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Trade Networking and Business Cycle Synchronisation

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Abstract: *Recent studies have shown a growing tendency for trade to have an undetected effect on business cycle synchronisation. This seems to be due to an increase in the analysis comprising data from developing countries, advances in the control of the endogeneity of trade variables using instrumental variables, and the use of various control variables as explanatory variables other than trade variables. This study examines how the networking of trade, in which numerous countries participate, changes the relationship between trade and business cycle synchronisation in two countries. Thus, we examine the possibility that business cycle linkage would increase if countries with common trading partners had the same impact on each other from a third country rather than having a direct impact on each other. The analysis results indicate that trade networking enhances business cycle linkages, but bilateral trade has no such effects. This result is confirmed when tradables are divided into final and intermediate goods.*

Keywords: *Trade-networking effect, bilateral trade intensity, business cycle synchronisation*

JEL: *F14; F44; F62*

1. Introduction

International business cycle synchronisation is closely related to the theory of the optimal currency area, and the euro area in Europe exclusively. This is an essential research theme at a time when economic integration is advancing in various parts of the world. It is also beneficial to know the degree of claudication and the mechanism of economic claudication in each country and region when the entire global economy deteriorates, such as the current Corona shock, and the Lehman shock in 2008-09, when considering the process of subsequent economic recovery.

Numerous previous studies have focused on the role of trade as a factor affecting business cycle linkage. Recent studies have focused on the effects of trade in final goods and trade in intermediate goods (intra-industrial trade) on business cycle linkage in response to the global expansion of the

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international production network. Additionally, analysis have been conducted in paired developed countries and in developing countries. Moreover, because the volume of bilateral trade, which explains business cycle linkage, is endogenous, research has focused on controlling its endogeneity.

Considering the results of research in this field in recent years, there have been an increasing number of cases in which the effects of trade on increasing business cycle synchronisation have not been clearly detected. This may be attributed to the increasing number of studies, including those on developing countries, the clarification of the specificity of developing countries (Calderon et al. 2007; Li 2017 & Lee 2019), the methodology for adjusting the endogeneity of trade variables using instrumental variables, and the methodology for adopting control variables other than trade.

The effect of trade on business cycle linkage between pairs of developed and developing countries is detected differently because inter-industrial rather than intra-industrial trade is predominant in pairs of developing countries; thus, the economies of the countries involved in trade tend to move asymmetrically. However, economies tend to comove among industrialised countries, as horizontal intra-industry trade, which exchanges differentiated final goods belonging to the same industry, is predominant.

Regarding the adjustment of the endogeneity of trade variables, the fixed effects of two country pairs (geographical proximity, cultural, and linguistic approximation, etc.) have traditionally been used as instrumental variables. In such cases, the fixed missing variables are supplemented; however, there is no guarantee that endogeneity will be sufficiently resolved. Therefore, recent studies use tariff rates, which are exogenous policy variables affecting trade, as instrumental variables (Duval et al. 2016). Regarding control variables other than trade, the estimation considers the effects of monetary and fiscal policies (Li 2017).

This study focuses on the effects of international trade networking as a control variable, other than trade. As the European Central Bank (2019) analyses in detail, the formation of a global production network has led to the establishment of a structure in which input and output activities are connected in a complex manner between different countries and industries. Some countries and industries become hubs in the network, and more efficient trade is performed through the hub. Because the two countries do not trade independently with each other, it is expected that the link between trade and business cycles will change. Thus, it is possible that business cycle linkage will increase if countries with common trading partners are similarly influenced by third countries, rather than being directly influenced by each

other. This study analyses the relationship between trade and business cycles by considering the effect of this networking after indexing the extent to which two particular countries belong to a common trade network. The results indicate that trade networking enhances business cycle linkages, but bilateral trade has no such effects. This result remains unchanged when tradable goods are divided into final and intermediate goods; final goods are divided into investment and consumer goods, and intermediate goods are divided into goods and services. Thus, estimates that do not incorporate network effects cannot detect the correct correlations between trade and business cycle linkage, and the results of this study are likely to affect major changes in future research in this area.

The remainder of this paper is organised as follows. Section 2 summarises previous research on the relationship between trade and business cycle synchronisation. Section 3 introduces an estimation method that considers network effects. Section 4 describes the data used and how the explanatory and dependent variables are created. Section 5 explains the results of the analysis, and Section 6 concludes the paper.

2. Literature Review

This section summarises previous studies on the relationship between business cycle linkage and trade.

Frankel and Rose (1998), the seminal paper of this field, studied how the currency union, trade, and business cycles are interrelated. These three events were considered interrelated endogenous events; however, they concluded that an increase in international trade increased the correlation of business cycles.

Since then, research on the impact of international trade and financial flows on international business cycle synchronisation has been conducted, but the contributions of Baxter and Kouparitsas (2005) and di Giovanni and Levchenko (2010) are of particular importance for the relationship between trade and international business cycles, which this study focuses on. The former study used data from more than 100 countries, including both developed and developing countries, and reaffirmed that bilateral trade increases the correlation of business cycles. This comprehensive study used explanatory variables, such as (1) bilateral trade, (2) total trade of the two countries, (3) similarity of the industrial structure, (4) production factor endowments, and (5) gravity variables (economic size and distance between two countries). They concluded that the similarity of the industrial structure and currency union had no effect on business cycle synchronisation, which contrasted with previous studies.

Di Giovanni and Levchenko (2010) examined the different effects of trade on the business cycle by focusing on its contents rather than on the entire trade. The results revealed that trade in parts and other intermediate goods, rather than final goods, increases the correlation of business cycles. The results of this analysis are extremely crucial, given that international trade, which was traditionally centered on final goods, has shifted its weight to the exchange of intermediate goods since the 2000s (Figure 1). The importance of the effects of trade in intermediate goods on global business cycles has been confirmed in subsequent studies (François & Gaillard 2019; European Central Bank 2019).

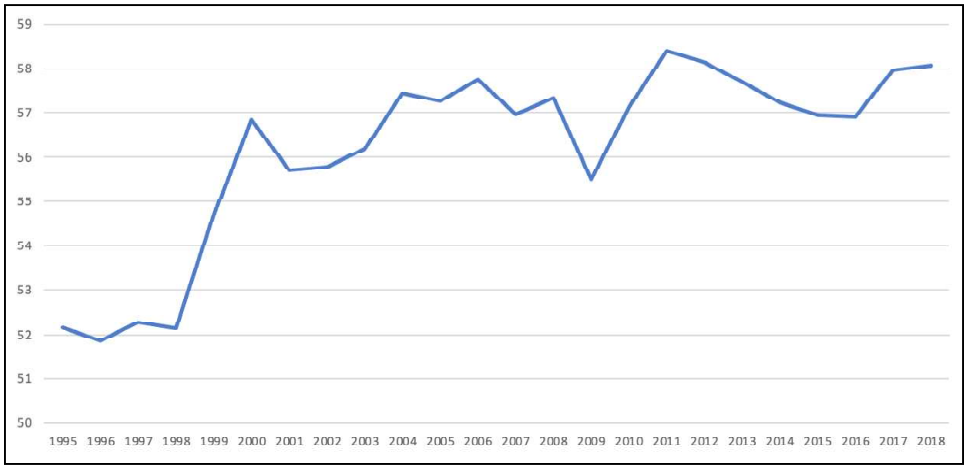

Figure 1: The share of intermediate goods in total trade from developed to developing countries (%)

Source: OECD TiVA Databasehare

This study examines how the relationship between trade and the business cycle changes with and without considering trade networking effects. Apart from introducing trade networking effects, the characteristics of this study can be summarised as follows. These were based on those of previous studies. (1) We further analysed the contents of intermediate goods by industry to clarify the types of intermediate goods that affected the business cycle. (2) We extracted two types of business cycle components from GDP data: short- and long-term. (3) We clarified the relationship between trade and business cycles in the pair of developed countries and in pairs that included developing countries.

(1) is based on the results of a recent study on economic development, in which the input of services have become crucial in developing economies that have been rapidly developing since the 2000s by accepting direct

investment from developed countries (Jones 2011 & Leal 2015). Regarding the international productivity gap, which has a major impact on long-term economic growth, Leal (2015) argued that "In addition to the size of productivity gaps among different sectors, the way sectors are interconnected with each other through input-output relationships can affect our assessment regarding the importance of each of them on economic development." The inefficiency of the service industry, which has a high input ratio to other industries, can influence the productivity of other industries, and thus, of the country at large. Leal (2015) concluded that of importance is not the difference in the level of productivity of some industries (particularly manufacturing) but rather the degree of impact on other industries (the degree of influence). We focus on the roles of the services industry.

(2) refers to the results of studies that used econometric modeling to analyse the global business cycle (Aguiar & Gopinath 2007; Comin et al. 2014). Comin et al. (2014) analysed the asymmetric relationship between developed and developing countries using a dynamic stochastic general equilibrium model. The motivation for this analysis was that the linkage between the business cycles of developed and developing countries was observed in the medium and long-term cycles, which were longer than the usual short-term cycle (with the U.S.-Mexican relationship in mind). The conclusion was drawn that direct investment and the imports and exports of intermediates, in which technologies were embodied, were behind such phenomena.

(3) is an area in which research has progressed in recent years against the backdrop of progress in data development, the acceleration of growth in developing countries in the 2000s, and the heightened presence of developing countries in the world economy.

In Calderon et al.'s (2007) relatively early study in this area, data from 147 countries, including developed and developing countries, were used to identify the following three points. First, they discovered that the effect of closer trade on business cycle linkage between developed countries is greater than that between pairs of developing countries or pairs of developed and developing countries. Second, the cross-term of the density of trade relations and industrial structure were analysed in addition to other explanatory variables, and the coefficients were estimated to be significant. Thus, there was a synergistic effect in which the effect of trade on business cycle linkage increased with the similarity in the industrial structures of the two countries. Third, the difference in the effect of trade in paired developed and developing countries on business cycle linkages is due to the different trade

structures; the pairs of developing countries mainly engaged in inter-industrial trade rather than intra-industrial trade. However, there is a tendency for industrialised economies to comove because these countries are mainly engaged in intra-industry trade, in which differentiated final goods belonging to the same industry are exchanged.

Focusing on the differences in the effects of inter- and intra-industry trade on business cycle linkage, Li (2017) compared the magnitude of their effects on business cycle linkage. In addition to the effect of trade variables, Li (2017) analysed the effect of monetary and fiscal policies on business cycle linkage using data from developing countries in East Asia, Japan, the United States, and Europe. Consequently, whereas intra-industry trade has a relatively strong positive effect on the linkage of the economy, the effect of inter-industry trade is almost insignificant. The expansion of intra-industrial trade in East Asian developing countries, unlike in the case of pairs of developed countries, is attributed to the increase in the so-called vertical intra-industrial trade associated with the international division of labour that develops in the Asian region. Regarding the effects of the economic policy variables, the effect of the degree of fluctuation of the exchange rate between the two countries (a proxy for asynchronous monetary policy) was strong.

The results of previous studies indicate that trade affects business cycle linkage differently between developed and developing country pairs (or when a developing country is included as one of the pairs). The key was the difference in the roles of intra- and inter-industrial trade in the economy. Although this conclusion remains unchanged, two previous studies related to this issue have been presented, each of which presents a new perspective.

Since Frankel and Rose (1998), almost all analyses of the relationship between trade and business cycles have been conducted using gross trade data. Conversely, Duval et al. (2016) used value-added trade data (so-called net-based export data, which excludes the value of imported intermediate goods to produce exports from gross exports) to analyse the linkage between trade and business cycles. Value-added trade data are used because the GDP data used for extracting the business cycle is the added value. Exports do not change the GDP when productive activities depend heavily on foreign intermediate goods and do not produce added value. An analysis using value-added trade data found that trade reduces business cycle linkage in the case of pairs of developing countries and conversely increases the linkage in the case of pairs of developed countries. However, Duval et al. (2016) did not analyse trade by industry, but merely by using the total amount of trade.

Lee (2019) analysed in detail, the mechanism by which imports and exports affect business cycle linkage. Lee (2019) revealed that the domestic input–output relationship served as an intermediary between trade and the macroeconomic cycle. Particularly, when the business cycle linkage between the exporting and importing countries increases, it becomes evident that the upstream industries of the exporting countries (industries supplying intermediate goods in the process of producing exports) were related to synchronisation. Moreover, such a mechanism worked only in the case of trade in manufactured goods, and could not be confirmed in the case of trade in services. Lee (2019) limited the scope of the analysis to the linkage between trade of South Korea and foreign countries and their business cycle synchronisation but focused on the relationship between trade and the input structure of trade goods and paid attention to the differences between goods and services, which can be said to be related to this study.

Compared with previous studies, it has become difficult to confirm the effects of trade on increasing business cycle linkage in recent studies. Underlying this trend is the fact that research using data from developing countries has increased and the specificity of developing countries, as mentioned above, has become apparent. Additionally, differences in estimation methods may also have an effect. Therefore, the method for adjusting the endogeneity of trade variables using instrumental variables and that for adopting control variables other than trade are related. This study focuses on the network effect as an extension of the control variables, in accordance with previous studies. To the author's best knowledge, no previous research has attempted to detect the impact of trade networking on business cycles by considering other kinds of control variables adopted in previous research.

3. Analytical method

0We consider the following explanatory variables using the correlation coefficients of the business cycles of two economies as dependent variables. The first is the trade variable (the strength of trade between the two countries, that is, the index of the sum of the exports to each country divided by the sum of their GDP, "Trade" in the equation below), and the second is the degree of correlations between technological shocks of the two countries ("Technology"). The third explanatory variable is the correlation between monetary and fiscal policies between the two countries ("Policy"). These two economic policy variables are indexed to determine whether the two countries have the same (or opposite) policy direction.

The fourth is the other control variables ("Controls"). The degree of openness of the two countries (the index obtained by dividing the sum of the two countries' exports and imports by the sum of the two countries' GDP), networking effect (the degree of similarity of the trading partners other than the two countries in question), and regional dummy are added. The degree of openness between the two countries represents their susceptibility to foreign shocks through exports and imports. Therefore, it was expedient to include them as control variables to extract the effects of trade and technological and economic policy shocks on the business cycle.

The networking effects focus on considering the possibility that business cycle linkage may be enhanced if countries with common trading partners, other than the countries concerned, are similarly affected by third countries. The calculation method and data sources for each variable are described later in this study.

The estimation equation can be summarised as follows, using the correlation coefficient (Corr) of the business cycles of the two countries (i,j) as the dependent variable.

$$Corr(ijt)=\alpha 0+\alpha 1Trade(ijt)+\alpha 2Technology(ijt)+\alpha 3Policy(\text{ijt})+\alpha 4Controls(\text{ijt})+\varepsilon(\text{ijt}) \quad (1)$$

The trade variable (Trade), which is the focus among the explanatory variables, uses the International Input-Output Table (WIOD) to divide trade as a whole into final goods and intermediate goods by stage of production, and then divide each into industry and final demand. The trade variable is calculated by dividing the value by GDP, which represents the strength of the trade linkage between the two countries. We prepare two types of trade variables for intermediates; the export GDP ratio for products (agriculture, forestry, fisheries, mining and industry, and manufacturing) input to the other country, and the export GDP ratio for services input to the other country. Final goods trade is classified into consumer and investment goods.

In the above estimations, to address endogeneity of trade variables, average tariff rate data for each country were collected with reference to previous studies (Duval *et al.,* 2016), and the mean values were calculated for each of the two countries as instrumental variables. Then estimates were conducted using the generalised method of moments. The exogeneity of the instrumental variables was verified, and the results of the Sagan test are shown for each estimation formula in the estimation results table. We discovered that the null hypothesis that the instrument variables are not correlated with the error term cannot be rejected in all estimates; thus, the instrument variables are appropriate.

4. Data

This section categorises the data covered by the study into four: (1) countries and periods to be analysed, (2) dependent variables, (3) explanatory variables, and (4) instrumental variables. Regarding the explanatory variables, we explain the source and calculation methods for the following seven variables: (a) trade variables, (b) technology shocks, (c) monetary policy shocks, (d) fiscal policy shocks, (e) external openness, (f) trade-networking effects, and (g) dummy variables.

Countries and Periods of Analysis

This study includes 39 countries: 30 developed and 9 developing countries that are subject to the WIOD, which are sources of trade data. The developed countries are Australia, Austria, Belgium, Canada, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, Taiwan, the United Kingdom, and the United States. The developing countries are Brazil, Bulgaria, China, India, Indonesia, Russia, Mexico, Romania, and Turkey. The classification of developed and developing countries was based on the World Bank's method. We constructed 741 country-pairs from 39 countries. For each period, we calculated the correlation coefficient of the business cycle, strength of trade relationships, degree of correlation of technology and economic policy shocks, and trade-network effect for each pair of countries. Subsequently, we regressed the correlation coefficient of the business cycle on other variables that served as explanatory variables. The analysis period was the data-recording period of the WIOD statistics from which trade variables were obtained. The estimation was conducted over four periods:1995Q1–1999Q4 (Phase 1), 2000Q1–2004Q4 (Phase 2), 2005Q1–2009Q4 (Phase 3), and 2010Q1–2014Q4 (Phase 4).

Dependent variable

Using the Hodrick–Prescott filter (HP filter), we extracted short- and long-term business cycle components from quarterly real GDP data (the data sources are International Financial Statistics of IMF and national SNA statistics) and calculated the correlations. The constant ë followed several previous studies and was set at 1600 and 400000 for the short- and long-term cycles, respectively.

Explanatory variables

(a) Trade variables: Trade variables are classified into seven patterns based on the industry and production stage. The seven categories for trade

variables were total, total intermediate goods, total final goods, intermediate goods (agriculture, forestry and fisheries, mining, and manufacturing), intermediate services, consumer goods, and investment goods exports. Trade strength (trade intensity) was calculated by dividing the sum of the two countries' exports by their GDP. Relevant trade and GDP data were extracted from the WIOD. The available data were from 1995 to 2014.

(b) Correlation between technology shocks: The similarity of each country's industrial structure was indexed; the larger this value (the closer the industrial structure), the greater the approximation of the technology shock. The assumption was that technological shocks depend on the industrial structure. The degree of correlation between the technological shocks (industrial structural approximation) in the two countries (i,j) was calculated as follows:

$$\text{Correlation between technology shocks} = 1-\frac{1}{2}\Sigma_s \left| \frac{T_i(s)}{\Sigma_s T_i(s)} - \frac{T_j(s)}{\Sigma_s T_j(s)} \right| \quad (2)$$

T(s) is the value of the production by industry (s). Industry classifications were based on the WIOD classifications. 35 classifications were for 1995–2009 and 56 classifications were for 2010–2014. This reflected the difference in the share of each industry in the two countries. If the industrial structure is perfectly identical, use one. The data source for this variable is the WIOD.

(c) Correlation between monetary policy shocks: Monetary policy shock calculates the volatility of the paired bilateral exchange rates. The greater the degree of volatility, the more the monetary policy shocks affected by both countries is considered to be different, and it is expected that there will be a negative impact on the comovement of business cycles. The source of the exchange rate data was the International Financial Statistics (IMF).

(d) Correlation between fiscal policy shocks: In a fiscal policy shock, the fiscal balance GDP ratio is regressed on the GDP gap. The residual was taken, and this was regarded as the structural fiscal balance (fiscal policy shock) that removes the impact of the business cycle on the fiscal balance. This fiscal policy shock was calculated for each of the two countries and the correlation coefficients were calculated. The data sources were the Fiscal Monitor (IMF), and National Accounts at a Glance (OECD).

(e) Degree of external openness: The degree of external openness was derived by dividing the total value of exports and imports of the two countries by their total value of GDP and is an index that evaluates the degree of external openness of the two countries rather than the relationship between the two countries. The higher the degree of openness, the more likely it is to be affected by bilateral trade relations and shocks. The source of the data was the World Development Indicators (World Bank).

(f) Networking effect: The networking effect index is an index of the extent to which two countries have common trading partners. We included this in the control variable list because the same impact from third countries may increase business cycle synchronisation. Using the trade value (T) with the third country (k), the share of the total trade value was calculated, and the difference in the share between the two countries was taken. The closer the composition of the trading partners of the two countries, the more they belong to the same trade network. The stronger the degree of similarity, the closer the index is to 1.

$$\text{Networking Effect Index} = 1 - \frac{1}{2}\Sigma_{k \neq i,j}\left|\frac{T_{i\to k} + T_{k\to i}}{\Sigma_k T_{i\to k} + T_{k\to i}} - \frac{T_{j\to k} + T_{k\to j}}{\Sigma_k T_{j\to k} + T_{k\to j}}\right| \quad (3)$$

The third countries to be calculated for each country-pair comprised 37 countries, excluding the two parties from the 39 countries to be analysed. The bilateral trade data used for computation were downloaded from the IMF's Direction of Trade Statistics (DOT). DOT data for 37 countries accounted for approximately 80% of the total value of exports and imports in each country, and the networking effect index calculated using these data accurately represents the strength of the network of two country pairs.

(g) Dummy variable: To determine whether the impact of trade strength on business cycle linkage differs between pairs of developed countries and those that include developing countries (one or both pairs of developing countries), a dummy variable with a pair including developing countries as one was prepared, and a coefficient dummy was given to trade variables. Regional dummies were set for the Euro Area (18 countries), the European Union (24 countries including the United Kingdom, which were members of the analysis period), East Asia (China, Taiwan, Indonesia, Korea, and Japan), and three North American countries (Canada, the United States, and Mexico) to confirm regional differences.

Instrumental variable

The trade variables in the explanatory variables are interrelated with business cycle movements and endogeneity is assumed. Therefore, we used the mean tariff rates of the two countries and lagged trade variables as the instrumental variables. Tariff data were obtained from the World Bank.[2]

5. Results

The estimation results of the estimation formulas presented in Section 3 are explained below. Table 1 presents the estimation results with the correlation

coefficients of short-term business cycles as dependent variables, and Table 2 presents the estimation results with the correlation coefficients of long-term business cycles as dependent variables. Table 1(1) includes network effects, whereas Table 1(2) does not. Seven estimation results are presented in each table. From the left, the estimation results use the following trade variables as explanatory variables: total trade, trade in total intermediate goods, trade in total final goods, trade in intermediate goods (agriculture, forestry and fisheries, mining and industry, and manufacturing), trade in intermediate services, trade in consumer goods, and trade in investment goods. The explanatory variables shown vertically at the far left are trade variables (trade GDP ratio between the two countries, strength of trade relations), correlations of technological shocks, correlations of monetary policy, correlations of fiscal policy, average degree of external openness of the two countries, and networking effects. Regarding model selection, all estimates were made using the fixed-effect model because it was selected using the Hausman test.

First, we present the estimation results using short-term cyclical data (Table 1).

As shown in Table 1(1), when network effects are considered, excluding the case of trade in intermediate services, the networking effects are estimated significantly as positive coefficients, as expected. However, no significant results were obtained for any of the other variables, excluding technology shocks. Some trade intensity and fiscal policy variables obtained significant results but under the opposite sign conditions. The results in Table 1(2), which do not include the networking effects, are almost identical to those in Table 1(1). Table 1(2) does not indicate the effect of the trade variable on increasing the comovement of the business cycle. Additionally, all monetary and fiscal policy variables for which significant results under assumed sign conditions were not obtained in Table 1(1) are also insignificant under the assumed sign conditions. From these results, it is evident that the results of previous studies, in which the strengthening of trade relations enhanced business cycle linkage, indicated a spurious correlation. In the situation where trade relations are becoming more complicated because of the globalisation of economic activities, the idea that bilateral trade relations have the effect of linking the business cycles of two countries has become uncertain. The results are similar to those in Table 2, which uses long-term business cycle data. However, regarding the long-term cycle, the coefficients associated with monetary and fiscal policy variables are significantly estimated with the expected sign condition when the networking-effect index is added to the explanatory variables.

Table 1(1): The estimation results using short-term cyclical data with networking effects

Short-term cycles													
Networking effects included													
	Total		*Int*		*Final*		*Int_ind*		*Int_serv*		*cons*		*investment*	
Trade	-0.0143		-0.0179		-0.0145		-0.3478	**	0.0418		-1.3392		-0.2733	***
	(0.0382)		(0.038)		(0.0389)		(0.1413)		(0.0629)		(0.9344)		(0.1047)	
Technology	2.1458	***	2.1522	***	2.1518	***	2.2304	***	1.9458	***	4.6255	**	2.0433	***
	(0.3432)		(0.3418)		(0.3472)		(0.3626)		(0.4263)		(1.9082)		(0.3652)	
Monetary Policy	-0.0193		-0.0186		-0.0208		0.0144		-0.0140		-0.0761		0.0238	
	(0.0242)		‘(0.0240)		(0.0250)		(0.0289)		(0.0250)		(0.0678)		(0.0306)	
Fiscal Policy	-0.0342	**	-0.0337	**	-0.3463	**	-0.0439	**	-0.0364	**	-0.0431		-0.0483	***
	(0.0155)		(0.0156)		(0.0155)		(0.0171)		(0.0159)		(0.0358)		(0.0177)	
Openness	0.0685		0.0693		0.0668		0.1447		0.0687		0.1339		0.0843	
	(0.0505)		(0.0506)		(0.0504)		(0.0626)		(0.0509)		(0.1237)		(0.0551)	
Networking effects	0.8305	**	0.8493	**	0.8250	**	1.4403	***	0.5750		3.9755	*	1.3431	***
	(0.3648)		(0.3679)		(0.3588)		(0.4442)		(0.4414)		(2.3591)		(0.4175)	
Country-pair fixed effects	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Observations	2223		2223		2223		2223		2223		2223		2223	
S.E.	0.3168		0.3168		0.3170		0.3401		0.3200		0.7201		0.3442	
Sagan test Chi-square	6.008		4.196		8.174		1.322		0.475		3.55		2.216	
(P-value)	(0.111)		(0.241)		(0.042)		(0.723)		(0.924)		(0.314)		(0.528)	

Standard errors are in parenthesis. ***, **, * indicates they are significant at the 1%, 5% and 10%.

Table 1(2): The estimation results using short-term cyclical data without networking effects

	Short-term cycles													
	Networking effects excluded													
	Total		*Int*		*Final*		*Int_ind*		*Int_serv*		*cons*		*investment*	
Trade	-0.0210		-0.0261		-0.0196		-0.3785		0.0469		-1.6035		-0.2827	***
	(0.0397)		(0.0399)		(0.0400)		(0.1503)		(0.0616)		(1.2905)		(0.1086)	
Technology	2.1066	***	2.1140	***	2.1122	***	2.1492	***	1.8912	***	4.8404	**	1.9579	***
	(0.3419)		(0.3418)		(0.3458)		(0.3672)		(0.4132)		(2.3999)		(0.3696)	
Monetary Policy	-0.0110		-0.0086		-0.0130		0.0328		-0.0078		-0.0397		0.0393	
	(0.0238)		(0.0238)		(0.0245)		(0.031)		(0.0242)		(0.0675)		(0.0322)	
Fiscal Policy	-0.0373	**	-0.0367	**	-0.0378	**	-0.0505	***	-0.0380	**	-0.0623		-0.0540	***
	(0.0155)		(0.0155)		(0.0155)		(0.0177)		(0.0158)		(0.0459)		(0.01817)	
Openness	0.0655		0.0666		0.0631		0.1451	**	0.0066		0.1272		0.0790	
	(0.0506)		(0.0507)		(0.0505)		(0.0638)		(0.0511)		(0.1435)		(0.0555)	
Networking effects														
Country-pair fixed effects	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Observations	2223		2223		2223		2223		2223		2223		2223	
S.E.	0.3176		0.3177		0.3178		0.3466		0.3210		0.8434		0.3476	
Sagan test Chi-square	6.073		4.244		8.313		1.219		0.550		3.182		2.185	
(P-value)	(0.108)		(0.236)		(0.039)		(0.748)		(0.907)		(0.364)		(0.534)	

Standard errors are in parenthesis. ***, **, * indicates they are significant at the 1%, 5% and 10%.

Table 2(1): The estimation results using long-term cyclical data with networking effects

	Long-term cycles													
	Networking effects included													
	Total		*Int*		*Final*		*Int_ind*		*Int_serv*		*cons*		*investment*	
Trade	-0.1090	*	-0.1349	**	-0.0708		-0.0762		-0.0007		-0.4183		-0.0537	
	(0.0586)		(0.0588)		(0.0591)		(0.1986)		(0.0936)		(0.6865)		(0.1452)	
Technology	2.3782	***	2.4239	***	2.3090	***	2.1918	***	2.1703	***	2.9505	**	2.1525	***
	(0.5263)		(0.5304)		(0.5268)		(0.5094)		(0.6344)		(1.4019)		(0.5065)	
Monetary Policy	-0.0850	**	-0.0794	**	-0.0889	**	-0.0686	*	-0.0758	**	-0.0938	*	-0.0675	
	(0.0371)		(0.0371)		(0.0380)		(0.0406)		(0.0372)		(0.0498)		(0.0424)	
Fiscal Policy	0.0609	**	0.0643	***	0.0580	**	0.0563	**	0.0584	**	0.0557	**	0.0556	**
	(0.0239)		(0.0242)		(0.0236)		(0.024)		(0.0237)		(0.2636)		(0.0245)	
Openness	-0.0353		-0.0295		-0.0477		-0.0297		-0.0468		-0.0259		-0.0434	
	(0.0775)		(0.0783)		(0.0765)		(0.0879)		(0.0758)		(0.0908)		(0.0764)	
Networking effects	2.4642	***	2.6007	***	2.2703	***	2.1490	***	2.0054	***	3.0034	*	2.1146	***
	(0.5594)		(0.5692)		(0.5444)		(0.6241)		(0.3539)		(1.73150)		(0.5790)	
Country-pair fixed effects	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Observations	2223		2223		2223		2223		2223		2223		2223	
S.E.	0.4859		0.4901		0.4810		0.4777		0.4762		0.5291		0.4773	
Sagan test Chi-square	2.384		2.154		2.832		1.175		1.099		0.154		1.725	
(P-value)	(0.496)		(0.540)		(0.418)		(0.758)		(0.777)		(0.984)		(0.631)	

Standard errors are in parenthesis. ***, **, * indicates they are significant at the 1%, 5% and 10%.

Table 2(2): The estimation results using long-term cyclical data without networking effects

	Long-term cycles													
	Networking effects excluded													
	Total		*Int*		*Final*		*Int_ind*		*Int_serv*		*cons*		*investment*	
Trade	-0.1336	**	-0.1596	**	-0.0853		-0.1010		0.0097		-0.5252		-0.0649	
	(0.0617)		(0.0626)		(0.0612)		(0.2089)		(0.0918)		(0.8559)		(0.1503)	
Technology	2.2697	***	2.3063	***	2.2231	***	2.0663	***	2.0081	***	2.9526	*	2.0195	***
	(0.5315)		(0.5368)		(0.5288)		(0.5104)		(0.6153)		(1.5918)		(0.5111)	
Monetary Policy	-0.0604		-0.0520		-0.6754	*	-0.0435		-0.0545		-0.0647		-0.0436	
	(0.0370)		(0.0374)		(0.0375)		(0.0432)		(0.0361)		(0.0448)		(0.0446)	
Fiscal Policy	0.0517	**	0.0551	**	0.0491	**	0.0473	*	0.0505	**	0.0426		0.0470	*
	(0.0241)		(0.0244)		(0.0238)		(0.0246)		(0.0235)		(0.0304)		(0.0251)	
Openness	-0.0438		-0.0380		-0.0580		-0.0330		-0.0548		-0.0346		-0.0519	
	(0.0786)		(0.0796)		(0.0773)		(0.0888)		(0.0762)		(0.0951)		(0.0768)	
Networking effects														
Country-pair fixed effects	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Observations	2223		2223		2223		2223		2223		2223		2223	
S.E.	0.4937		0.4990		0.4861		0.4817		0.4780		0.5594		0.4807	
Sagan test Chi-square	2.790		2.582		3.239		1.436		1.462		0.250		2.022	
(P-value)	(0.425)		(0.460)		(0.356)		(0.697)		(0.690)		(0.969)		(0.567)	

Standard errors are in parenthesis. ***, **, * indicates they are significant at the 1%, 5% and 10%.

Tables 3 and 4 present the results of examining the effects of the regional dummy. These are the results of the estimation with a dummy for the trade intensity (total trade) and monetary policy variables, assuming that the effects of changes in these variables differ depending on the region and stage of development.[3] This study sets a regional dummy for the Euro area (dummy 1), the European Union (dummy 2), East Asia (China, Taiwan, Indonesia, Korea, and Japan, dummy 3), three North American countries (Canada, the United States, and Mexico, dummy 4), and a developing-country dummy (nine developing countries listed in Chapter 4, dummy 5).

In Table 3 (1), which presents the estimation result of the short-term cycle, the conclusion that the trade variable does not affect the business cycle when the networking effect is added, remains unchanged except in the estimations with dummies 1 and 2 (Euro area and European Union). These results are consistent with previous researches. As discussed previously, the effect of trade on business cycle linkage between pairs of developed and developing countries is detected differently because inter-industrial rather than intra-industrial trade is predominant in pairs of developing countries; thus, the economies of the countries involved in trade tend to move asymmetrically. However, economies tend to comove among industrialised countries, as horizontal intra-industry trade, which exchanges differentiated final goods belonging to the same industry, is predominant. The networking effect on business cycle linkage was significant in all estimations. The monetary policy variables for which significant results under assumed sign conditions were not obtained in Tables 1 are significant under the assumed sign conditions in the estimations with dummies 1 and 2. The estimation results for the short-term cycle without networking effects in Table 3 (2) are almost identical to those in Table 3 (1).

The estimation results for the long-term cycle in Table 4 are almost the same as those for the short-term cycle. However, the coefficients of the interaction term between the trade and dummy variables are insignificantly estimated, and the coefficients of the trade variable are estimated with the minus sign in almost every case, regardless of whether the networking effect is included or not.

The aforementioned estimation results are summarised as follows: (1) The trade intensity between two countries has no positive effect on their business cycle synchronisation with the exception of the short-term cycles in European countries; (2) The networking of trade, in which numerous countries participate, enhances business cycle synchronisation in two countries. This result is confirmed when tradables are divided into final and intermediate goods, and trade variables are estimated with different

Table 3: The estimation results of the estimation with a dummy for the trade intensity (total trade) and monetary policy variables (short-term cycles)

Short-term cycles										
Networking effects included										
	dummy 1		*dummy 2*		*dummy 3*		*dummy 4*		*dummy 5*	
Trade	-0.0806	**	-0.0901	**	-0.0144		-0.0053		0.0430	
	(0.0439)		(0.0454)		(0.0385)		(0.0442)		(0.0439)	
Trade*dummy	0.3397	***	0.2676	***	0.0251		-40.4881		-0.2454	**
	(0.1121)		(0.0895)		(0.2906)		(27.2734)		(0.1018)	
Technology	2.2761	***	2.0011	***	2.1444	***	2.2571	***	2.2646	***
	(0.3574)		(0.3567)		(0.3435)		(0.4044)		(0.3534)	
Monetary Policy	0.0631	*	0.0532		-0.0193		-0.0207		-0.0488	*
	(0.0333)		(0.0386)		(0.0243)		(0.0279)		(0.0268)	
Monetry Policy*dummy	-0.1951	***	-0.1086	**	-0.2050		-28.6254		0.1117	
	(0.0492)		(0.0506)		(2.1167)		(19.9147)		(0.0722)	
Fiscal Policy	-0.0455	***	-0.0352	**	-0.0342	**	-0.0399	**	-0.0313	**
	(0.0164)		(0.0161)		(0.0156)		(0.01837)		(0.0159)	
Openness	0.0695		0.0666		0.0685		0.0675		0.0589	
	(0.0523)		(0.0522)		(0.0505)		(0.0582)		(0.0516)	
Networking effects	0.8714	**	0.8630	**	0.8304	**	0.9235	**	0.9063	**
	(0.3786)		(0.3780)		(0.3655)		(0.4259)		(0.3731)	
Country-pair fixed effects	Yes		Yes		Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes		Yes		Yes	
Observations	2223		2223		2223		2223		2223	
S.E.	0.3281		0.3273		0.3170		0.3652		0.3229	
Sagan test Chi-square	6.504		8.074		9.825		6.006		10.733	
(P-value)	(0.260)		(0.152)		(0.080)		(0.305)		(0.056)	

Standard errors are in parenthesis. ***, **, * indicates they are significant at the 1%, 5% and 10%.

Table 3.2: (1) Networking effects included (2) Networking effects excluded

	Short-term cycles									
	Networking effects excluded									
	dummy 1		*dummy 2*		*dummy 3*		*dummy 4*		*dummy 5*	
Trade	-0.0018		-0.0949	**	-0.0213		-0.0129		0.0348	
	(0.0462)		(0.0463)		(0.0400)		(0.0461)		(0.0453)	
Trade*dummy	0.3696	***	0.2616	***	0.0354		-41.5697		-0.2408	**
	(0.1149)		(0.0896)		(0.2915)		(27.5974)		(0.1019)	
Technology	2.0945	***	1.9630	***	2.1048	***	2.2176	***	2.2194	
	(0.3644)		(0.3550)		(0.3423)		(0.4052)		(0.3517)	
Monetary Policy	0.0718	**	0.0598		-0.0109		-0.0114		-0.0388	
	(0.0340)		(0.0387)		(0.0238)		(0.0276)		(0.0264)	
Monetry Policy*dummy	-0.1882	***	-0.1055	**	-0.2956		-29.5128		0.1071	
	(0.0504)		(0.0505)		(2.1224)		(20.1587)		(0.0724)	
Fiscal Policy	-0.0507	***	-0.0384	**	-0.0373	**	-0.0435	**	-0.0348	**
	(0.0167)		(0.0160)		(0.0155)		(0.0185)		(0.0148)	
Openness	0.0579		0.0635		0.0656		0.0642		0.0558	
	(0.0536)		(0.0522)		(0.0506)		(0.0587)		(0.0516)	
Networking effects										
Country-pair fixed effects	Yes		Yes		Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes		Yes		Yes	
Observations	2223		2223		2223		2223		2223	
S.E.	0.3365		0.3275		0.3178		0.3684		0.3236	
Sagan test Chi-square	6.371		8.202		11.253		6.134		10.570	
(P-value)	(0.271)		(0.145)		(0.046)		(0.293)		(0.060)	

Standard errors are in parenthesis. ***, **, * indicates they are significant at the 1%, 5% and 10%.

Table 4: The estimation results of the estimation with a dummy for the trade intensity (total trade) and monetary policy variables (long-term cycles)

Long-term cycles										
Networking effects included										
	dummy 1		*dummy 2*		*dummy 3*		*dummy 4*		*dummy 5*	
Trade	-0.1268	*	-0.1226	*	-0.1147	*	-0.1117	*	-0.1031	
	(0.0651)		(0.0673)		(0.0591)		(0.0590)		(0.0660)	
Trade*dummy	0.0474		0.0269		0.1110		-6.8202		-0.0271	
	(0.1662)		(0.1328)		(0.4463)		(36.3796)		(0.1531)	
Technology	2.4126	***	2.3085	***	2.3819	***	2.4219	***	2.4087	***
	(0.5299)		(0.5293)		(0.5276)		(0.5394)		(0.5312)	
Monetary Policy	0.0010		0.0596		-0.0853	**	-0.0856	**	-0.1258	***
	(0.0495)		(0.0573)		(0.0372)		(0.0372)		(0.0403)	
Monetry Policy*dummy	-0.1941	***	-0.2432	***	-0.8347		-7.4107		0.2625	**
	(0.0730)		(0.0752)		(3.2509)		(26.5639)		(0.1085)	
Fiscal Policy	0.0573	**	0.0580	**	0.0611	**	0.0602	**	0.0629	***
	(0.0243)		(0.0239)		(0.0239)		(0.0245)		(0.0239)	
Openness	-0.0330		-0.0332		-0.0349		-0.0344		-0.0389	
	(0.0776)		(0.0775)		(0.0776)		(0.0777)		(0.0776)	
Networking effects	2.5515	***	2.5505	***	2.4857	***	2.4955	***	2.5105	***
	(0.5614)		(0.5608)		(0.5614)		(0.5681)		(0.5609)	
Country-pair fixed effects	Yes		Yes		Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes		Yes		Yes	
Observations	2223		2223		2223		2223		2223	
S.E.	0.4865		0.4856		0.4868		0.4871		0.4854	
Sagan test Chi-square	6.504		2.001		2.857		6.006		10.733	
(P-value)	(0.260)		(0.761)		(0.721)		(0.305)		(0.056)	

Standard errors are in parenthesis. ***, **, * indicates they are significant at the 1%, 5% and 10%.

Table 4.2: (1) Networking effects included (2) Networking effects excluded

	Long-term cycles									
	Networking effects excluded									
	dummy 1		*dummy 2*		*dummy 3*		*dummy 4*		*dummy 5*	
Trade	-0.1034		-0.1381	**	-0.1354	**	-0.1314	**	-0.1269	*
	(0.0668)		(0.0697)		(0.0623)		(0.0620)		(0.0690)	
Trade*dummy	0.0741		0.0090		0.1416		-9.6094		-0.0153	
	(0.1663)		(0.1349)		(0.4533)		(37.0786)		(0.1552)	
Technology	2.2202	***	2.1982	***	2.2636	***	2.3138	***	2.2854	***
	(0.5270)		(0.5341)		(0.5321)		(0.5444)		(0.5354)	
Monetary Policy	0.0214		0.0794		-0.0603		-0.0606		-0.0981	**
	(0.0492)		(0.0582)		(0.0371)		(0.03719)		(0.0402)	
Monetry Policy*dummy	-0.1790	**	-0.2343	***	-1.1060		-9.7109		0.2496	**
	(0.0729)		(0.0761)		(3.2997)		(27.0824)		(0.1102)	
Fiscal Policy	0.0469	*	0.0485	**	0.0518	**	0.0505	**	0.0534	**
	(0.0242)		(0.0241)		(0.0242)		(0.02487)		(0.0241)	
Openness	-0.0466		-0.0423		-0.0438		-0.0434		-0.0473	
	(0.0775)		(0.0785)		(0.0787)		(0.0789)		(0.0786)	
Networking effects										
Country-pair fixed effects	Yes		Yes		Yes		Yes		Yes	
Year fixed effects	Yes		Yes		Yes		Yes		Yes	
Observations	2223		2223		2223		2223		2223	
S.E.	0.4867		0.4928		0.4941		0.4950		0.4926	
Sagan test Chi-square	6.371		8.202		11.253		6.134		10.570	
(P-value)	(0.271)		(0.145)		(0.046)		(0.293)		(0.060)	

Standard errors are in parenthesis. ***, **, * indicates they are significant at the 1%, 5% and 10%.

dummy variables; (3) The significance of the monetary and fiscal policy variables varies depending on different specifications; however, these variables tend to be estimated with the expected sign condition in the long-term cycle estimations; and (4) The correlations between two countries' technology shocks are estimated significantly as positive coefficients, as expected in all specifications.

6. Conclusion

We examined how the results would change when the networking effects of trade were considered in an analysis regressing the linkage of two countries' business cycles on the strength of trade between them. Regarding the networking effect of trade, we used an index of the degree to which two countries share a common trading partner besides one another. This study considered the possibility that the correlation coefficient of business cycles increases under the influence of third countries. The results of the analysis indicated that the networking of trade enhances business cycle linkages, but bilateral trade has no such effects. This result remained unchanged when tradable goods were divided into final goods and intermediate goods, final goods were divided into investment and consumer goods, and intermediate goods were divided into manufacturing and service industries. Estimates that do not incorporate networking effects may misunderstand correlations between trade and business cycle linkages, and the results of this study are likely to effect major changes to future research in this area.

Notes

1. https://data.worldbank.org/indicator/TM.TAX.MRCH.WM.AR.ZS
2. We also estimated equations with the interaction terms between the fiscal policy variable and dummies and between the networking effect and various trade variables. The coefficients of these interaction terms were insignificantly estimated. The latter estimation was conducted to examine the possibility that the effect of trade networking on business cycle linkages would be different depending on different tradables.

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