition, the effect of each channel could be heterogeneous depending on the degree of other channels. For example, the complimentary effect could also depend on Korea's ICT export to China for some reasons. Although this endogenous and heterogeneous effect would not make any critical changes for the results of the present paper, it is important to understand this issue for policy implications. Therefore, I think, to study this issue combining the three channels with a general equilibrium model or VAR model could be worthwhile for future research.

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