Journal of Korea Trade Vol. 25, No. 6, October 2021, 126-142
https://doi.org/10.35611/jkt.2021.25.6.126
ISSN 1229-828X

Global Value Chain Formation and Human Capital: Case of Korea and ASEAN*

JKT 25(6)

Received 29 August 2021
Revised 8 October 2021
Accepted 11 October 2021

Jia-En Li
Department of International Business and Trade, Kyung Hee University, South Korea
Young-Jun Choi†
Department of International Business and Trade, Kyung Hee University, South Korea

Abstract

Purpose – This study discusses the effects of human capital in the formation of GVC linkages. We also investigate GVC intensity between Korea and ASEAN.

Design/methodology – To solve the doubling-counting problem in evaluating comparative advantage, RCA has been re-computed using domestic value-added (henceforth RCA_VA) at the country-sector level instead of value of trade. The impact of human capital on GVC intensity was empirically analyzed by establishing a panel data set with four industries (ISIC Rev. 4) in eight ASEAN countries from 2005 to 2015 from OECD-TiVA and WDI.

Findings – The empirical results show that human capital has a negative effect on GVC intensity in the agriculture and manufacture industries, while it has a positive effect in the service and information industries. The results do not mean that low human capital is a barrier and inefficient to GVC linkages. Low Value-added activities may be more profitable to some emerging countries. These findings suggest that it is important to accurately identify the competitive elements to increase gains from trade under the GVC. Also, it shows that comparative advantages can be misled by an RCA index evaluated in trade volume under the GVC.

Originality/value – This study highlights the importance of human capital as a factor for the efficient formation of Global Value Chain (GVC). This study has different from the literature in analyzing the role of human capital in formation of linkage of the GVC. And we clarify the changing patterns of trade by removing the double-counting problem under the GVC.

Keywords: ASEAN, Global value chain, Human capital, Korea, Trade intensity
JEL Classifications: D12, F14, O53

1. Introduction

Nowadays, the global trade environment constantly faces unexpected changes and risks. Nevertheless, many products are not made in one country, but are actually completed throughout several countries. Specifically, participating in the Global Value Chain (GVC) plays a great role in driving ASEAN's exports. ASEAN's participation in the GVC amounts to nearly 46 over the past two decades, with assembling final goods the major comparative advantage in China, but it is now being transferred out of China to emerging ASEAN countries. Thorbecke (2010) said that labor-intensive goods (e.g., footwear and clothing) are the two main export categories in ASEAN. He argued that multinational companies in Japan, South Korea, and Taiwan export sophisticated technology-intensive intermediate goods to ASEAN countries for assembly and re-export. ASEAN has become a global factory to produce

* This work was supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2016S1A2A3913925).
† **Corresponding author:** yjchoi@khu.ac.kr

labor-intensive goods. This result is similar to Yamaguchi's (2018) study that found ASEAN economies generally have a stronger tendency for backward participation, a pattern in which they export products assembled with imported parts and intermediates. ASEAN countries account for about 29% of backward linkages and about 17% of forward linkages. This shows that there are many assembly and processing processes when ASEAN countries participate in the GVCs. Therefore, it is worthwhile to study what determines the formation of GVC linkages.

There are various factors affecting the trade of developing countries. Falling trade barriers and communication costs create opportunities for entrepreneurs and workers to become involved in the global economy without having to develop a complete product or value chain (Baldwin, 2013; Escaith, 2014; OECD, 2013; Stamm, 2004). Bamber, Fernandez-Stark, Gereffi, and Guinn (2014) and OECD (2013) suggested that human capital development through education and training, infrastructure development, and an improved availability of capital help integrate economies into the GVC. Many developing countries are prioritizing human capital training as they push for GVC participation and export-led industrialization. The experience of East Asia, such as Korea from the 1980s to 1990s and China and Vietnam more recently, suggests that these two goals are compatible (Bank, 2019). However, human capital development varies widely among countries, which can have different effects on GVC linkages. This can explain how ASEAN countries focused on backward participation. Therefore, more research is needed to discuss the impact of human capital on the formation of the GVC.

Meanwhile, ASEAN is becoming an important trading partner for Korea. Its trade volume with South Korea accounts for about 5% of ASEAN's total trade volume. Further, their cooperation is active in the 'New Southern Policy' of Korea. It has been strengthening organic connections with ASEAN over time and will likely increase trade cooperation. Recently, ASEAN countries have shifted domestic added value from backward to forward to increase exports. However, ASEAN countries still have a higher proportion of backward rather than forward participation in the GVC. In other words, exports of intermediate goods from Korea to ASEAN have exceeded those of final goods, and the gap has gradually been increasing (see Appendix B1). This shows that Korea's intermediate goods and services contribute to ASEAN's final goods and services.

According to previous studies, human capital increases bilateral trade and has a positive impact on participation in the GVC. Owen (1999) demonstrated that countries with less human capital tend to increase trade by accumulating human capital. Cheng et al. (2015) showed that developing countries could benefit from improving human capital through participation in the GVC. As noted above, human capital will be a critical factor for ASEAN countries to be regionally and globally competitive.

Therefore, this study discusses the effects of human capital on the formation of GVC linkages. We also investigate GVC intensity between Korea and ASEAN. To solve the doubling-counting problem in evaluating comparative advantage, RCA has been re-computed using domestic value-added (henceforth RCA_VA) at the country-sector level instead of the value of trade. This also gives a clear picture of changing trade patterns under the GVC background. The impact of human capital on GVC intensity was empirically analyzed by establishing a panel data set with four industries (ISIC Rev. 4) in eight ASEAN countries from 2005 to 2015 from OECD-TiVA and WDI.

The empirical results imply that gains from trade depend on how it integrates into the GVC. It was shown that human capital strengthens the integration into the GVC in information and services industries while it weakens GVC intensity in industries. The result does not mean that low human capital is a barrier and inefficient to GVC linkages. Low value-added activities may be more profitable to some countries, such as developing or emerging

countries. It was also found that ranks of competitiveness changed when comparative advantage was re-evaluated in RCA_VA. This implies that the trade patterns evaluated in trade volumes cannot reveal the true comparative advantage under the GVC. Therefore, it is important to identify competitive elements accurately to increase gains from trade.

This study suggests a new indicator to improve the existing RCA. In particular, it is different from previous studies in that it reflects the characteristics of the GVC based on added value rather than simply the size of trade. Moreover, it is meaningful in that it suggests the necessity of the division of labor by industry according to the level of human resources in each country. Also, considering the growing importance of the GVC in a situation where protectionism is intensifying, it is a good attempt to explain the source of national competitiveness through human resources.

The rest of the paper is organized as follows. Section 2 presents the literature review. Section 3 discusses methodology. Section 4 provides the empirical model and data used in this paper. Section 5 reports the estimation results. Section 6 summarizes the major findings and concludes.

2. Literature Review

2.1. Global Value Chain and Double Counting in Gross Exports

Global value chains (GVC) are often considered a defining feature of the current wave of globalization. The emergence of the GVC has changed each country's industrial structure and the pattern of international trade. Specifically, the different decisions involved in GVC configuration can be examined by considering the possible interdependencies and cooperation between different countries. Many economists (Daudin, Rifflart, & Schweisguth, 2011; Hummels, Ishii, & Yi, 2001; Johnson and Noguera, 2012a); Koopman, Powers, Wang, & Wei, 2010; Koopman, Wang, & Wei, 2014) suggest that changes cannot be detected through traditional data measurement methods. As subsequent discussions would reveal, in the event of the growing importance of global value chains, an analysis of RCA indices based solely on gross export values is questionable.

Knowing the relative importance of different double-counted trade values in a country's gross exports can help reestablish the depth and pattern of that country's participation in the GVC. There have been efforts by many scholars to redefine the double-counting problem. Growing works of literature attempt to define the components of foreign and domestic trade in value-added (Daudin, Rifflart, & Schweisguth, 2011; Hummels, Ishii, & Yi, 2001; Johnson & Noguera, 2012a, 2012b; Koopman, Powers, Wang, & Wei, 2010; Stehrer, 2012) and distinguish the concepts of value-added trade (TiVA) (Vries, Foster-McGregor, & Stehrer, 2012). Specifically, Koopman, Wang, and Wei (2014) are more systematic by completely decomposing gross exports into various value-added by tracing the value chain in global production intensity. Since then, research on the global value chain has been easily accessible and more active. Based on existing excellent literature, we try to identify value-added trade (see Appendix B2).

2.2. Global Value Chain and Human Capital

According to previous studies, human capital increases bilateral trade and plays a positive role in the GVC. Previous work approached Heckscher-Ohlin's theory in that international differences in production are determined by international differences in factor endowments

(Heckscher, 1919). Many papers extend a large body of theoretical literature to trade openness, and human capital is a significant explanatory variable of trade quality (Ferragina & Pastore, 2005). Bougheas and Riezman (2013) also showed that differences in human capital distributions can determine the pattern of trade between two otherwise symmetrical countries. Ghosh and Yamarik (2004) found that differences in per capita land were positively related to bilateral trade flows in their dataset, while differences in educational attainment and capital-labor ratios were significant in their regression estimates. Unel (2015) studied the interaction between human capital formation and trade using a two-sector, two-country trade model in which individuals choose to become either unskilled workers and work in agriculture or skilled workers and work in manufacturing. The only difference between the two countries is that the cost of human capital acquisition was lower in the Home country.

Recent studies on trade intensity and factor endowment used a new cross-country dataset compiled by WIOD that includes 37 OECD and non-OECD countries and 26 sectors (Johansson & Olaberria, 2014). They found cross-country differences in factor endowments, such as capital and labor, can explain cross-country differences in industrial structure. Value-added of the revealed comparative human capital, or physical capital indices, will make it possible to control for Heckscher–Ohlin effects in the analysis of trade diversification in a way that was not possible before (Shirotori, Tumurchudur, & Cadot, 2010). Research on the corporate side demonstrated empirically that the accumulation of human capital plays a positive role in small and medium-sized enterprises being incorporated into the global value chain. Berger and Bruhn (2017) studied the impact of human capital on SME participation in the GVC in Indonesia. He suggested the importance of human capital as a critical factor in creating linkages for SMEs to participate in the manufacturing and service GVC.

3. Methodology

3.1. Global Value Chain Intensity Index

The trade intensity approach was developed by Brown (1947) and Kojima (1964). Their trade intensity describes bilateral trade between two countries with the total value of world trade and its share. Yamazawa (1971) applied the trade intensity formula and further analyzed trade between pairs of countries. His work also assessed trade changes and factors affecting them. Then, Kunimoto (1977) provides a trade intensity approach that takes each country's total imports and exports as given, and divides the determinants of international trade between two countries.

We propose measures of the GVC intensity index that the percentage of one country's intermediate goods or services contribute to another country's final goods or services comes from the GVC. If the value of the index above (below) 1 indicates the GVC intensity between two countries is more (less) intensive than expected. In other words, the GVC intensity index (GII_{ij}^{k}) above (below) 1 has a relatively strong (weak) GVC linkage between both countries. The GVC intensity index from the existing literature can be derived as follows:

$$GII_{ij}^{k} = \frac{x_{ij}^{k} / x_{ij}}{x_{iw}^{k} / x_{iw}} \tag{1}$$

Where *i*, *j*, *w*, and *k* refer to ASEAN countries, Korea, the world, and industries, respectively.

X_{iw}: the value of the foreign value-added (a component of gross export)[1] of country *i*;
X_{iw}^{k}: the value of the foreign value-added (a component of gross export) of country *i* in commodity *k*;
X_{ij}[2]: the value of the foreign value-added (a component of gross export) from country *i* to county *j*;
X_{ij}^{k}[3]: the value of the foreign value-added (a component of gross export) from country *i* to county *j* in commodity *k*;

The index can range from zero to infinity. Table 1 presents the GVC intensity index between ASEAN and Korea. It shows that Korea specializes in the service and information industry. Korea has strong linkages with Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam in the service industry. As follows, the share of domestic content in these exports is small, implying that ASEAN's value-added is small. This proves again that ASEAN mainly uses domestic (labor) and foreign (intermediate good or service) inputs to produce products through labor-intensive assembly and processing, and sell them worldwide. The strong GVC linkages will boost the competitiveness of ASEAN countries compared to other emerging factory countries, and play a key role in attracting them to export-led industrialization.

Table 1. GVC Intensity Index between ASEAN and Korea by Sector

Country	Agriculture		Industry		Service		Information Industry	
	2005	2015	2005	2015	2005	2015	2005	2015
BRN	0.242	0.000	1.255	1.239	0.623	0.139	1.803	0.099
KHM	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
IDN	0.058	0.073	0.884	0.926	1.604	1.407	1.000	0.600
MYS	0.052	0.205	0.986	0.961	1.128	1.216	1.118	0.932
PHL	0.120	0.342	0.961	0.841	1.236	1.783	1.019	0.865
SGP	0.265	0.498	0.567	0.439	1.589	1.582	1.250	1.313
THA	0.075	0.363	0.839	0.888	1.729	1.507	0.947	0.561
VNM	0.073	0.026	0.944	1.013	1.558	1.079	1.080	1.228

Notes: Authors' estimates based on OECD TiVA database (2018).

3.2. Value-added Adjusted RCA

Over the years, researchers have identified several original Balassa indices. The index explores the possibility of relying on various theoretical explanations of international trade to determine the patterns of comparative advantage. With these considerations in mind, the indicators of competitiveness, such as the revealed comparative advantage (RCA) index (Balassa, 1965), have proven to be useful in research and policy applications as an index based on gross export values.

[1] Foreign value-added component of gross export. It is the value-added of inputs that were imported to produce intermediate or final goods/services to be exported. It corresponds to "Backward GVC participation" (WTO, 2016).
[2] Foreign value-added contents can show partner countries domestic value-added in the intermediate component of gross export because of the data limitation from *i* country to *j* country. We used mirror data that domestic value-added in intermediate good and service from *j* country to *i* country.
[3] The same as above

When, as export value-added becomes decomposed, the RCA index begins to be re-examined. Balassa RCA indices have been criticized because countries and commodities are double-counted. Also, they are based on gross exports. As Koopman et al. (2014) suggested, RCA's traditional computation can be noisy and misleading. Timmer, Los, Stehrer, and De Vries (2013) reported that the global value-added supply chain was gaining more and more prominence, and reconstructing the RCA indices using value-added in export values rather than gross export values and examining performance is perhaps a better way to proceed (Deb & Hauk, 2015). Substantial literature re-computed RCA using domestic value-added in exports, and one of the interesting findings was that both China and India would have a strong comparative advantage if RCA was based on gross exports. However, the RCA ranking of both countries fell dramatically when RCA was based on domestic value-added exports (Koopman et al., 2014). Similar results were found and examined the competitiveness of 56 countries in five industries using the trade-in value-added (TiVA) database developed by the OECD and the World Trade Organization (Ceglowski, 2017). These issues are worth referring to.

As the argument goes, it should be based on net exports instead. We re-compute the RCA_VA approach to reshape our understanding of global trade patterns. If the value of the index above 1 indicates, the country has competitiveness in its exports. The RCA_VA index measured from previous research can be written:

$$RCA\_VA_i^k = \frac{{DVA_{iw}^k}/{DVA_{iw}}}{{DVA_w^k}/{DVA_w}} \quad (2)$$

Where *i*, *w*, and *k* refer to export countries, the world and industries, respectively. RCA_VA is one country value-added RCA index; DVA is the domestic value-added component of gross export.

The indices can range from zero to infinity. We calculated both gross exports and domestic value-added RCA to compare the competitiveness of ASEAN countries by sector, as detailed in Appendix B1. Overall, competitiveness in 2015 was stronger than in 2005. Specifically, the industry and service sector's competitiveness increased more than other industries (Appendix B3). The interesting findings are that Thailand, Malaysia, Philippines, Singapore, and Brunei Darussalam exhibited a comparative advantage if RCA was based on domestic value-added exports in agriculture. There is a non-comparative advantage if RCA is based on gross exports. In the manufacturing industry, the Philippines, Cambodia, and Singapore exhibited a comparative advantage if RCA was based on domestic value-added exports.

On the contrary, there is a non-comparative advantage if RCA is based on gross exports. In service, Thailand, Cambodia, Indonesia, and Malaysia have a comparative advantage if RCA is based on domestic value-added exports. As before, there is a non-comparative advantage if RCA is based on gross exports. Finally, Vietnam and Cambodia have a comparative advantage if RCA is based on domestic value-added exports in the information industry. However, there is a non-comparative advantage if RCA is based on gross exports.

Unsurprisingly, the rankings for other countries rise and fall. For example, Vietnam's RCA_VA ranking moved from a sixth-place under the conventional calculation to second place under the new calculation in agriculture. However, the Philippines, Indonesia, and Thailand's RCA rankings in RCA_VA dropped. In manufacturing, Vietnam and Indonesia rankings in RCA_VA rose in 2005. On the contrary, Malaysia's ranking has fallen significantly from 2nd to 4th. There was no significant change in manufacturing in 2015, but the rankings of Malaysia and Indonesia changed. In service, the rankings of Malaysia and

Indonesia changed in both 2005 and 2015. Singapore and Malaysia changed rankings in the information industry in 2005. There was no change in 2015.

One key reason for the change is that domestic value-added is often contained in intermediates (goods or services) exported to a partner country that re-export them to a third country in other products. Indeed, recalculating RCA using domestic value-added in exports can significantly modify the understanding of trade patterns and reveal that comparative advantage could be modified substantially.

4. Empirical Model and Data

4.1. Empirical Model

Based on the gravity equation, the following basic regression model is shown in this paper

$$GII_{ijt}^{k} = \beta_0 + \beta_1 \ln pgdp_{it} + \beta_2 \ln pgdp_{jt} + \beta_3 \ln dist_{ij} + \beta_4 Z + \beta_5 Human\ capital_{it} + \tau_t + \varepsilon_{ijkt} \quad (3)$$

$$Z = \int \left(\text{comlang}_{ij},\ wto_{dum}\right)$$

Where *i, j, k,* and *t* refer to ASEAN countries, Korea, sectors, and years, respectively. The dependent variable $ln\ GII_{ij}^{k}$ is a log of GVC intensity between *ASEAN* and *Korea* in sector *k* at year *t*.

The key variable is $Human\ capital_{it}$ that the *ASEAN country's* average years of schooling in the population over age 15 from Barro and Lee (2013). $ln\ pgdp_{it}$ and $ln\ pgdp_{jt}$ are the log of gross domestic product per capita (GDP) of *ASEAN countries* and *Korea* at *t,* respectively. $ln\ Dist$ is the log of geographical distance between *ASEAN countries* and *Korea.* Comlang_{ij} dummy variables represent whether *i* and *j* have common language spoken by at least 9% of the population. WTO_{dum} is a dummy that is 1 if ASEAN countries join the WTO members at *t*.

Meanwhile, we verified whether it was affected by factors in Korea (Model 2). We empirically checked by adding an $RCA\_VA_{jit}^{k}$ variable of a comparative advantage between Korea and the ASEAN countries-sector. We also tested the individual influence of factor endowment on exports among ASEAN countries. Therefore, we added the capital-labor ratio (physical) to explanations of traditional trade (Heckscher-Ohlin) (Model 3). We measured capital intensity based on fixed assets. The corresponding regression model is as follows:

$$GII_{ijt}^{k} = \beta_0 + \beta_1 \ln pgdp_{it} + \beta_2 \ln pgdp_{jt} + \beta_3 \ln dist_{ij} + \beta_4 Z + \beta_5 Human\ capital_{it} + + \beta_6 RCA\_VA_{jit}^{k} + \tau_t + \varepsilon_{jkt} \quad (4)$$

$$GII_{ijt}^{k} = \beta_0 + \beta_1 \ln pgdp_{jt} + \beta_2 \ln dist_{ij} + \beta_3 Z + \beta_4 Human\ capital_{it} + \beta_5 Physical\ capital_{it} + \beta_6 RCA\_VA_{jit}^{k} + \tau_t + \varepsilon_{ijkt} \quad (5)$$

In all regressions, we performed an F-test and Hausman test to check whether the Fixed or Random effects estimation was more appropriate than the pooled OLS estimation. However, time-invariant variables such as $dist_{ij}$, comlang_{ij}, and wto_{dum} should be omitted in the estimation of Fixed effects. Hence, we performed a Hausman-Taylor estimation to obtain not

only time-invariant variables but also consistent coefficients[4]. In the Random effects model, the estimated amount of GLS was estimated when heteroskedastic or first-order autocorrelation problems exist. To show that our baseline results are robust, we estimate standard errors, which are robust and clustered by country-sectors and year level(Moulton, 1990).

Further, the small sample data may not be an efficient estimate. If the number of members of each group is small, only under special circumstances are two-step estimation efficient, and do t-statistics from two-step estimation have t-distributions (Donald & Lang, 2007). Hayakawa (2007) suggested testing a two-step estimate instead of reducing the mean square error of the variance component estimator. Wooldridge (2016) suggested endogeneity concerns, with the IV method to estimate equation using the two-stage least-square (2SLS) estimator as the most common strategy that researchers use to address the endogeneity problem. Thus, we consider a two-stage least square (2SLS) estimation to check the robustness of the basic econometric specification. We suspect that the human capital variable is endogenous. We introduce the instruments variable as an alternative strategy to address the endogeneity concern. The instrument contains children out of school (number) and government expenditure per student (% of GDP per capita) in primary school[5] in each country.

4.2. Data Description

We compiled country-sector panel data covering ASEAN countries and Korea over the period of 2005-2015. Appendix A1 a lists data necessary for calculating variables and the respective source. We calculate GII_{ij}^{k} with domestic value-added and foreign value-added, components in gross-export data from OECD-TiVA. The dataset consists of 352 observations of 4 industries in 8 ASEAN countries during the sample period of 2005 to 2015. Industrial classification criteria were based on Version 4 of the International Standard Industrial Classification used in the OECD-TiVA. We selected basic industries from a list of industries based on TiVA and WTO as detailed in Appendix A2. Appendix A3 reports the summary statistics of key variables.

5. Empirical Results

5.1. Basic Estimation

Table 2 reports the baseline empirical results of the GLS (Column 1) and Hausman-Taylor estimation (Columns 2, 3, 4). It shows the results with agriculture, industry, service, and information service, respectively. As shown in Column (1) below, the Hausman test results show that it is appropriate to measure with the random effects model (Hausman, 1978); otherwise, measure with the fixed-effect model. Due to the lack of data for Myanmar and Lao's trade in value-added, these countries were excluded from the models.

The coefficient estimates of human capital are positive and statistically significant in the service and information industries. Conversely, human capital is negative and statistically significant in the industry. However, the result from agriculture is statistically insignificant. All other gravity variables have both positive and negative signs appearing in a different industry. As suggested by theoretical and empirical literature, we do not provide a detailed explanation for reasons of space.

---

[4] We also performed the fixed-effects model as the robustness check and found that the results were consistent with the Hausman–Tylor estimation.

[5] The data from UNESCO Institute for Statistics (http://uis.unesco.org/).

Table 3 reports the regression results for the Hausman-Taylor estimation measured by adding elements of Korea (Columns 1, 2, 3, and 4). The coefficient estimates of human capital are still positive and statistically significant in the service and information industries. Human capital is positive and statistically significant in agriculture. However, at a significant level of 1%, it is not a remarkable result. It can be seen that the two empirical analyses produced the same results.

Table 4 reports the regression results to demonstrate the relevance of Heckscher-Ohlin trade theory (Columns 1, 2, 3, 4). The coefficient estimates of comparativeness in human capital are both positive and negative, which is statistically significant (industry, service, and information industries, respectively) despite controlling other variables that affect GVC intensity. It was found that physical capital (capital-labor ratios) coefficients on GVC intensity were negative, as predicted by the theory, but not statistically significant. This supports existing studies that Frankel, Stein, and Wei (1995) believed were weak enough to have no support for the Heckscher-Olin hypothesis in regional trade block studies. They had included, along with other variables, differences in capital-labor ratios in a standard gravity equation. They found that the coefficients on these variables were positive, as predicted by the theory, but were not statistically significant.

In summary, the result is that human capital and GVC intensity negatively affect industry. However, this does not mean that low human capital is a barrier and inefficient in backward linkages. Low Value-added activities may be more profitable to some countries, such as developing or emerging countries. On the contrary, human capital had a positive effect on GVC intensity in the service and information industries. Essentially, greater skill endowment allows the formation of GVC linkages in services.

5.2. Robustness Check

Table 5 reports the regression results of the two-stage estimation to check whether the estimates are robust across different industries. Before discussing the results, we check whether our instruments are valid. Stock and Yogo (2002) suggested what first-stage F-statistics greater than 9.08 prove. In this case, the null hypothesis is that the instrument variable is external and that the measured variable is not correlated with the error term. First, the value of the first-stage F-statistics of our 2SLS regression is all above 9.08. This implies that our instruments are strong, and thus satisfy the relevance condition. Second, we ran an instrument exogeneity test and instrumented endogeneity test. Since the null theories were adopted at a significant level of 10%, we cannot reject the exogeneity of our instruments. The instrumented variable is shown to be endogenous by rejecting the null hypothesis at a significant level of 1%. Thus, the instrument and instrumented variables satisfy the exogeneity and endogeneity conditions.

As expected, the 2SLS regression results show that it is similar to baseline estimation after controlling for sample selection bias. The coefficient of human capital appears to be strongly positive in the service and information industries (Columns 3, 4), and negative in agriculture and industry (Columns 1, 2). When Korea has a competitive advantage in industry and service, its intensity with ASEAN is further strengthened. Other control variables, per GDP, distance, and capital intensity, have positive (or negative) and significant impacts on GVC intensity. Like the baseline results, low-level education was more likely to be involved in industry GVC. On the contrary, the higher the human capital. the stronger the GVC linkages in the service and information industries. In summary, the results from the alternative method allow us to conclude that the positive relationship between human capital and GVC intensity is robust.

Table 2. Basic Regression Results (Model 1)

Variable	Agriculture (1)	Industry (2)	Service (3)	Information Industry (4)
$ln\,pgdp_{it}$	0.041*	0.053	-0.200	0.626
	(0.022)	(0.032)	(0.182)	(0.259)
$ln\,pgdp_{jt}$	0.183*	-0.159	0.023	-2.213***
	(0.103)	(0.093)	(0.534)	(0.809)
$ln\,dist_{ij}$	-0.019	-0.336	0.375	-1.606
	(0.062)	(0.142)	(0.326)	(1.339)
comlang_{ij}	0.146***	-0.302	0.463	-0.182
	(0.045)	(0.102)	(0.131)	(0.436)
wto_{dum}	0.009	0.139***	-0.124**	-0.238**
	(0.098)	(0.019)	(0.078)	(0.104)
$\boldsymbol{Human\ capital_{it}}$	**-0.042**	**-0.114*****	**0.130*****	**0.444*****
	(0.094)	**(0.012)**	**(0.059)**	**(0.089)**
$Constant$	-1.707	5.671**	-1.079	27.829
	(1.295)	(1.933)	(5.840)	(14.366)
$F-test$	20.83***	39.22***	13.37***	6.87***
$Hausman\ test$	3.87	8.37**	7.65**	7.78**
$Chi2$	22.90***	5391.28***	518.40***	931.97***
$Obs.$	77	77	77	77

Notes: 1. Dependent Variable: GVC Intensity Index.
2. *p<0.1, **p<0.05, ***p<0.001.
3. Robust standard errors in parentheses.

Table 3. Basic Regression Results (Model 2)

Variable	Agriculture (1)	Industry (2)	Service (3)	Information Industry (4)
$ln\,pgdp_{it}$	0.038**	0.170*	-0.084	0.584***
	(0.015)	(0.098)	(0.161)	(0.166)
$ln\,pgdp_{jt}$	-0.202	-0.367*	-0.270	-2.155**
	(0.126)	(0.098)	(0.457)	(0.738)
$ln\,dist_{ij}$	-0.008	-0.526	0.487	-1.517
	(0.161)	(0.380)	(0.305)	(0.940)
comlang_{ij}	-0.023	-0.326*	0.477***	-0.099
	(0.092)	(0.174)	(0.112)	(0.336)
wto_{dum}	-0.036**	0.118***	-0.165**	-0.238**
	(0.016)	(0.017)	(0.083)	(0.080)
$\boldsymbol{Human\ capital_{it}}$	**0.058***	**-0.094*****	**0.176*****	**0.448*****
	(0.032)	**(0.025)**	**(0.054)**	**(0.089)**
$\boldsymbol{RCA\_VA_{jit}^{k}}$	**0.115*****	**0.043**	**0.161**	**0.072**
	(0.014)	**(0.029)**	**(0.124)**	**(0.072)**
$Constant$	1.345	8.041*	-0.861	26.737**
	(1.003)	(4.169)	(4.475)	(10.947)
				(34.722)
$F-test$	3.33***	38.43***	13.47***	7.80***
$Hausman\ test$	12.27***	35.29***	12.74***	5.99
$Chi2$	117.18***	1679.36***	8100.83***	445.87***
$Obs.$	77	77	77	77

Notes: 1. Dependent Variable: GVC Intensity Index.
2. *p<0.1, **p<0.05, ***p<0.001.
3. Robust standard errors in parentheses.

Table 4. Basic Regression Results (Model 4)

Variable	Agriculture (1)	Industry (2)	Service (3)	Information Industry (4)
$ln\,pgdp_{jt}$	-0.107	-0.104	-0.264	-1.667**
	(0.160)	(0.139)	(0.440)	(0.653)
$ln\,dist_{ij}$	0.184	0.008	0.491**	-0.173
	(0.116)	(0.279)	(0.233)	(0.229)
comlang_{ij}	0.021	-0.203	0.480***	0.204
	(0.056)	(0.124)	(0.127)	(0.128)
wto_{dum}	-0.027	0.130***	-0.158	-0.221**
	(0.0174)	(0.015)	(0.110)	(0.106)
$\boldsymbol{Human\ capital_{it}}$	**0.064*** **	**-0.088*** **	**0.181*** **	**0.454*** **
	(0.020)	**(0.037)**	**(0.055)**	**(0.094)**
$\boldsymbol{Physical\ capital_{it}}$	**-0.032***	**-0.040**	**-0.056**	**0.041**
	(0.019)	**(0.036)**	**(0.089)**	**(0.035)**
$\boldsymbol{RCA\_VA_{ji}^{k}}$	**0.116*** **	**0.036**	**0.178** **	**0.071**
	(0.014)	**(0.027)**	**(0.088)**	**(0.076)**
$Constant$	-0.631	2.800	-1.449	15.863**
	(2.061)	(3.184)	(3.939)	(6.602)
$F-test$	12.65***	38.43***	13.47***	7.80***
$Hausman\ test$	3.33***	24.67***	19.85***	1.15
$Chi2$	1181.93***	261.83***	3743.80***	240.567***
$Obs.$	77	77	77	77

Notes: 1. Dependent Variable: GVC Intensity Index.
2. *p<0.1, **p<0.05, ***p<0.001.
3. Robust standard errors in parentheses.

Table 5. Two-Stage Estimation Results (2SLS)

Variable	Agriculture (1)	Industry (2)	Service (3)	Information Industry (4)
$ln\,pgdp_{jt}$	1.139*	0.509	1.997***	-3.687
	(0.585)	(1.152)	(0.375)	(2.337)
$ln\,dist_{ij}$	-0.099	0.139	0.324*	-0.777**
	(0.087)	(0.119)	(0.181)	(0.330)
comlang_{ij}	0.062	0.133	0.292	-0.196
	(0.051)	(0.127)	(0.178)	(0.194)
wto_{dum}	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
$\boldsymbol{Human\ capital_{it}}$	**-0.207** **	**-0.146***	**0.334***	**0.629*** **
	(0.101)	**(0.231)**	**(0.317)**	**(0.464)**
$\boldsymbol{Physical\ capital_{it}}$	**0.048*** **	**0.081** **	**-0.104**	**0.203**
	(0.014)	**(0.033)**	**(0.102)**	**(0.134)**
$\boldsymbol{RCA\_VA_{ji}^{k}}$	**-0.008**	**0.090***	**0.117***	**0.037**
	(0.058)	**(0.050)**	**(0.065)**	**(0.034)**
$Constant$	-9.605**	-5.125	-22.783	39.364*
	(4.766)	(11.361)	(16.137)	(20.991)
instruments	2	2	2	2
$F-test(first\ stage)$	32.39***	11.33***	15.44***	10.16***
$Exogeneity\ test(instruments)$ $(p-value)$	0.298	0.092	0.399	0.013
$Endogeneity\ test$(instrumented)	100.48***	38.71***	15.44**	13.78**
$Adj.R-sq$	0.780	0.672	0.751	0.672
$RMSE$	0.048	0.054	0.186	0.249
$Obs.$	65	65	65	65

Notes: 1. Dependent Variable: GVC Intensity Index.
2. *p<0.1, **p<0.05, ***p<0.001.
3. Robust standard errors in parentheses.

6. Conclusion

This study analyzed interactions between human capital formation and GVC intensity in trade between Korea and ASEAN using OECD-TiVA data from 2005 to 2015. It has been argued that higher quality human capital helps successful integration into the GVC. This paper shows that higher quality human capital is not a requirement for integrating into GVC. Human capital can affect the intensity of GVC asymmetry across industries. The results show that human capital positively affects the service and information industries' value chain activities, while negatively affecting agriculture and industrial value chain activities. We also re-computed comparative advantage using value-added instead of trade volume to remove the double-counting problem under the GVC. We found that comparative advantage evaluated in trade volume cannot reveal the actual shape of comparative advantage when countries are integrated into the GVC.

For low-income countries, the ability to effectively integrate into the GVC has become a prerequisite for reducing unemployment and poverty by developing the national economy, creating more and better jobs, and enhancing national capabilities (Gereffi & Fernandez-Stark, 2011). This suggests that there are more gains from trade under the GVC, and it is important to identify a country's competitive elements accurately. Countries should consider strategies to properly join the GVC. Countries with low quality human capital participate in the GVC by entering low-skill intensive activities in manufacturing industries. Countries with relatively high quality human capital can move to the information and services sectors by improving the quality of education and training. Cheng et al. (2015) showed that emerging Asian economic participation in the GVC was important to sustain strong growth by repositioning themselves toward higher-value stages of production.

This study suggests a new indicator to improve the problems of the existing RCA. In particular, it is different from previous studies in that it reflects the characteristics of the GVC based on added value rather than simply the size of trade. Moreover, it is meaningful in that it suggests the necessity of the division of labor by industry according to the level of human resources in each country. Also, considering the growing importance of the GVC in a situation where protectionism is intensifying, this is a good attempt to explain the source of national competitiveness through human resources.

Every study has limitations, and this study is no exception. Addressing these limitations can lead to further research. Most importantly, the data used in this study only included Korea and ASEAN countries. Therefore, generalization of the results to other dyads should be performed with care. More research is needed to extend knowledge by increasing the coverage of countries in the data in the future. It will also be meaningful to expand the study to analyze the role of human capital in trade between developed countries under dyads GVC in the future.

Appendices

Appendix A1. Data Sources

Variable	Description	Unit	Source
$GNII$	GVC Intensity	from zero to infinity	Author's elaborations based on the OECD-TiVA database (2018).
$PGDP$	GDP per capita, PPP	current international $	World Development Indicators database, World Bank
$Dist$	Bilateral distance	kilometer	CEPII Dataset
comlang	Dummy for the language spoken by at least 9% of the population in both countries	0 or 1	CEPII Dataset; Head et al. (2010)
wto_dum	1 if j is GATT/WTO member	0 or 1	WTO
$Human\ capital_{it}$	Average years of educational attainment	year	Use Barro · Lee (2012) estimation
$Physical\ capital_{it}$	Labor force/Gross fixed capital formation	ratio	World Development Indicators database, World Bank
$RCA\_VA^{k}_{jit}$	Value-added adjusted revealed comparative advantage	from zero to infinity	Author's elaborations based on the OECD-TiVA database (2018).

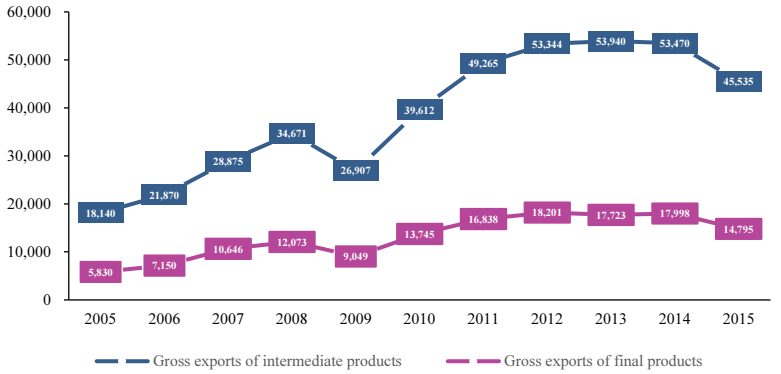
Appendix A2. Industry List

TiVA_Industry_Code	Label	ISIC Rev.4
D01T03	Agriculture, forestry, and fishing	From 01 to 03
D05T39	Industry (mining, manufactures, and utilities)	From 05 to 39
D41T98	Total services (incl. construction)	From 41 to 98
DINFO	Information industries	26, from 58 to 60,61, 62, 63
DTOTAL	TOTAL	ratio

Appendix A3. Descriptive Statistics

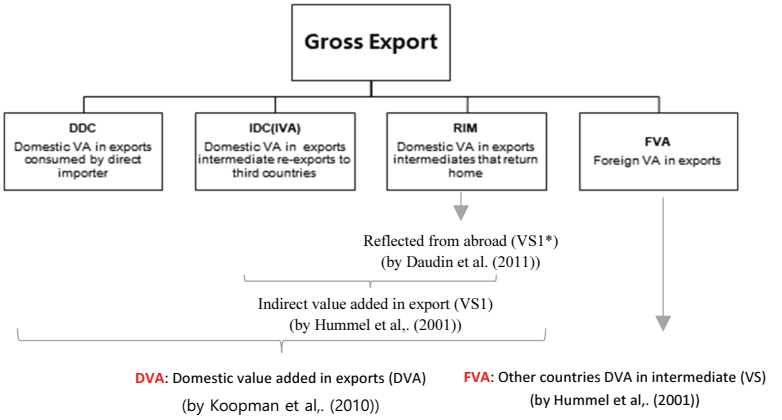
Variable	Obs.	Mean	SD	Min	Max
$GNII^{k}_{ij}$	308	0.850	0.512	0	20163
$ln\ pgdp_{it}$	352	9.467	1.206	7.452	11.388
$ln\ pgdp_{jt}$	352	10.304	0.112	10.094	10.485
$ln\ dist_{ij}$	352	8.239	0.235	7.869	8.574
comlang_{ij}	352	0.250	0.434	0	1
wto_{dum}	352	0.648	0.478	0	1
$Human\ capital_{it}$	352	7.477	0.519	6.910	7.950
$Physical\ capital_{it}$	352	7.078	1.461	4.495	9.779
$RCA\_VA^{k}_{jit}$	352	1.878	1.637	0	14.735

Appendix. B1. Gross Exports of Intermediate and Final Products from Korea to ASEAN



Source: The dataset from Trade in Value Added (TiVA).

Appendix. B2. Gross Export of Intermediate and Final Products from Korea to ASEAN



Note: Author based on literatures ((Daudin et al., 2011; Hummels et al., 2001; Koopman et al., 2010; Koopman et al., 2014; WTO., 2016)).

Appendix. B3. Value-Added Adjusted Revealed Comparative Advantage Indicators

Agriculture (2005)				Agriculture (2015)			
RCA_VA		RCA		RCA_VA		RCA	
19.755	KHM	KHM	19.388	23.833	KHM	KHM	10.603
2.781	VNM	PHL	1.247	4.450	VNM	VNM	1.863
1.425	PHL	IDN	1.004	2.677	IDN	IDN	1.271
1.339	MYS	MYS	0.953	2.357	THA	THA	0.913
1.004	IDN	THA	0.611	1.513	MYS	MYS	0.578
0.746	THA	VNM	0.288	1.225	PHL	PHL	0.534
0.029	SGP	SGP	0.028	0.047	SGP	SGP	0.020
0.004	BRN	BRN	0.006	0.015	BRN	BRN	0.010
Industry (2005)				**Industry (2015)**			
RCA_VA		RCA		RCA_VA		RCA	
1.422	BRN	BRN	1.338	3.115	BRN	BRN	1.384
1.229	VNM	MYS	1.235	2.767	VNM	VNM	1.309
1.212	IDN	VNM	1.206	2.550	IDN	MYS	1.202
1.182	MYS	IDN	1.178	2.480	MYS	IDN	1.172
1.056	THA	THA	1.099	2.090	THA	THA	1.046
0.959	PHL	PHL	0.990	1.747	PHL	PHL	0.876
0.834	SGP	SGP	0.920	1.592	KHM	KHM	0.802
0.657	KHM	KHM	0.727	1.439	SGP	SGP	0.764
Service (2005)				**Service (2015)**			
RCA_VA		RCA		RCA_VA		RCA	
1.355	SGP	SGP	1.226	3.401	SGP	SGP	1.525
1.048	PHL	PHL	1.007	2.799	PHL	PHL	1.272
0.914	THA	THA	0.817	2.141	THA	THA	0.916
0.654	MYS	IDN	0.628	1.554	KHM	KHM	0.745
0.621	IDN	MYS	0.511	1.536	MYS	IDN	0.647
0.507	KHM	KHM	0.478	1.341	IDN	MYS	0.636
0.485	VNM	VNM	0.463	0.854	VNM	VNM	0.341
0.304	BRN	BRN	0.352	0.559	BRN	BRN	0.319
Information Industry (2005)				**Information Industry (2015)**			
RCA_VA		RCA		RCA_VA		RCA	
2.860	SGP	MYS	3.663	5.304	PHL	PHL	2.669
2.703	MYS	PHL	2.421	4.440	MYS	MYS	2.583
2.251	PHL	SGP	2.377	4.347	SGP	SGP	1.890
1.488	THA	THA	1.766	2.396	THA	THA	1.244
0.642	IDN	IDN	0.670	1.253	VNM	VNM	0.749
0.292	VNM	VNM	0.290	1.152	KHM	KHM	0.531
0.271	KHM	KHM	0.247	0.717	IDN	IDN	0.352
0.074	BRN	BRN	0.064	0.159	BRN	BRN	0.073

Note: Authors' estimates based on OECD TiVA database (2018).

References

Balassa, B. (1965), Trade liberalisation and "revealed" comparative advantage 1. *The Manchester School, 33*(2), 99-123.

Barro, R. J. and J. W. Lee (2013), A new data set of educational attainment in the world, 1950–2010. *Journal of Development Economics,* 104, 184-198.

Berger, A. and D. Bruhn (2017), Vietnam's preferential trade agreements: implications for GVC participation and upgrading. In.

Bougheas, S. and R. Riezman (2013), Trade and the distribution of human capital. In *International Trade Agreements and Political Economy* (pp. 395-407): World Scientific.

Brown, A. J. (1947), *Applied Economics: Aspects of the World Economy in War and Peace, by AJ Brown*: G. Allen and Unwin.

Ceglowski, J. (2017), Assessing export competitiveness through the lens of value added. *The World Economy*, 40(2), 275-296.

Cheng, M. K. C., S. Rehman, M. D. Seneviratne and S. Zhang (2015), *Reaping the benefits from global value chains*: International Monetary Fund.

Daudin, G., C. Rifflart and D. Schweisguth (2011), Who produces for whom in the world economy? *Canadian Journal of Economics/Revue Canadienne D'économique*, 44(4), 1403-1437.

Deb, K. and W. R. Hauk (2015), RCA indices, multinational production and the Ricardian trade model. *International Economics and Economic Policy*, 14(1), 1-25. doi:10.1007/s10368-015-0317-z

Donald, S. G. and K. Lang (2007), Inference with difference-in-differences and other panel data. *The review of Economics and Statistics*, 89(2), 221-233.

Ferragina, A. M. and F. Pastore (2005), Factor Endowment and Market Size in EU-CEE Trade: Would Human Capital Change Actual Quality Trade Patterns? *Eastern European Economics*, 43(1), 5-33.

Frankel, J., E. Stein and S.-J. Wei (1995), Trading blocs and the Americas: The natural, the unnatural, and the super-natural. *Journal of Development Economics*, 47(1), 61-95.

Ghosh, S. and S. Yamarik (2004), Are regional trading arrangements trade creating?: An application of extreme bounds analysis. *Journal of International Economics*, 63(2), 369-395.

Hausman, J. A. (1978), Specification tests in econometrics. *Econometrica: Journal of the Econometric Society*, 1251-1271.

Hayakawa, K. (2007), Small sample bias properties of the system GMM estimator in dynamic panel data models. *Economics Letters*, 95(1), 32-38.

Heckscher, E. F. (1919), *The effect of foreign trade on the distribution of income*.

Hummels, D., J. Ishii and K.-M. Yi (2001), The nature and growth of vertical specialization in world trade. *Journal of International Economics*, 54(1), 75-96.

Johansson, Å. and E. Olaberria (2014), New Evidence on the Determinants of Industrial Specialisation.

Johnson, R. C. and G. Noguera (2012a), Accounting for intermediates: Production sharing and trade in value added. *Journal of International Economics*, 86(2), 224-236.

Johnson, R. C. and G. Noguera (2012b), *Fragmentation and trade in value added over four decades* (0898-2937). Retrieved from

Kojima, K. (1964), The pattern of international trade among advanced countries. *Hitotsubashi Journal of Economics*, 5(1), 16-36.

Koopman, R., W. Powers, Z. Wang and S.-J. Wei (2010), *Give credit where credit is due: Tracing value added in global production chains* (0898-2937). Retrieved from

Koopman, R., Z. Wang and S.-J. Wei (2014), Tracing value-added and double counting in gross exports. *American Economic Review*, 104(2), 459-494.

Kunimoto, K. (1977), Typology of trade intensity indices. *Hitotsubashi Journal of Economics*, 17(2), 15-32.

Moulton, B. R. (1990), An illustration of a pitfall in estimating the effects of aggregate variables on micro units. *The review of Economics and Statistics*, 334-338.

Shirotori, M., B. Tumurchudur and O. Cadot (2010), *Revealed factor intensity indices at the product level* (Vol. 44): UN.

Stehrer, R. (2012), *Trade in value added and the valued added in trade*. Retrieved from

Stock, J. H. and M. Yogo (2002), *Testing for weak instruments in linear IV regression* (0898-2937). Retrieved from

Timmer, M. P., B. Los, R. Stehrer and G. J. De Vries (2013), Fragmentation, incomes and jobs: an analysis of European competitiveness. *Economic Policy*, 28(76), 613-661.

Unel, B. (2015), Human Capital Formation and International Trade. *The B.E. Journal of Economic Analysis & Policy*, 15(3), 1067. doi:https://doi.org/10.1515/bejeap-2014-0041

Vries, G. D., N. Foster-McGregor and R. Stehrer (2012), *Value added and factors in trade: A comprehensive approach*. Retrieved from

Wooldridge, J. M. (2016), *Introductory econometrics: A modern approach*: Nelson Education.

WTO. (2016). Trade in value added and global value chains: Statistical profiles.

Yamazawa, I. (1971), Structural changes in world trade flows. *Hitotsubashi Journal of Economics*, 11(2), 11-21.