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Intra-Industry Trade and Business Cycles in East Asia[1]

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東アジアの産業内貿易と景気循環に関する研究

孟　静静

This paper investigated trade integration and its impact upon the correlations of business cycles in East Asia. The intra-industry trade shares in total trade changed in the past. Data showed that intra-industry trade has been increasing over the last two decades but the growth of the intra-industry trade shares in total trade slowed down entering into the 21st century. The intra-industry trade played a role in stabilizing bilateral trade flows during the economic turmoil times of the 1997 Asian financial crisis and the 2008 global financial crisis. Empirical evidence showed that increased intra-industry trade had a positive impact upon the correlations of business cycles among regional economies. The recent global financial crisis had a distortive effect upon the connective relationship between intra-industry trade and the correlations of business cycles.

Keywords: Intra-industry trade, correlation of business cycles, East Asia
JEL Classification: F32, F36, F41

1. Introduction

International trade has been growing remarkably in East Asia. The past decades witnessed emerging regional production networks and expanding intra-industry trade. Professor Urata has been for years making valuable contributions to this field. Urata (2008a, 2008b) showed that East Asia's exports had a higher share of parts in its intra-regional trade compared with its trade with the United States and the European Union using data over 1990–2004. He suggested that this revealed the fact that East Asia became a factory for the world and China became an increasingly important country for the location of importing parts from other East Asian economies, assembling finished products and exporting to the outside world. Intra-industry trade was thriving.

The trade boom fostered economic growth and strengthened economic linkages among the regional economies. Trade growth and economic developments have been reinforcing each other in the region. Changing economic and trade policies helped unleash domestic economic forces for individual economies and economic achievements further promoted policy innovation that helped upgrade regional

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production networks. Free Trade Agreements (FTA) began to proliferate and played an important role in facilitating regional economic integration (e.g., Urata, 2018). Economic and trade integration is to the benefit of the developments of the regional economies. East Asia as a region delivered strong growth in the 21st century and its position as the growth engine of the world economy has intensified in recent years. Further promotion of integration and policy coordination would continue to unleash economic forces in the region and help promote industrial upgrading during the ongoing Fourth Industrial Revolution.

This paper investigated the development of intra-industry trade and its impact upon the correlations of business cycles among the regional economies. Economic and monetary integration theories have suggested that the correlation of business cycles is a key indicator measuring the level of integration in a group of economies. Actual trade and monetary integration process in East Asia is admittedly full of political obstacles; nevertheless, a higher level of the synchronization of business cycles provides the foundation from an economics perspective for the claim that supports the further deepening of trade and monetary integration in the region. This paper contributes to the literature by showing empirically the positive impact of trade developments upon the correlations of business cycles based on a dataset over 1992–2013. It also compliments the existing literature on economic and trade integration.

The remainder of the paper is structured as follows. Section 2 is the literature review. Section 3 introduces methodology. Section 4 describes data. Section 5 outputs the estimation results. Section 6 concludes.

2. Literature Review

Economic and monetary integration theories have suggested that the levels of factor mobility, symmetric disturbances to output, openness of the economy, product diversification, and the extent of automatic stabilizers were associated with deepening economic integration and coordinated monetary policy (e.g., Mundell, 1961; Kenen, 1969; McKinnon, 1963). The properties of the criteria in these traditional theories were more often than not conflicting in practice. Therefore, the correlation of business cycles is often used as a comprehensive indicator by later researchers (e.g., Bayoumi & Eichengreen, 1992; Frankel & Rose, 1998; Lee & Koh, 2012; Lee & Azali, 2012).

Trade integration could have ambiguous effect on cross-country correlation of business cycles. Frankel & Rose (1998) conjectured that business cycles might become more asymmetric if closer trade ties led to *inter-industry trade* (or specialization) but, on contrary, become more correlated if *intra-industry trade* (IIT) dominated.[2] They constructed the bilateral trade intensity index and found that

[2] Grubel (1967) pragmatically defined intra-industry trade and inter-industry trade: "…because of the similarity of these products they are commonly accounted for in the same statistical 'industry' classification, and the resultant international pattern of production and trade can conveniently be described as 'intra-industry specialization' as contrasted with 'inter-industry specialization' which results when countries produce and export but do not import the output of some industries while they import but do not produce or export the output of some other industries" (p. 36).

higher levels of bilateral trade intensity were associated with more correlated business cycles using data from 21 industrialized countries. The relationship between trade integration and the correlation of business cycles in East Asia began to receive attention as the regional production networks developed quickly (e.g., Shin & Wang, 2003; Rana *et al.*, 2012).

This paper used the unit-value (UV) differentials between exported and imported goods to construct the intra-industry trade index. Abd-el-Rahman (1991) used this method to distinguish different types of trades based on the assumption that the gap between the unit value of imports and the unit value of exports for each commodity revealed the difference in the quality of products exported and imported between the two economies. This is the so-called "the threshold method" (Greenaway, Hine, and Milner, 1995; Fontagné, Freudenberg, and Péridy, 1997). Fukao, Ishido, and Ito (2003) and Ando (2006) used the method to show the drastic increase of vertical intra-industry trade in East Asia before 2000.

Recent evidence on the share of intra-industry trade versus inter-industry trade in East Asia was, however, mixed. For example, Moon & Rhee (2012) showed that the share of intra-industry trade in the region grew quickly from 1990 to 2000 but changed in different directions and varied in magnitude by comparing year 2009 data with year 2000 data based on the Grubel & Lloyd index (Grubel & Lloyd, 1971). Voices also emerged that the growth of parts and components trade in the region began to slow down. The mixed evidence on the importance of intra-industry trade in the overall trade of the region in recent years motivates this writing. This research may complement the existing literature on trade integration and economic linkages in the region.

3. Methodology

This analysis followed the threshold method to define intra-industry trade. Based on the degrees of overlap and unit value differentials, all trade transactions were separated into intra-industry trade (IIT) and inter-industry trade; intra-industry trade transactions were further separated into horizontal

Table 1 The Method to Separate Different Types of Trade

Trade types	Criteria	
	Degree of overlap	Unit value differentials
Inter-industry trade	$\frac{Min(M_{ijk}, M_{jik})}{Max(M_{ijk}, M_{jik})} \leq 0.1$	
Horizontal intra-industry trade	$\frac{Min(M_{ijk}, M_{jik})}{Max(M_{ijk}, M_{jik})} > 0.1$	$\frac{1}{1+\alpha} \leq \frac{UV_{ijk}}{UV_{jik}} \leq 1+\alpha$
Vertical intra-industry trade		$\frac{UV_{ijk}}{UV_{jik}} < \frac{1}{1+\alpha}$ *or* $\frac{UV_{ijk}}{UV_{jik}} > 1+\alpha$

Notes: M_{ijk} and M_{jik} are imports values from j to i and imports values from i to j respectively in industry k. UV_{ijk} and UV_{jik} are unit values respectively. Previous studies used different threshold values (α=15% or 25%) to differentiate horizontal intra-industry trade and vertical intra-industry trade.

Source: Adapted by the author based on table 2.5 in Fukao *et al.* (2003), p. 474.

and vertical intra-industry trade. Following previous studies, imports data were used to make calculations.

The trade intensity index of a particular trade type Z for pairs of economies i and j is:

$$Share\ of\ trade\ type\ Z = \frac{\sum_{k \in Z}(M_{ijk} + M_{jik})}{\sum_{k}(M_{ijk} + M_{jik})}$$

where Z is any of the three types of trade listed in Table 1; M_{ijk} and M_{jik} are imports values from j to i and imports from i to j respectively in industry k. Based on this equation, for example, dividing the intra-industry trade value by the total trade value between economies i and j provides us the bilateral intra-industry trade intensity variable:

$$iit_{ij} = \frac{\sum_{k \in Z^*}(M_{ijk} + M_{jik})}{\sum_{k}(M_{ijk} + M_{jik})} where\ Z^* = \left\{ z \in Z^* \middle| \frac{Min(M_{ijz}, M_{jiz})}{Max(M_{ijz}, M_{jiz})} > 0.1 \right\}.$$

Following a similar way of thinking, the variables of the shares of horizontal and vertical intra-industry trade in bilateral intra-industry trade can be constructed. The vertical intra-industry intensity variable between economies i and j can be obtained by dividing the vertical intra-industry trade (*VIIT*) value by the bilateral intra-industry trade value:

$$viit_{ij}\left(Share\ of\ VIIT\ in\ IIT\right) = \frac{\sum_{k \in Z_1^*}(M_{ijk} + M_{jik})}{\sum_{k \in Z^*}(M_{ijk} + M_{jik})}$$

where the intra-industry trade set Z^* is already defined and the vertical intra-industry set is $Z_1^* = \{z \in Z_1^* | either\ (Min(M_{ijz}, M_{jiz})/Max(M_{ijz}, M_{jiz})) > 0.1\ and\ (UV_{ijz}/UV_{jiz}) < 1/(1+\alpha),\ or\ (Min(M_{ijz}, M_{jiz})/Max(M_{ijz}, M_{jiz})) > 0.1\ and\ (UV_{ijz}/UV_{jiz}) > 1+\alpha\}$. According to these definitions, the sum of the shares of the horizontal and vertical intra-industry trade in IIT is 1.

Aside from the above variables, a bilateral trade intensity variable (Frankel & Rose, 1998) was also tested in estimation. Trade intensity between economies i and j is:

$$ti_{ij} = \frac{M_{ij} + M_{ji}}{X_i + M_i + X_j + M_j}$$

where X_i denotes the total export of economy i to the world and M_i the total import of economy i from the world; X_j and M_j are the respective exports and imports of economy j.

For the dependent variable, pairwise correlation coefficients were calculated based on the log real GDP data.

4. Data

The dataset includes trade and economic growth data of a number of East Asian economies: China mainland, Indonesia, Japan, South Korea, Malaysia, the Philippines, Singapore, and Thailand. As for the trade variables, data are taken from the United Nations *Comtrade* database (at 3-digit level, SITC Rev. 3). Annual data ranges from 1992 to 2013. Annual trade intensity indices were calculated from the raw data. For the economic growth variable, the nominal GDP data and GDP deflator data are taken from the IMF's *International Financial Statistics* database and National Bureau of Statistics of China. Quarterly data ranges from 1992Q1 to 2014Q3. The real GDP data is by deflating the nominal GDP data using the GDP deflator indices. The logarithm form of the real gross domestic product is used. Trade and economic growth data are missing for some pairs of economies in some years. Table 2 presents a data summary.

The total volume of intra-industry trade and regional trade has been increasing quickly in East Asia over the last two decades. To examine the changes of intra-industry trade shares, Figures 1 and 2 depict the values of IIT shares in total trade and VIIT shares in IIT in different sub-periods over 1992–2013. The four time periods include: 1992–1996 (a quickly developing time for the region before the Asian financial crisis), 1997–2001 (a time period when the regional economies were struggling with the Asian financial crisis), 2002–2006 (another quickly developing time for the region between the regional financial crisis and the global financial crisis), 2007–2013 (a time period when the global financial crisis depressed the world economy).

Figure 1 depicts the mean values of annual numbers in different time periods. The annual numbers were the weighted averages of the IIT shares in total trade for pairs of economies, using the bilateral trade shares in total regional trade as the weights. The figure shows that the intra-industry trade share in total regional trade has been increasing steadily. The vertical intra-industry trade share in intra-industry trade decreased slightly, suggesting that the unit value differentials of a larger share of traded goods decreased to levels below thresholds throughout the time.

Table 2 Summary Statistics

Variables	Obs.	Mean	Std. Dev.	Min	Max	Description
Bilateral trade value	1,126	1.5E+10	3.6E+10	7835	3.8E+11	US$
IIT value	1,126	9.1E+09	2.4E+10	0	2.4E+11	US$
VIIT value (25% threshold)	1,126	2.8E+09	7.2E+09	0	8.4E+10	US$
VIIT value (15% threshold)	1,125	3.2E+09	8.0E+09	0	9.2E+10	US$
Bilateral trade share	1,126	1.3	1.6	0	8.8	Percentage
IIT share in total trade	1,126	34.1	28.5	0	91.3	Percentage
VIIT share in total trade (25% threshold)	1,126	11.4	11.2	0	61.5	Percentage
VIIT share in total trade (15% threshold)	1,126	12.9	12.3	0	63.5	Percentage
VIIT share in total IIT (25% threshold)	1,099	39.6	25.8	0	100	Percentage
VIIT share in total IIT (15% threshold)	1,099	43.3	26.2	0	100	Percentage
Correlation of log real GDP	586	0.5	0.6	− 1.0	1.0	[− 1, 1]

Notes: IIT is the abbreviation of intra-industry trade. VIIT is the abbreviation of vertical intra-industry trade.
Source: Author's calculations.

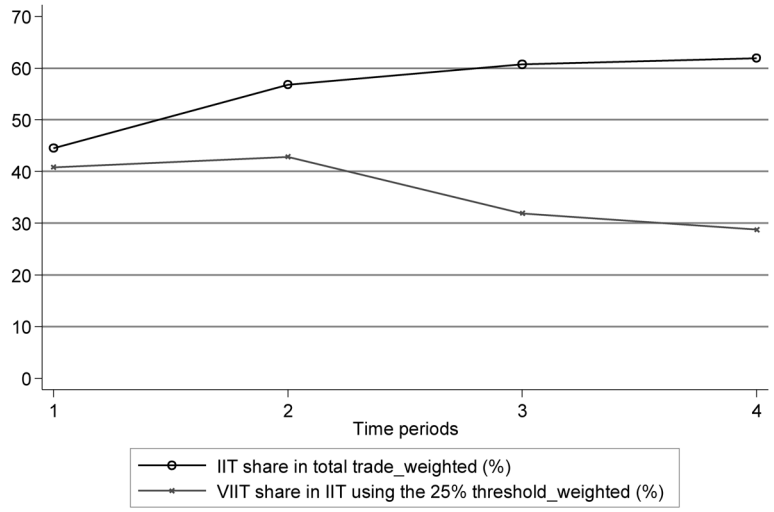

Figure 1 Intra-Industry Trade and Vertical Intra-Industry Trade Shares (%) in Different Time Periods over 1992–2013, Weighted Averages

Notes: For the horizontal axis, the four sub-periods are as follows: (i) from 1992 to 1996; (ii) from 1997 to 2001; (iii) from 2002 to 2006; (iv) from 2007 to 2013. The figure depicts the mean values of annual numbers in different time periods. The annual numbers were the weighted averages of the IIT shares in total trade for pairs of economies, using the bilateral trade shares in total regional trade as the weights. IIT is the abbreviation of intra-industry trade. VIIT is the abbreviation of vertical intra-industry trade.

Source: Author's calculations.

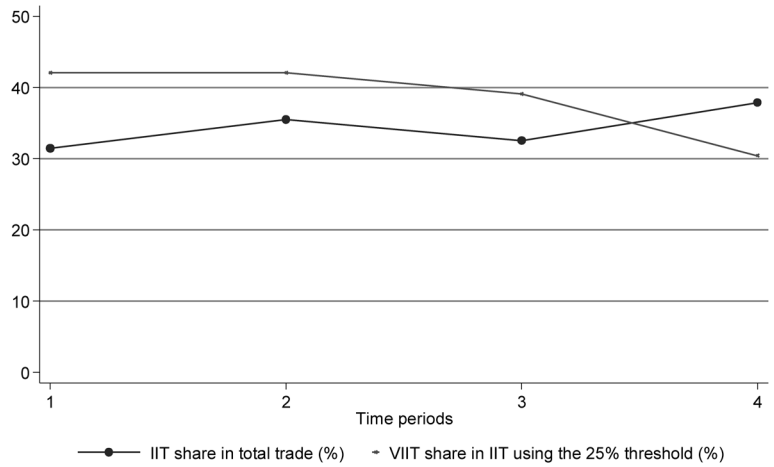

Figure 2 Intra-Industry Trade and Vertical Intra-Industry Trade Shares (%) in Different Time Periods over 1992–2013, Simple Averages

Notes: For the horizontal axis, the four sub-periods are as follows: (i) from 1992 to 1996; (ii) from 1997 to 2001; (iii) from 2002 to 2006; (iv) from 2007 to 2013. The figure depicts the mean values of annual numbers in different time periods. The annual numbers were the simple averages of the IIT shares in total trade for pairs of economies. IIT is the abbreviation of intra-industry trade. VIIT is the abbreviation of vertical intra-industry trade.

Source: Author's calculations.

Figure 2 shows the mean values of annual numbers in different time periods; different from the previous figure, the annual numbers in Figure 2 were the simple averages of IIT shares in total trade for pairs of economies. The figure highlights a bilateral perspective. It shows that the intra-industry trade has become a force in stabilizing bilateral trade flows inside the region during hard crises time. East Asian economies prospered during 1992–1996 and 2002–2006 but economic and trade growths were temporarily under pressure during the two crises. The average intra-industry shares in total trade were slightly higher during the regional and global crises times. The vertical intra-industry trade share in intra-industry trade was gradually falling.

5. Estimation

Intra-industry trade supported a large quantity of firms surviving in the same or similar industries. The production activities of these firms became an integrated part of the regional economy and were subjected to shocks at the industry level. Real business cycles theories have suggested that intra-industry trade variables captured the demand side of shocks to economies. Intra-industry trade attracted similar investments and had spillover effects by generating more employment and consumption in different economies. The learning-by-doing mechanism common in the developing economies might also strengthen the synchronization effect. The development of intra-industry trade affected the correlations of business cycles among the regional economies.

Apart from trade-led shocks, other shocks also affected the business cycles. During the Asian financial crisis and the global financial crisis, different degrees of financial instability frustrated investment decisions and consumer confidence, which might distort the connective relationship between the intra-industry trade and the correlations of business cycles.

Our simple OLS estimating equation is:

$$\begin{aligned} Corr_{ij\tau} = {} & \alpha + \beta_1 iit_{ij\tau} + \beta_2 (iit_{ij\tau} * Dummy_{regional}) + \beta_3 (iit_{ij\tau} * Dummy_{global}) + \beta_4 viit_{ij\tau} \\ & + \beta_5 (viit_{ij\tau} * Dummy_{regional}) + \beta_6 (viit_{ij\tau} * Dummy_{global}) + \beta_7 Dummy_{regional} \\ & + \beta_8 Dummy_{global} + \boldsymbol{\gamma} \boldsymbol{X}_{ij\tau} + \varepsilon_{ij\tau} \end{aligned} \quad (1)$$

where $corr_{ij\tau}$ is the correlation of business cycles between economies i and j over time span τ; iit_{ijt} is the intra-industry trade intensity; $viit_{ijt}$ is the vertical intra-industry trade intensity; the dummy variables include the Asian financial crisis dummy variable, $Dummy_{regional}$, to account for the regional shock over 1997–2001 and the global financial crisis dummy variable, $Dummy_{global}$, to account for the global economic shock over 2007–2013; $\boldsymbol{X}_{ij\tau}$ is a vector variable including other influencing variables; $\varepsilon_{ij\tau}$ is the error term.

In order to control for the unobserved characteristics that affect the dependent variable, this analysis used the fixed-effects (FE) model and the random effects (RE) model. The simple equation for the fixed-effects model is: $Y_{it} = \boldsymbol{\beta} \boldsymbol{X}_{it} + \alpha_i + \varepsilon_{it}$, where $\boldsymbol{\beta}$ is $1 \times n$ matrix, $\boldsymbol{X}_{it}$ is $n \times 1$ matrix, α_i denotes the

fixed effects for each group of observations, and ε_{it} is the error term. The equation for the random-effects model is: $Y_{it} = \alpha + \boldsymbol{\beta}\boldsymbol{X}_{\text{it}} + u_{it} + \varepsilon_{it}$, where $\boldsymbol{\beta}$ is $1 \times n$ matrix, $\boldsymbol{X}_{it}$ is $n \times 1$ matrix, u_{it} is the between-group error term which is assumed to be uncorrelated with regressors X_{it}, and ε_{it} is the within-group error term. The Hausman tests were conducted.

Table 3 shows the results. Three pairs of regressions were listed in the table. The first pair of regressions only examined the impact of the intra-industry trade variable. The *iit* variables were statistically and economically significant: An increase of the intra-industry trade share in total bilateral trade tends to increase the correlation of business cycles. The impacts of the global financial crisis dummy variables were statistically significant; the coefficients of the dummy variables and the interactive terms

Table 3 Regression Results

	Dependent variable: Correlations of log real GDP					
	(1)		(2)		(3) Robust	
	FE	RE	FE	RE	FE	RE
iit	0.005 (2.59)***	0.006 (4.24)***	0.005 (2.77)***	0.007 (4.64)***	0.005 (3.4)***	0.007 (5.08)***
viit			0.002 (1.06)	0.002 (1.61)	0.002 (1.47)	0.002 (2.27)**
$iit^{*}Dummy_{regional}$	0.002 (0.53)	0.001 (0.4)	0.000 (−0.05)	−0.001 (−0.27)	−0.000 (−0.05)	−0.001 (−0.29)
$iit^{*}Dummy_{global}$	−0.009 (−4.78)***	−0.008 (−4.7)***	−0.009 (−4.86)***	−0.009 (−4.7)***	−0.009 (−5.23)***	−0.008 (−4.99)***
$viit^{*}Dummy_{regional}$			−0.005 (−1.86)*	−0.006 (−2.2)**	−0.005 (−2.07)**	−0.006 (−2.39)**
$viit^{*}Dummy_{global}$			−0.002 (−0.69)	−0.001 (−0.34)	−0.002 (−0.87)	−0.001 (−0.47)
$Dummy_{regional}$	−0.395 (−2.37)**	−0.378 (−2.33)**	−0.089 (−0.37)	−0.027 (−0.12)	−0.089 (−0.39)	−0.027 (−0.12)
$Dummy_{global}$	0.263 (2.6)***	0.246 (2.46)**	0.354 (2.38)**	0.306 (2.08)**	0.354 (2.38)**	0.306 (2.14)**
_cons	0.369 (4.2)***	0.297 (3.97)***	0.283 (2.35)**	0.179 (1.76)*	0.283 (3.13)***	0.179 (1.88)*
Rho	0.362	0.303	0.356	0.264	0.356	
Obs.	586	586	584	584	584	584
Groups	45	45	45	45	45	45
Obs. per group	Min = 3 Avg = 13 Max = 22	Min = 3 Avg = 13 Max = 22	Min = 2 Avg = 13 Max = 22	Min = 2 Avg = 13 Max = 22	Min = 2 Avg = 13 Max = 22	Min = 2 Avg = 13 Max = 22
Prob>F	0.000		0.000		0.000	
$Prob>chi^2$		0.000		0.000		0.000
Hausman tests	Prob > chi^2 = 0.605		Prob > chi^2 = 0.347			

Notes: *t* statistics (FE) or *z* statisitcs (RE) in parentheses. *Rho* statistics indicate the fraction of variance due to difference between groups. ***Significant at the 1 percent level. **Significant at the 5 percent level. *Significant at the 10 percent level.
Source: Author's calculations.

were both statistically significant. The signs of the global financial crisis dummies were positive but the interactive terms with the *iit* variables were negative, which suggested that the global financial crisis disrupted the positive connection between the intra-industry trade variable and the dependent variable in spite of the fact that the global crisis provided common demand shocks. The regional financial crisis variables themselves were also economically and statistically significant but the interactive terms were not. The signs of the regional financial crisis dummies were negative. The regional economies performed differently during the Asian financial crisis; a number of economies such as Thailand and Indonesia were hit while other economies such as China and Japan were not severely affected. The sources of the performance divergence rooted inside the region, including differences in capital liquidity, financial fragility and macro-prudential policies.

The other two pairs of regressions included the vertical intra-industry trade variables. The Hausman tests showed that the random-effects models could not be rejected in the second group of regressions. The coefficient of the vertical intra-industry trade variable was statistically significant after controlling for heteroskedasticity in the third group of regressions using the random-effects method; however, its impact was economically limited. The interactive terms of the vertical intra-industry trade variables and regional financial crisis variables were also economically minimal. Adding the vertical intra-industry trade variables did not change the signs or significance of the intra-industry trade variables. Changing the thresholds from 25% to 15% to measure the vertical intra-industry trade variable does not change the results much.

Our empirical analysis showed that intra-industry trade had a positive impact upon the correlations of business cycles. The impact of the vertical intra-industry trade shares in intra-industry trade was only economically and statistically limited. The recent global financial crisis had a strong impact. The bilateral trade share variable, *ti*, was also tested but was not significant.

6. Conclusion

Trade integration has deeply changed the regional economic landscape. Intra-industry trade has been increasing over the last two decades. Together with globalization and reforms, trade expansion contributed to economic developments of the regional economies. The growing trade gave incentives to foreign direct investments in the region; individual economies absorbed technology and managerial know-how during the process. The increased intra-industry trade strengthened the correlations of business cycles among the regional economies. It also played a role in stabilizing bilateral trade flows during the economic turmoil times of the Asian financial crisis and the recent global financial crisis.

The increase of the intra-industry trade shares in total trade slowed down quickly recently. Whether the upgrading of the regional production networks could continue to be the pulling force of the regional economy in the era of the Fourth Industrial Revolution became a question. The globalization process had setbacks in the past two years at the international level; the threat of protectionism cast a shadow upon the economic prospect of the world. Trade frictions both at the regional and global levels

attracted much attention. To further remove cross-border economic and trade hurdles is to the benefit of the developments of the regional economies.

East Asia is still one of the fastest growing regions around the world. Nevertheless, the future prosperity of the regional economy relies heavily upon wise policies from individual nations. To further promote economic and trade integration is essential for East Asia.

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