Catalyst of Business Cycle Synchronization in East Asia: Internal or External?

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Abstract

The essential question this paper seeks to answer is whether the business cycle co-movement in East Asia are fostered by internal bilateral trade within the region, specifically, intra-industry trade or by external forces like the influence of the world's largest economy, namely, the United States. This paper examines the extent and robustness of the relationship between trade intensity and business cycle synchronization for nine East Asian countries in the period 1965-2008. Unlike previous studies which assume away the region's concurrent connection with the rest of the world, in our regressions we control for both the US effect and the exchange rate policy coordination in the region. We find that the coefficient estimates for intra-industry trade intensity remain robust and significant even after controlling for the US effect and the exchange rate coordination. The findings confirm that regional intra-industry trade fosters business cycle correlations among countries in East Asia.

JEL Classification: F32, F36, F41

Keywords: Business cycle co-movements; Trade integration; Inter-industry trade; Intra-industry trade

1. Introduction

Learning from the lessons of the Asian financial crisis and the experience of the European Monetary Union, many East Asian countries have been endeavouring to reduce financial risk and to promote regional monetary cooperation[1]. The benefits of higher degree of monetary integration and coordination, specifically the formation of a currency union, are widely known since the pioneering work of Mundell (1961), McKinnon (1963) and Kenen (1969). While such arrangements may facilitate trade flows among their members and promote regional stability, the cost of relinquishing an independent monetary policy can be significant when member countries are exposed to very asymmetric business cycles and shocks. Mundell, McKinnon and Kenen develop a set of criteria for an optimal currency area. One of them is the degree of business cycle synchronization among members. If business cycles are not synchronized among member countries, possibly as a result of asymmetric shocks or differences in the transmission of common shocks due to difference in fundamental economic structures and policies, the formation of a currency union could be costly. As a result, in the process of identifying potential members for higher degree of monetary integration and coordination, understanding the extents and patterns of their business cycle co-movements is of tremendous importance.

Factors determining the correlation between the business cycles of different countries include the degree of trade integration (Frankel and Rose, 1998), similarity in industrial structure (Imbs, 1998, 1999 and 2003) and currency unions (Rose and Engel, 2000). Other economic variables include similarity in export and import baskets, factor endowments, distance between countries and common languages. Among all, much effort has gone into predicting the impact of greater trade integration has on business cycle synchronization. One might expect that closer trade links would lead to more synchronized business cycles. However, theoretically this relationship is ambiguous as the effect of trade integration could result in either a more or a less converged business cycle synchronization. As trade integration increases, if demand shocks are dominating and intra-industry trade is more pervasive, business cycle will be more converged (Frankel and Rose, 1998). On the other hand, if industry-specific shocks are dominating and

[1] Recent notable initiatives to promote regional stability and monetary policy cooperation in East Asia include the establishment of the Chiang Mai Initiative (CMI) and the Asian Bond Market Initiative (ABMI). The CMI is a multilateral currency swap arrangement among ASEAN+3. Drawing from a foreign exchange reserves pool worth US$120 billion, the CMI aims to create a regional liquidity support system to manage regional short-term liquidity problems and to supplement the existing international financial arrangements. The ABMI, on the other hand, is design to integrate regional financial markets. Japanese government has contributed to the ABMI as issuances of and guarantee provisions for the bonds denominated in Asian local currencies.

inter-industry trade is deeper due to more specialization in production, business cycle will be less converged (Kenen, 1969 and Krugman, 1993). For instance, suppose that country *i* and country *j* specialize in same industry, say industry *A*, but at different steps of a production process, then a negative demand shock that hits country *i* will also hit country *j* adversely. However, suppose that country *i* specializes in industry *A* while country *j* specializes in industry *B*, then any specific depressive effects on industry *A* will be localized to country *i*. The total effect of trade integration on business cycle synchronization is thus far theoretically ambiguous.

The ambiguity in the economic theory on this matter has made this an essentially empirical matter. This paper focuses on the impact of trade intensity on business cycle correlations among nine East Asian countries for the period of 1965-2008. These economies are the original five members of ASEAN (Indonesia, Malaysia, Philippines, Singapore and Thailand), the two Asian newly industrialized economies (Korea and Hong Kong), the two largest economies in the region (Japan and China). However, unlike many previous studies which quietly assume away the potential of larger but more distant economies such as the United States in affecting the output fluctuation of domestic economy, we specifically raise the question of whether the increased in business cycle correlations among East Asian countries is internally driven, due to higher intra-regional trade, or externally induced because of reaction to disturbances in the US economy. Put it differently, suppose trade intensity of two countries in the region is increasing and at the same time the outputs of these two countries are also correlated to the output of the US economy, ignoring the potential influence of the US economy on these two countries could possibly amplify the impact of trade intensity on business cycle synchronization between the two countries.

Our paper extends the literature by dealing with three issues that are important in the literature of trade and business cycle synchronization. First, we apply a model which includes a larger set of explanatory variables of business cycle synchronization than examined in the previous studies (Cortinhas, 2007 and Shin and Wang, 2004). Besides taking into consideration all explanatory variables, such as trade intensity and intra-industry trade at various digits, we also include explanatory variables that accounts for US effect and exchange rate policy coordination. Second, to ensure reliable inference, following Inklaar et al. (2008), we transform the dependent variables i.e. correlation coefficients so that the transformed correlations are normally distributed. Finally, as a robustness check, we construct six proxies for bilateral trade intensity and include each of them separately in the regression model. These include two proxies where total trade between two countries are scaled by total trade and total GDP as in Frankel and Rose (1998), two proxies where the product of total trade or total GDP of the two countries concerned is used as scaling factor as in Clark and van Wincoop (2001), and two other proxies where the maximum of $\frac{x_{ijt}+m_{ijt}}{X_{it}+M_{it}}$ or $\frac{x_{ijt}+m_{ijt}}{X_{jt}+M_{jt}}$ and the maximum of $\frac{x_{ijt}+m_{ijt}}{Y_{it}}$ or $\frac{x_{ijt}+m_{ijt}}{Y_{jt}}$ are taken.

Our main findings are as follows. Trade intensity in East Asia is found to affect business cycle synchronization even after taken into account the potential US effect on these countries. We also find that besides the intensity of trade, distance, common language and border are important contributory factors of business cycle synchronization.

The remainder of the paper is organized as follows. Section 2 presents our econometric methodology and Section 3 provides data description. Section 4 analyzes the estimation results and discusses the economic relevance of our findings. Section 5 offers some concluding comments.

2. Econometric Methodology

2.1 Baseline model

The baseline estimation approach follows the regression model of Shin and Wang (2004). We examine the impact of bilateral trade intensity (*ti*) and intra-industry trade intensity (*iit*) on business cycle co-movements. The dependent variable in the regression model is the bivariate correlation between filtered GDP. Theoretically, trade intensity has ambiguous but indisputable effect on the co-movement of output. On the one hand, as trade integration increases, if demand shocks are dominating and intra-industry trade is more pervasive, business cycle will be more converged (Frankel and Rose, 1998). On the other hand, if industry-specific shocks are dominating and inter-industry trade is deeper due to more specialization in production, business cycle will be less converged (Kenen, 1969 and Krugman, 1993). As the intra-industry trade plays a specific role out of trade intensity in affecting the business cycle co-movements, the intra-industry trade intensity is also included in our framework. Therefore, the baseline model is as follows:

$$\rho_{ij\tau}=\alpha_0+\alpha_1 ti_{ij\tau}+\alpha_2 iit_{ij\tau}+\epsilon_{ij\tau}, \qquad (1)$$

where $\rho_{ij\tau}$ refers to correlation of output between country *i* and country *j* of the nine Asian countries during period τ, and $ti_{ij\tau}$ is their bilateral trade intensity, $iit_{ij\tau}$ is a variable representing intra-industry trade intensity and $\epsilon_{ij\tau}$ is the error term.

2.2 The role of exchange rate policy coordination

Given the comparable investment and consumption behaviors in East Asia, convergence of exchange rate policies could influence economic decisions in investment and consumption in similar manners, which would probably in turn precipitate business cycle synchronizations. Therefore, it is reasonable to take into account the regional exchange rate policy coordination as a control variable to improve the robustness of our model. Specifically, a variable $sigma\_e_{ij\tau}$ is added to control the effects of exchange rate policy coordination in our extended model. It is the normalized standard derivation of the exchange rate between country *i* and country *j* during period τ, defined as:

$$\mathrm{sigma\_e}_{ij\tau}=\frac{\mathrm{std}\{e_{ijt}\}_{t\in\tau}}{\mathrm{mean}\{e_{ijt}\}_{t\in\tau}},$$

where e_{ijt} is the nominal exchange rate between country *i* and country *j* at time *t*. With this control variable added, we estimate the following extended regression:

$$\rho_{ij\tau}=\alpha_0+\alpha_1 ti_{ij\tau}+\alpha_2 iit_{ij\tau}+\alpha_3\ \mathrm{sigma\_e}_{ij\tau}+\epsilon_{ij\tau}, \tag{2}$$

2.2 The US effects

Of key importance to policymakers is the reaction of domestic economy to disturbance not only from economies with close geographic proximity but also larger but perhaps more distant economies such as the United States. Therefore, estimating the impact of trade intensity on business cycle co-movement in East Asia only by taking into consideration the intra-regional effects, shielding the region's concurrent connection with the rest of the world could potentially overestimate the impact of trade on business cycle synchronization. As a result, the essential question this paper seeks to answer is that whether the business cycle co-movement in East Asia are fostered just by the internal bilateral trade, specifically, intra-industry trade or by external forces like the influence of the world's largest economy, namely, the United States. Specifically, it is expected that US's relative intimate correlation with one country leaving the other one out in the cold, would have a negative effect on the underlying business cycle co-movement in East Asia . To test the hypothesis, our extended model with the US effect as a control variable to represent the influence from the rest of the world on the business cycle co-movements in East Asia is the following:

$$\rho_{ij\tau}=\alpha_0+\alpha_1 ti_{ij\tau}+\alpha_2 iit_{ij\tau}+\alpha_3\ \mathrm{sigma\_e}_{ij\tau}+\alpha_4 \mathrm{corr}_\tau(i,us)+\alpha_5 \mathrm{corr}_\tau(j,us)+\epsilon_{ij\tau} \tag{3}$$

2.3 Endogeneity concerns

It brings to our attention that the ordinary least square estimates for trade intensity variable might be biased or inconsistent because the association between trade intensity and business cycle correlation could be due to reverse causality. In other words, trade intensity may be explained by output correlation, or both variables are explained by a third variable, such as monetary or fiscal policy coordination, which is omitted from the model. To tackle this problem, a two-stage least square regression is employed, in which four other variables that may pick up similarity between economies are used as instruments. First, a distance variable between country *i* and *j* is included in the model as geographic proximity may proxy for structural similarity. Second, a dummy variable of 0 or 1 indicating the two countries' geographical adjacency is used as an explanatory of business cycle correlation. Third, a dummy variable indicating whether or not the two countries share at least one common official language is used. Finally, a variable indicating the geographical remoteness for countries *i* and *j* that measures how far each country lies from alternative trading partners is also considered. Based on Wei (1996) and Deardorff (2005), we specify the following regression for bilateral trade:

$$ti_{ij\tau}=\beta_0+\beta_1\ln(dist_{ij})+\beta_2 B_{ij}+\beta_3 L_{ij}+\beta_4\ln(GDP_{i\tau})+\beta_5\ln(GDP_{j\tau})+\beta_6\ln(rem_{i\tau})+\beta_7\ln(rem_{j\tau})+Z_\tau'\theta+\epsilon_{ij\tau}, \quad (4)$$

where $ln(dist_{ij})$ is the distance between countries *i* and *j* (in logs), B_{ij} is a dummy variable equal to one for countries that share a common border, L_{ij} is a dummy variable equal to one for countries that share at least one common official language, and $rem_{i\tau}$ and $rem_{j\tau}$ are indicators of geographical remoteness for countries *i* and *j* that measures how far each country lies from alternative trading partners, respectively. For country *i*, $rem_{i\tau}$ is defined as:

$$rem_{i\tau}=\frac{1}{y_w}\sum_{k\neq j} dist_{ik}\, y_k,$$

where y_k and y_w are the nominal GDP of country *k* and the world, respectively. We expect that bilateral trade between countries *i* and *j* will increase if their outputs increase, if they are closer in distance, and if they share a common border or language. Finally, the matrix *Z* comprises other variables that are used in the empirical literature of the gravity equation model of trade. Here, we include other standard controls in this paper such as the area and recent population in countries *i* and *j*, dummies for common colonial origin, and ASEAN countries. In addition, all the other variables used in the second stage regression are added into the independent variable list in the first stage regression.

3. Data Description

Three sets of data are collected to measure output co-movements, trade intensity and intra-industry trade intensity.

3.1 Output co-movements

We examine the evidence on GDP correlations in nine countries in East Asia and the United States over the period of 1965-2008. The sample includes the original five members of ASEAN (Indonesia, Malaysia, Philippines, Singapore and Thailand), the two Asian newly industrialized economies (Korea and Hong Kong), the two largest economies in the region (Japan and China). The dependent variable in the regressions models is the bivariate correlation between filtered GDP. All the GDP data are drawn from the IMF International Financial Statistics. Artis and Zhang (1997) and Calderón et al. (2007) conclude that the choice of filtering method to decompose business cycles into trends and cycles does not after their conclusion. Likewise Massmann and Mitchell (2004), who consider the largest number of business cycle measures, also report substantive similarities across alternative measures of business cycles. Crosby (2003) also shows that Hodrick-Prescott filter and first differenced correlations are highly correlated. Hence, at the first step, to avoid complexity the simple unconditional correlation coefficient of the first difference of logarithm of real GDP series is used as our measure of bilateral business cycle synchronization.

[Insert Figure 1 here]

Figure 1 plots the 11-year moving average of the correlation coefficients among 9 East Asian (solid line) and between these 9 East Asian countries and the United States (dotted line). While output co-movement among East Asian countries does not seem to be caused by the US effects, the figure shows that average bilateral business cycle correlation among East Asian was fluctuating around 0.05 and 0.4 before the Asian financial crisis, but jumped abruptly to 0.6 after the Asian financial crisis and stabilized around 0.8. This provides a reasonable ground to split the sample into four sub-periods of equal length of 11 years, 1965-1975, 1975-1986, 1987-1997 and 1998-2008 leaving us with a maximum of 144 observations (9×8/2×4). This also allows us to access time-series changes in trade patterns and business cycles correlations. Nonetheless, since a Pearson's correlation coefficient is bounded at -1 and 1, the error terms in the regression model are unlikely to be normally distributed if the unconditional simple correlation coefficients are used. This issue, however, with very few exceptions, is not tactfully treated in many previous studies and hence complicates reliable inference. In our panel regression, following Inklaar et al. (2008), Fisher's z-transformations of the correlation coefficients are employed as the dependent variable instead. The transformed correlation coefficients are calculated based on the following:

$$\text{trans\_}\rho=\frac{1}{2}\ln\left(\frac{1+\rho}{1-\rho}\right),$$

where ρ is the pair-wise correlation coefficient for each country pair. The transformed correlations indeed do not suffer from this problem, since the transformation ensures that they are normally distributed (David, 1949). Fig. 2(a), showing histogram of the untransformed correlation coefficients, suggests that it is necessary to transform the dependent variable, while Fig. 2(b) shows that the transformed correlation coefficients are much closer to being normally distributed.

[Insert Figure 2 here]

3.2 Bilateral trade intensity measures

Data on bilateral trade volume and each country's total global trade volume are retrieved from the United Nations Commodity Trade Statistics Database (UN Comtrade). In spite of overall strength, many studies use different but imperfect proxies for trade intensity and usually do not justify explicitly the choice of proxies used. Therefore, in our regression models, we construct six most popular proxies for bilateral trade intensity: $ti1_{ij\tau}$, $ti2_{ij\tau}$, $ti3_{ij\tau}$, $ti4_{ij\tau}$, $ti5_{ij\tau}$, and $ti6_{ij\tau}$. Here, $ti1_{ij\tau}$ and $ti4_{ij\tau}$ are total trade between two countries scaled by total trade and total GDP, respectively. Following Otto et al. (2001), $ti5_{ij\tau}$ is developed. It takes the maximum of $\sum_t \frac{x_{ijt}+m_{ijt}}{Y_{it}}$ and $\sum_t \frac{x_{ijt}+m_{ijt}}{Y_{jt}}$, arguing that what matters is whether or not at least one country is exposed to the other. Similarly, $ti2_{ij\tau}$ is developed and normalized using trade volume. Finally, instead of using the sum of trade or GDP of the two countries as scaling factor, some authors prefer scaling by the product of GDP or trade of the two countries concerned (see, for instance, Clark and van Wincoop, 2001) as this indicator is not size-dependent. This yields $ti3_{ij\tau}$ and $ti6_{ij\tau}$. The six intensity measures are summarized as follows:

$$ti1_\tau = \frac{1}{|\tau|}\sum_{t\in\tau}\frac{x_{ijt}+m_{ijt}}{X_{it}+M_{it}+X_{jt}+M_{jt}},$$

$$ti2_\tau = \frac{1}{|\tau|}\sum_{t\in\tau}\max\left\{\frac{x_{ijt}+m_{ijt}}{X_{it}+M_{it}},\frac{x_{ijt}+m_{ijt}}{X_{jt}+M_{jt}}\right\},$$

$$ti3_\tau = \frac{1}{|\tau|}\sum_{t\in\tau}\frac{x_{ijt}+m_{ijt}}{(X_{it}+M_{it})\times(X_{jt}+M_{jt})},$$

$$ti4_\tau = \frac{1}{|\tau|}\sum_{t\in\tau}\frac{x_{ijt}+m_{ijt}}{Y_{it}+Y_{jt}},$$

$$ti5_\tau = \frac{1}{|\tau|}\sum_{t\in\tau}\max\left\{\frac{x_{ijt}+m_{ijt}}{Y_{it}},\frac{x_{ijt}+m_{ijt}}{Y_{jt}}\right\},$$

$$ti6_\tau = \frac{1}{|\tau|}\sum_{t\in\tau}\frac{x_{ijt}+m_{ijt}}{Y_{it}\times Y_{jt}},$$

where x_{ijt} denotes total nominal exports from country i to country j during year t, m_{ijt} denotes the total nominal imports from country i to country j during year t; X_{it}, X_{jt}, M_{it}, and M_{it} denote total global exports and imports for the corresponding country; and $|\tau|$ is the length of the each period which is 11 years. It is noted that for each country pair, the trade data reported by the country with larger GDP is used.

3.3 Intra-trade intensity measures

The industry-level trade data are retrieved from the United Nations Commodity Trade Statistics Database (UNComtrade). The UNComtrade database provides bilateral trade flows, by partner, at the industry level. The sector disaggregation in the database follows the Standard Industrial Trade Classification (SITC) and is provided at the three and four-digit level. A measure of intra-industry trade intensity is derived from Grubel and Lloyd (1975). The constructed measure is:

$$\mathrm{iit}_{ij\tau} = \frac{1}{T}\sum_{t}\left\{1 - \frac{\sum_k \left|x_{ijt}^k - m_{ijt}^k\right|}{\sum_k\left(x_{ijt}^k + m_{ijt}^k\right)}\right\},$$

where $x_{ij\tau}^k$ denotes total nominal exports of industry *k* from country *i* to country *j* during year *t*, $m_{ij\tau}^k$ the total nominal imports of industry *k* by country *i* from country *j* during year *t*. Depending on how an industry is classified, we construct two measures of intra-industry trade intensity: *iit3* at three-digit level and *iit4* at four-digit level. It could be seen that as the industries are further disaggregated, the portion of intra-industry trade shrinks and eventually goes to nil, thus the values of *iit* get larger and approach one. Hence, it is expected that *iit3* is larger than *iit4*.

3.4 11-year moving average of transformed output correlations, trade intensity and intra-industry trade intensity

After constructing all the measures of transformed output correlations, trade intensity and intra-industry trade intensity, we plot the 11-year moving average values of them in Figs. 3(a)-(d). It is noted that there are strong correlations between the different measures of trade intensity. All trade intensity measures, except *ti3* and *ti6*, are strong correlated. All other measures such as transformed output correlation, trade intensity measures and intra-industry trade intensity measures show an appreciable upward trend. This suggests that using the product of total trade volumes i.e. ti3 and the product of outputs i.e. ti6 to normalized bilateral trade is not appropriate. As a result, we drop these two measures in our subsequent analysis.

[Insert Figure 3 here]

4. Empirical Findings

To begin with, the panel regression parsimoniously with only either trade intensity or intra-trade intensity as a single variable is presented in Table 1. Tables 1(a) and 1(b) report results for the panel regression with country pair specific fixed effects and random effects, respectively. It is found that when only trade intensity is used as an explanatory variable, not all the coefficient estimates are significant and not all of the coefficient estimates have the uniform sign. For this sample of countries, the sign of the trade coefficient does vary across specifications, but the statistical insignificance of trade appears to be very robust. However, when only intra-industry trade intensity is used, the signs of the coefficient estimates are consistent and are significant at 1 percent level for the specification at iit3 and iit4. This implies that more intra-industry trade leads more output synchronization in the region. Most empirical evidence to date seems to be consistent with this possibility. Also, to investigate whether random effects are more appropriate for when intra-industry trade intensity is used as a single independent variable, a

Hausman test is called. The result is reported in Table 1(c) suggesting that there is no consistent conclusion for different regressors.

[Insert Table 1 here]

Following the econometric framework of Shin and Wang (2004), we include both trade intensity and intra-industry trade intensity as regressors in the panel regression. The regression results are presented in Table 2. Surprisingly, all the coefficient estimates for trade intensity become not significant, while the coefficient estimates for intra-industry trade intensity remain positive and significant at 1 percent level at both digits. Similarly, a Hausman test is also called here. Since the null hypothesis is rejected, fixed effects models are found more appropriate. It is also noted that the result of iit3 and iit 4 are similar and hence not reported.

[Insert Table 2 here]

As mentioned earlier, an important question concerning business cycle co-movement in East Asia is whether the business cycle is fostered mainly by internal regional bilateral trade or by external forces like the influence of the United States on the region. We investigate this question by running a series of panel regressions using the US effect as a control variable. Besides the US effect, we also add in a variable to control for exchange rate coordination in the region. This control variable is justifiable especially a new resolve for increased in exchange rate coordination has started to emerge since the 1997-1998 Asian financial crisis. The estimates from this analysis are presented in Table 3. Both exchange rate coordination and the US effect are significant in all model specifications. The first point to note is that the results in Table 2 remain robust even after controlling for exchange rate coordination and the US effect. In fact, the point estimates of intra-industry trade are positive and significant at 1% level across different specifications although these values are generally smaller as compared to those reported in Table 2. Second, as expected, the measures of exchange rate coordination has a statistically significance negative sign implying that two countries that have more variance in exchange rates should have less synchronized cycles as *sigma_e* is defined as the ratio of the standard deviation of the bilateral exchange rate and the mean of the bilateral exchange rate, $std(e_{ij})/mean(e_{ij})$. Third, as expected, the GDP correlation with the US for one country in each country pair has a significantly negative effect on the business cycle co-movement within this pair, leaving the effect of the other country's GDP correlation with US insignificant. This is because for each country pair, US's relative intimate correlation with one country leaving the other one out in the cold, causes a one-sided bifurcation from the underlying synchronized trajectories.

[Insert Table 3 here]

As stated before, ordinary least square (OLS) estimation may be inappropriate in this case. Therefore, the regressions are estimated by two-stage least square (TSLS). Table 4 shows the first stage regression result when fitting different trade intensity measures into a trade gravity model. It is shown that the most significant instruments used in the two-stage least squares are dummies for common border and common language. By employing the Hausman test, Table 5 compares the OLS regression results and the TSLS regression results. With the null hypothesis accepted it is concluded that the OLS estimators shown in Table 3 are consistent. To sum up, it is found that the catalyst of business cycle synchronization in East Asia is not only from the rest of world but also from the increased regional intra-industry trade in East Asia.

[Insert Table 4 here]

[Insert Table 5 here]

5. Conclusions

The essential question this paper seeks to answer is whether the business cycle co-movement in East Asia are fostered just by the internal bilateral trade, specifically, intra-industry trade or by external forces like the influence of the world's largest economy, namely, the United States. This paper examines the extent and robustness of the relationship between trade intensity and business cycle synchronization for nine East Asian countries in the period 1965-2008. Unlike previous studies which assume away the region's concurrent connection with the rest of the world, in our regressions we control for both the US effect and the exchange rate coordination in the region. We find that (1) increasing trade itself does not necessarily lead to more synchronized business cycles. More trade will only lead to more synchronized business cycles only if it is of the intra-industry type, (2) the measures of exchange rate coordination has a statistically significance negative sign implying that bilateral exchange rate coordination between two countries leads to more synchronized business cycles, and (3) the coefficient estimates for intra-industry trade intensity remain robust and significant even after controlling for the US effect and the exchange rate coordination. These results lead us to conclude that even after controlling for both the exchange rate coordination and the influence from the rest of the world, intra-industry trade still remains as a pillar for the business cycle synchronization in East Asia. Nonetheless, theoretically if the United States has effects on both countries of the same degree instead of on only one of them asymmetrically, the US effect would propel the underlying synchronization for this country pair evenly. This could not be revealed in our results without an appropriate measure to calibrate the overall effect of US on each country pair, which tosses a brick for further study.

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Figures and Tables

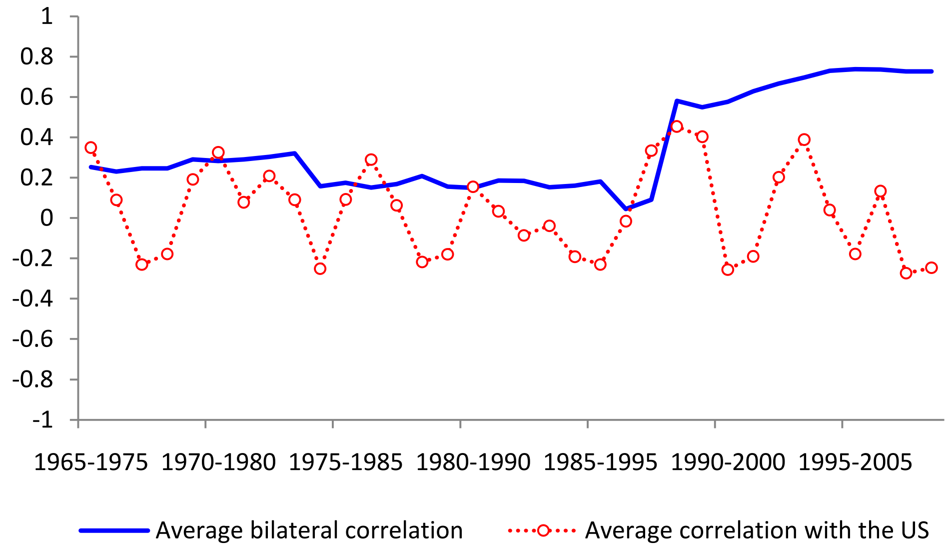

Figure 1 Average of bilateral business cycle correlation, 11-year moving windows, 1965-2008.

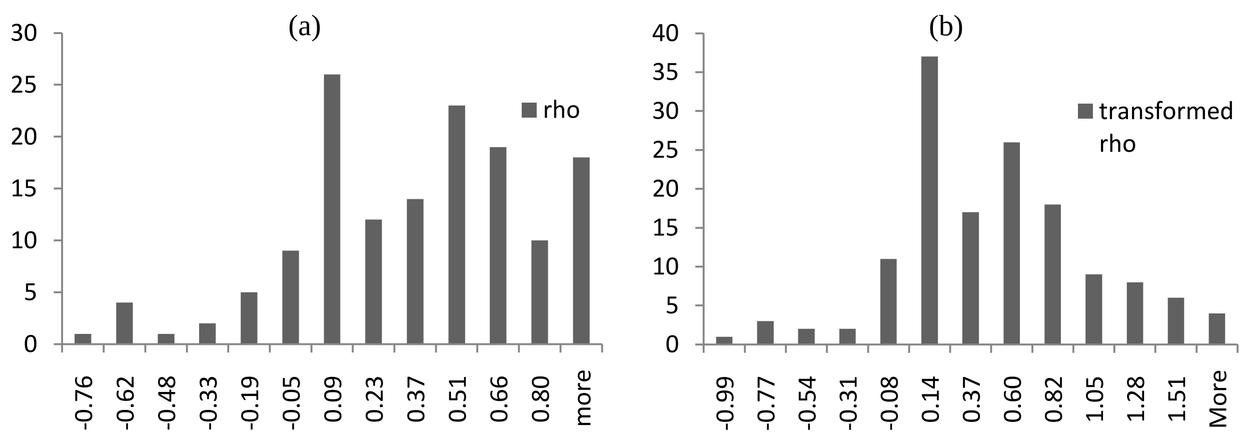

Figure 2 (a) Estimated density plot of untransformed business cycle correlations and (b) estimated density plot of transformed business cycle correlations.

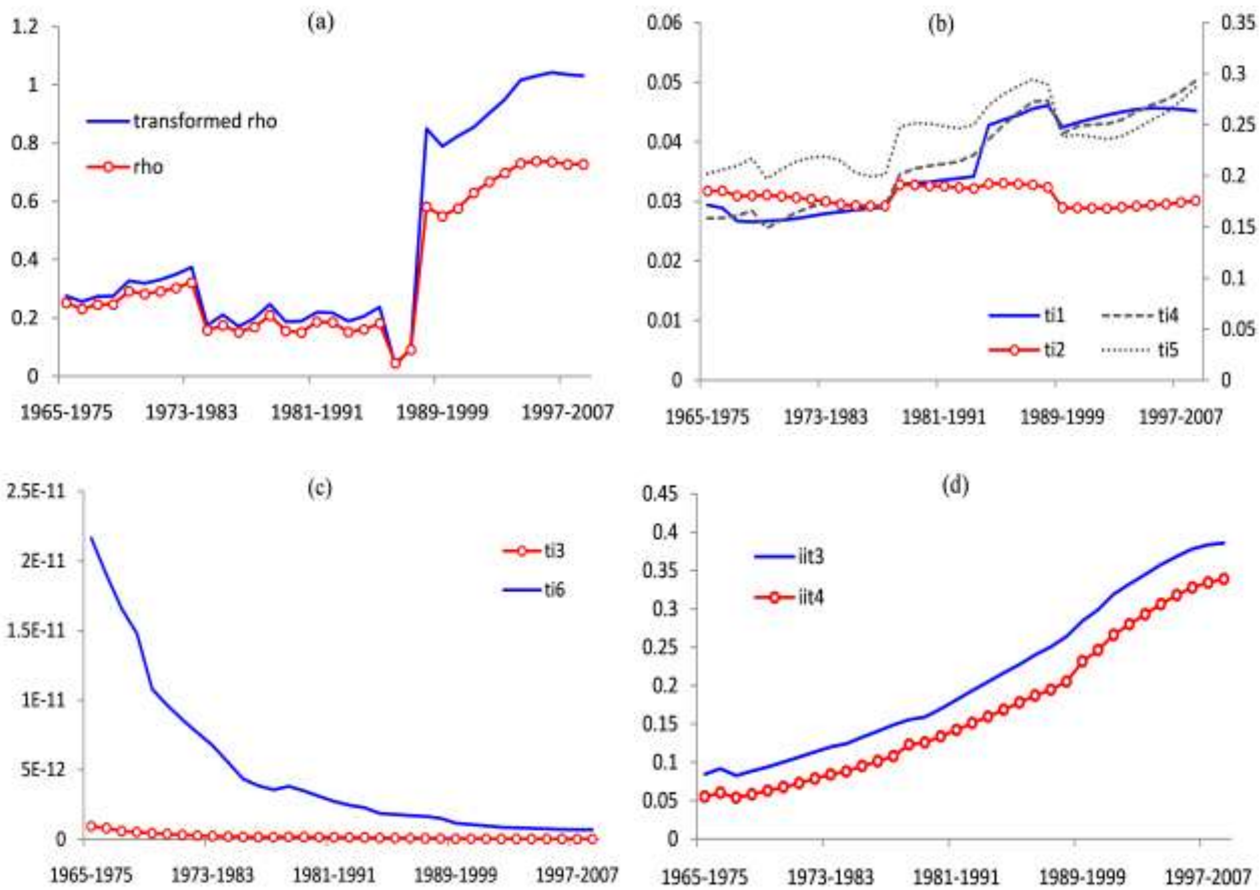

Figure 3 (a) 11-year moving average of transformed output correlations, (b) and (c) 11-year moving average of trade intensity measures, and (d) 11-year moving average of intra-trade intensity measures.

Table 1

The effects of trade intensity or intra-industry trade intensity on output co-movement (single variable)

	1	2	3	4	5	6
(a) Country pair specific random effects						
ti1	1.023					
	(1.098)					
ti2		-0.091				
		(0.248)				
ti4			1.079			
			(0.681)			
ti5				0.104		
				(0.156)		
iit3					1.336***	
					(0.252)	
iit4						1.694***
						(0.264)
Observations	124	124	118	118	141	139
R-square	0.007	0.001	0.021	0.004	0.169	0.225
(b) Panel regression with country pair specific fixed effects						
ti1	12.414					
	(4.648)					
ti2		-0.348				
		(0.839)				
ti4			7.002**			
			2.907			
ti5				0.779		
				0.673		
iit3					1.509***	
					0.312	
iit4						1.895***
						0.312
Observations	124	124	118	118	141	139
R-square	0.007	0.001	0.021	0.004	0.169	0.225
(c) Hausmen test						
Chi-square	6.36	0.10	4.39	1.06	0.88	1.46
Model	Fixed	Random	Fixed	Random	Random	Random

Notes: (a) The dependent variable is transformed output correlation between any two East Asian countries for four sub-periods, 1965-1975 (period 1), 1976-1986 (period 2), 1987-1997 (period 3) and 1998-2008 (period 4). Four trade intensity measures, ti1, ti2, ti4 and ti5 are used. The intra-industry trade intensity measures, iit3 and iit4 based on SITC three- and four-digit classifications.

(b) The values in parentheses are standard errors.
- * The significance at 10% of the estimated coefficients.
- ** The significance at 5% of the estimated coefficients.
- *** The significance at 1% of the estimated coefficients.

(c) The null hypothesis of Hausman test is ‘H_0: Difference in coefficients not systematic’.

Table 2
The effects of trade intensity or intra-industry trade intensity on output co-movement (multiple variables)

	1	2	3	4
(a) Country pair specific random effects				
ti1	-1.322			
	(1.085)			
ti2		-0.176		
		(0.224)		
ti4			0.582	
			(0.725)	
ti5				-0.159
				(0.152)
iit4	1.612***	1.479***	1.561***	1.540***
	(0.298)	(0.274)	(0.335)	(0.309)
Observations	123	123	117	117
R-square	0.202	0.197	0.179	0.182
(b) Panel regression with country pair specific fixed effects				
ti1	3.194			
	(4.444)			
ti2		-0.350		
		(0.720)		
ti4			-2.885	
			(3.258)	
ti5				-0.948
				0.646
iit4	1.955***	2.056***	2.249***	2.258***
	(0.383)	(0.353)	(0.464)	(0.403)
Observations	123	123	117	117
R-square	0.146	0.196	0.142	0.117
(c) Hausman test				
Chi-square	6.40	6.95	7.32	8.03
Model	Fixed	Fixed	Fixed	Fixed

Table 3
The effects of trade intensity or intra-industry trade intensity on output co-movement with exchange rate policy coordination and US effects as control variables

	1	2	3	4
(a) Country pair specific random effects				
ti1	-1.251			
	(1.050)			
ti2		-0.143		
		(0.221)		
ti4			0.510	
			(0.712)	
ti5				-0.215
				(0.148)
iit4	1.259***	1.130***	1.241***	1.278***
	(0.324)	(0.300)	(0.357)	(0.328)
sigma_e	-1.135***	-1.118***	-1.234***	-1.281***
	(0.398)	(0.405)	(0.428)	(0.426)
corr(i, us)	0.164	0.405	0.176	0.202
	(0.130)	(0.131)	(0.138)	(0.139)
corr(j, us)	-0.274**	-0.281**	-0.277**	-0.288**
	(0.122)	(0.123)	(0.131)	(0.128)
Observations	123	123	117	117
R-square	0.285	0.279	0.267	0.277
(b) Panel regression with country pair specific fixed effects				
ti1	2.390			
	(4.302)			
ti2		-0.215		
		(0.697)		
ti4			-0.736	
			(3.286)	
ti5				-1.292
				(0.631)
iit4	1.792***	1.867***	1.905***	2.074***
	(0.506)	(0.489)	(0.611)	(0.509)
sigma_e	-0.970*	-0.969*	-0.946	-1.141*
	(0.565)	(0.566)	(0.621)	(0.595)
corr(i, us)	0.337*	0.338*	0.327*	0.326*
	(0.184)	(0.184)	(0.192)	(0.186)
corr(j, us)	-0.250*	-0.253*	-0.248	-0.299*
	(0.145)	(0.145)	(0.152)	(0.149)
Observations	123	123	117	117
R-square	0.218	0.263	0.250	0.141
(c) Hausman test				
Chi-square	5.00	5.67	3.57	6.78
Model	Random	Random	Random	Random

Notes:
(a) See Table 1.
(b) sigma_e is the exchange rate policy coordination measure, as defined.
(c) corr(i, us) and corr(j, us) are the output correlation between country *i* and the US, and country *j* and the US, respectively

Table 4
First stage regression: gravity equations

	ti1	ti2	ti3	ti4
constant	0.057	0.384	0.059	-0.178
	(0.127)	(0.567)	(0.189)	(0.999)
iit4	0.053*	0.109	0.079*	0.010*
	(0.030)	(0.133)	(0.044)	(0.233)
sigma_e	-0.002	0.276**	-0.021	-0.344
	(0.026)	(0.117)	(0.040)	(0.213)
corr(i, us)	-0.009	-0.042	-0.016	-0.026
	(0.011)	(0.051)	(0.017)	(0.090)
corr(j, us)	0.006	-0.027	0.022*	0.046
	(0.009)	(0.039)	(0.013)	(0.068)
distance	-0.018**	-0.062*	-0.016	0.061
	(0.008)	(0.037)	(0.012)	(0.063)
Border dummy	0.046***	0.101*	0.070***	0.402***
	(0.012)	(0.055)	(0.018)	(0.095)
Common language	0.036***	0.112**	0.059***	0.290***
	(0.010)	(0.045)	(0.015)	(0.077)
GDP_i	0.007	0.068***	0.003	0.123***
	(0.005)	(0.021)	(0.007)	(0.037)
GDP_j	-0.004	-0.063**	-0.002	-0.124***
	(0.005)	(0.024)	(0.008)	(0.042)
Remote_i	-9.56E-05**	6.80E-05	-5.61E-05	-2.33E-04
	(3.82E-05)	(1.70E-04)	(5.76E-05)	(3.04E-04)
Remote_j	-4.22E-05	-4.86E-04	4.13E-05	-5.60E-04
	(3.00E-05)	(1.34E-04)	(4.41E-05)	(2.33E-04)
Colonial origin	0.019	0.094*	0.086***	0.052
	(0.012)	(0.053)	(0.017)	(0.090)
Area_i	3.07E-09	-1.59E-07	-2.53E-08	2.67E-07
	(3.27E-08)	(1.46E-07)	(4.82E-08)	(2.55E-07)
Area_j	3.65E-08	1.99E-07	1.93E-08	1.51E-07
	(2.05E-08)	(9.14E-08)	(3.09E-08)	(1.63E-07)
Population_i	-1.85E-11	1.01E-09	2.34E-10	-2.58E-09
	(2.82E-10)	(1.26E-09)	(4.13E-10)	(2.18E-09)
Population_j	-2.24E-10	-1.27E-09	-1.15E-10	-7.78E-10
	(1.48E-10)	(6.62E-10)	(2.24E-10)	(1.18E-09)
ASEAN	0.020**	0.050	0.028**	0.005
	(0.009)	(0.041)	(0.014)	(0.074)
Observations	123	123	117	117
Wald Chi-square	177.000***	203.000***	255.000***	168.000***

Notes: (a) The dependent variables are bilateral trade intensity measures, ti1, ti2, ti4 and ti5, between any two of the 9 East Asian countries considered for the four sub-period.

Table 5

The effects of trade intensity or intra-industry trade intensity on output co-movement with and without instrumental variables

	1	2	3	4
(a) Country pair specific random effects (without instrumental variables)				
ti1	-1.251			
	(1.050)			
ti2		-0.143		
		(0.221)		
ti4			0.510	
			(0.712)	
ti5				-0.215
				(0.148)
iit4	1.259***	1.130***	1.241***	1.278***
	(0.324)	(0.300)	(0.357)	(0.328)
sigma_e	-1.135***	-1.118***	-1.234***	-1.281***
	(0.398)	(0.405)	(0.428)	(0.426)
corr(i, us)	0.164	0.405	0.176	0.202
	(0.130)	(0.131)	(0.138)	(0.139)
corr(j, us)	-0.274**	-0.281**	-0.277**	-0.288**
	(0.122)	(0.123)	(0.131)	(0.128)
Observations	123	123	117	117
R-square	0.285	0.279	0.267	0.277
(b) Panel regression with country pair random effects (with instrumental variables)				
ti1	-0.891			
	(1.363)			
ti2		-0.083		
		(0.276)		
ti4			-0.183	
			(0.881)	
ti5				-0.098
				(0.196)
iit4	1.213***	1.117***	1.161***	1.190***
	(0.342)	(0.302)	(0.0.379)	(0.343)
sigma_e	-1.143***	-1.136***	-1.219***	-1.243***
	(0.565)	(0.566)	(0.621)	(0.430)
corr(i, us)	0.159	0.153	0.170	0.182
	(0.131)	(0.132)	(0.139)	(0.141)
corr(j, us)	-0.274**	-0.278**	-0.287**	-0.291**
	(0.122)	(0.123)	(0.132)	(0.129)
Observations	123	123	117	117
R-square	0.284	0.279	0.265	0.273
(c) Hausman test the appropriateness of the OLS estimator				
Chi-square	0.17	0.13	0.40	0.83
Model	OLS	OLS	OLS	OLS

Notes: (a) See Tables 1 and 3.

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