# Does Intra-Regional Trade Matter in Regional Stock Markets?: New Evidence from Asia-Pacific Region

Sei-Wan Kim [*], Moon Jung Choi [**], Young-Min Kim [***]

**Abstract**

We provide new evidence on the relationship between bilateral trade and stock market return over the Asia-Pacific region. Using three regional blocs in the Asia-Pacific region – the Far Eastern bloc, the Chinese bloc, and the Australian bloc, we examine whether trade linkages between countries affect their stock returns. By incorporating two distinct dynamic properties of regime shifting and co-integration in intra-regional trade and stock market return, we employ a newly suggested multi-variable smooth transition autoregressive vector error correction model (STAR-VECM). A series of estimations reveals evidence that bilateral trade significantly Granger-causes stock returns in the Asia-Pacific region; and the effects are asymmetric depending on economic regime, varying across country pairs. Among the three blocs, Far Eastern bloc displays the most pronounced positive effect of bilateral trade growth on stock returns compared to other blocs.

**Keywords**: Regional trade, Stock markets, Regime change, Smooth Transition Autoregressive Model.

**JEL Classifications**: F15, G14, C40, C51

* Department of Economics, Ewha Womans University, E-mail: swan@ewha.ac.kr
** Economic Research Institute, Bank of Korea, E-mail: mjchoi@bok.or.kr
*** Kangwon National University, E-mail: ymkim1@kangwon.ac.kr

The authors are grateful to Woon Gyu Choi, Geun-Young Kim, Hyun Hak Kim, Seungwon Kim, Ahrang Lee, Jaerang Lee, Hyung-kwon Jeong, Kum Hwa Oh, Seryoung Park, Wook Sohn, an anonymous referee, and participants in the seminar at the Bank of Korea and at the Korea International Economic Association Annual Meeting for their helpful comments. We also thank Hyunkyung Choi for careful editing. The views expressed herein are those of the authors and do not necessarily reflect the official views of the Bank of Korea. When reporting or citing this paper, the authors' names should always be explicitly stated.

# 1. Introduction

Since the 2000s, trade within the Asia-Pacific region has increased much faster than the world average.[1] The spread of global value chain and the growth of intermediate goods trade in the region made their economies more dependent on one another. At the same time, financial markets – particularly, stock markets – also developed enormously in this region. Based on the fact that many Asian-Pacific countries are foreign dependent economies with high trade intensity, it is questionable whether the trade growth significantly affects their stock market growth. Trade may affect their financial sector as more financial transactions occur with an increase in trade. Also, firms' trade performance should directly and indirectly affect their stock value. Considering that stock markets quickly reflect firm performances as well as macroeconomic activities, the noticeable growth of stock markets in Asian-Pacific countries should be related with and affected by their trade growth.[2] Against this backdrop, this paper aims to investigate how the bilateral trade between Asian-Pacific countries affects their stock markets.

While there have been many studies examining the relationship between stock markets and trade linkages among countries,[3] we particularly focus on the Asia-Pacific region, considering the distinct characteristics of trade and stock market movements in the region to setup a more appropriate empirical specification. One of the challenges in investigating the relationship is that an economic regime change has to be taken into account because bilateral trade and stock market movements are very susceptible to changes in economic regimes, such as booms and recessions. As an extreme example, the global financial crisis in 2008-09 had a devastating impact on trade and stock markets. Especially, the boom-and-bust stock market cycle of the Asia-Pacific region is known to change more frequently and stay in the same regime much shorter, compared to matured stock markets such as the G7 markets (Edwards et al., 2003; Kim et al., 2015). Another challenge is the long-run co-movement of stock indices between countries, which needs to be considered in the model specification (Azman-Saini et al., 2002; Sharma and Wongbangpo, 2002; Valadkhani and Chancharat, 2008).

---

[1] Trade within the Asia-Pacific region (for 8 sample countries) increased by 2.5 times in a nominal term (from 1.18 tril. USD to 4.14 tril. USD) from 2000 to 2013; while world trade only grew by 1.9 time (from 12.96 tril. USD to 37.31 tril. USD) for the same period. (Data source: DOTs IMF)

[2] See figures in Appendix for the movement of real stock index and real bilateral trade value in Asian-Pacific sample countries.

[3] In general, the relation between trade and cross-border capital flow has been discussed in literature on trade and international finance. The neoclassical trade theory (Heckscher-Ohlin-Mundell model) views the trade-capital flow relation as substitutes, while recent studies (Antras and Caballero, 2009; Obstfeld and Rogoff, 2001) view the relation as complements. A growing volume of empirical studies regard trade linkages between countries as a significant determinant of their stock market co-movement (Chen and Zhang, 1997; Bracker et al., 1999; Soydemir, 2000; Pretorius, 2002; Chinn and Forbes, 2004; Chambet and Gibson, 2008; Tavares, 2009; Beine et al., 2010; Walti, 2011; Paramati et al., 2016). Their findings support the positive relation between trade growth and stock market co-movement, and some of them explain that the growth of bilateral trade between two countries makes their stock markets more correlated. Other studies show that the effect of trade on stock markets is not always positive depending on country groups and trade structure (Liu et al., 2006; Bracker et al., 1999; Johnson and Soenen, 2002; Narayan et al., 2014).

Unless considering this dynamic property, the probability of misspecification would be high in the empirical framework.

We, therefore, investigate the mutual relation between stock markets and intra-regional bilateral trade by incorporating two distinct features of endogenous state changes and co-integration between stock markets in a framework of the Smooth Transition Autoregressive Vector Error Correction model (STAR-VECM). The STAR-VECM methodology allows us to determine stock markets' boom-and-bust by individual markets' endogenous characteristics unlike previous studies that determine stock market cycles through ad hoc defined characteristics between stock markets (Edwards et al., 2003; Candelon et al., 2008; Yu et al., 2010). Another important advantage of using the STAR-VECM model is that we can capture asymmetric effects that can differ depending on economic regimes.

For our empirical analysis, we select eight Asian-Pacific countries (Australia, China, Hong Kong, Japan, Korea, New Zealand, Singapore, and Taiwan) based on their importance in intra-regional trade and stock market development (Lee et al., 2012; Kim et al., 2015).[4] The eight Asian-Pacific countries are playing a major role in the regional trade and have relatively developed financial markets in the region. Therefore, as for a country whose share of regional trade is substantial and stock market is mature, its trade growth is highly likely to be linked to the business performance of the country, ultimately affecting their stock returns.[5]

We further divide these sample countries into three regional blocs considering their geographical closeness, trade relationship, and shared cultural backgrounds as follows: a) Far Eastern Asian bloc: China, Japan and Korea, b) Chinese bloc: China, Hong Kong and Taiwan, and c) Australian bloc: Australia, New Zealand and Singapore.[6] These countries are leading economies in the region with the large share of trade and the significant size of financial markets. Therefore our analysis focuses more on implications specified for the region.

The STAR-VECM estimation result reveals that the growth of bilateral trade and stock returns exhibit non-linear movements with regime changes and that stock markets are co-integrated. The cumulative net effects show that the growth of bilateral trade Granger-causes changes in stock returns in each country; and the effects differ in magnitude and signs depending on regime shifting, indicating that trade growth has either a negative or a positive effect on stock returns with different magnitudes according to country pair and regime shifting. Among the three country blocs, however, the Far Eastern bloc displays the most frequent positive effect of trade on stock returns with a large magnitude compared to the other two blocs, suggesting that the positive effect of trade growth on stock returns is most pronounced in the Far Eastern bloc.

[4] In our analysis, the ASEAN bloc is not included due to the relatively small stock market size and limited data even though its trade is quite sizable and important in the region.

[5] It is continuously reported that early 2017 stock market booms in the Asia-Pacific region are highly associated with global trade recovery. CNNFN May 2017.

[6] When grouping Australia and Singapore in the same bloc, we consider the case that Singapore Stock Exchange has attempted to merger with Australian Stock Exchange even though the proposal was rejected in 2011 on financial regulatory grounds.

The remainder of the paper is organized as follows. Section 2 shows literature review, and Section 3 introduces the empirical model and data. Section 4 presents STAR-VECM estimation results and interpretations of empirical results. Section 5 concludes the paper.

## 2. Literature Review

A general theoretical background of the relation between trade and cross-border capital flows can be found in trade and international finance literature. The neoclassical trade theory (Heckscher-Ohlin-Mundell model) views trade and capital flows as substitutes. Specifically, when two countries produce two goods with two factors, free trade results in factor price equalization (FPE) between the countries even without factor mobility. Thus, there is no incentive for international capital mobility to happen even if capital is perfectly mobile. Also, an increase in trade impediments to capital intensive goods in a capital-scare country induces a higher return on capital and attracts more capital inflows until FPE holds again, showing that trade and capital flows are substitutes. On the contrary, some studies argue that trade and capital mobility are complementary to each other. Feeney (1994) explains that the relationship between trade in goods and trade in assets can be complementary under endogenous resource allocations to market completeness. Antras and Caballero (2009) also show that trade and capital mobility are complements in financially underdeveloped economies. Obstfeld and Rogoff (2001) demonstrate that financial asset holdings across countries increase with the extent of goods traded. In addition, empirical studies provide evidence on the positive relationship between trade and financial integration. Lane and Milesi-Ferretti (2003) find that the growth in international asset trade is significantly associated with the growth in goods trade by analyzing data for advanced economies from 1991 to 2001; and Eichengreen and Park (2005) highlight intra-regional trade as an important determinant of financial integration by comparing Europe and Asia. However, these studies discuss capital flows and financial market integration in a broader sense rather than specifically point out stock markets, which is our interest.

Empirical studies on the relation between trade linkages and stock market integration reveal that trade relation is a significant determinant of stock market interdependence. Chen and Zhang (1997) show that countries with a tighter trade relation tend to have a strong co-movement in stock markets by analyzing Pacific-Basin countries from 1980 to 1990. Soydemir (2000) shows that the difference in stock market response patterns between two countries depends on their trade ties, using the data of trade flows between the US and its trading partners. Pretorius (2002) also shows that bilateral trade between two countries is a significant determinant of correlation between stock markets for 10 emerging countries. Chinn and Forbes (2004) suggest that bilateral trade linkages are significant determinants of stock market interdependence between large and small markets. Chambet and Gibson (2008) analyze weekly stock market data from 1995 to 2004 in 25 emerging countries and find that trade openness positively contributes to stock market integration. Tavares (2009) reveals that bilateral trade intensity increases the co-movement in stock returns, by using the panel data of

40 developed and emerging countries from the 1970s to 1990s. Beine et al. (2010) show that trade integration significantly increases the co-movement of stock market return, by using 17 advanced countries' daily stock-market index data. Walti (2011) finds that trade and financial integration contributes to higher stock market return co-movements by using data on 15 developed economies over the period of 1975-2006. Paramati et al. (2016) more specifically focus on Australia and Asian countries and find that trade intensity significantly drives the interdependence between their stock markets. Narayan et al. (2016) also show that the effect of stock market interdependence, in terms of risk-sharing, on trade in goods and services is positive in Asia, suggesting that the relationship between the two is characterized as complementary.

Meanwhile, other studies provide evidence that the effect of trade relations on stock markets may not be positive or differ depending on country groups and trade structure. Bracker et al. (1999) argue that the effect of export dependence between trading partners on stock market integration is positive, but the effect of import dependence can be ambiguous; as competitions in international markets between exporters from trading partners have negative effect on their stock returns, which can offset the positive effect of import growth between the trading partners on stock market performances. Similarly, Johnson and Soenen (2002), using daily return data from 1988 to 1998 for 12 Asian-Pacific countries, show that a higher import share has a negative effect on stock market co-movements between country pairs despite its positive effect. Liu et al. (2006) show that the positive effects of trade relations on stock market co-movements are significantly revealed only in Europe, but not in Asia. Narayan et al. (2014) find the positive effects of bilateral trade relations on stock market co-movements only for some country pairs, but find them negative for other country pairs in their sample.[7] Even though previous studies inform us that trade has either positive or negative effects on stock markets, our study more focuses on the effect of bilateral trade growth on stock returns of trading partners, using the methodology that takes into account Asia-Pacific stock market's distinct characteristics related to regime shifting.

Our empirical methodology is related to recent literature on the Asia-Pacific stock market integration that employs Granger causation tests, co-integration with consideration for regime changes in stock markets. Phylaktis (1999), Azman-Saini et al. (2002), Valadkhani and Chancharat (2008), Burdekin and Siklos (2012) use Grander causation tests or co-integration methodology and find that stock markets are significantly interdependent in the Aisa-Pacific region.[8] Along with these simple linear estimations and Granger causality tests, another influential framework takes financial market cycles into account to incorporate the dynamic properties in the model.[9] For example, Edwards et al. (2003), Candelon et al. (2008) and Yu et al. (2010) analyze Asian stock market integration incorporating market regime changes and suggest that there is a high probability of misspecification in the empirical framework without considering this regime property of Asia-Pacific stock markets. However, these

[7] Didier et al. (2012) also find that trade linkages between the US and its trading partners have no significant effect on their stock market co-movement with the US during the global financial crisis.

[8] There are also other approaches to assess stock market integration such as measuring the correlation of stock markets, but we focus on the approach using Granger-causality.

[9] See Pagan and Sossounov (2003), Edwards et al. (2003), Candelon et al. (2008) and Yu et al. (2010).

empirical frameworks include the boom-and-bust period of stock markets determined by ad hoc defined characteristics between stock markets, not by individual markets' endogenous characteristics. For employing more appropriate regime changing characteristics, Kim et al. (2015) use the smooth transition autoregressive (STAR) model because this model incorporates endogenous changes of stock market states in the traditional Granger causality test from a single empirical model. They find a significantly different degree of financial market integration in expansionary and contractionary regimes over the Asia-Pacific region. However, these studies only focus on the interconnectedness between stock market returns, without explicitly regarding trade relations as the determinant of stock market returns between foreign dependent countries.

Our study builds on the existing literature by employing a newly suggested STAR-VECM framework, and incorporating endogenous regime changes of stock index and trade as well as co-integration between stock markets of trading partners.

## 3. Empirical Model and Data

### 3.1. Smooth Transition Autoregressive (STAR) Model

Given significant evidence on co-integration between endogenous variables for countries in each bloc,[10] the most appropriate model is the one in which endogenous variables are linked by a linear long-run equilibrium relation; and adjustment toward the equilibrium is nonlinear and can be characterized by a slow regime switch triggered by a long run relationship between bloc member countries.[11] Here, the regimes are determined by the size and sign of the deviation from the equilibrium relation. Therefore, in the empirical analysis, we fully take into account non-linearity, co-integration, and regime changes.

In linear time series, this type of behavior is captured by a co-integration and a linear vector error-correction model (VECM) (Engle and Granger, 1987).[12] Escribano and Mira (2002) extend the linear VECM to a general nonlinear VECM by employing the Near Epoch Dependence (NED) concept suggested by Gallant and White (1988) and Wooldridge and White (1988). In particular, they show that the nonlinear VECM can be theoretically formalized by incorporating a smooth transition autoregressive model (STARM) among many possible nonlinear parameterizations.[13]

---

[10] For each bloc of the Asia-Pacific region, there are two groups of endogenous variables: bilateral trade between member countries; and stock market index of each country. The co-integration relationship between stock market indices in each bloc is reported in Table A2 in appendix. The result of the preliminary test for co-integration is not reported in this paper due to a space limitation, but available upon request.

[11] There are two types of nonlinear regime-switching models regarding the speed of transition between regimes: the threshold autoregressive model (TARM) developed by Tsay (1989); and the smooth transition autoregressive model (STARM) developed by Luukkonen, Saikkonen, and Teräsvirta (1988), Teräsvirta and Anderson (1992), and Teräsvirta (1994). While the TARM specifies a sudden transition between regimes with a discrete jump, the STARM allows a smooth transition between regimes.

[12] See also Johansen (1995) and Hatanaka (1996).

[13] For details of the proof, see Section 5 in Escribano and Mira (2002).

In preliminary tests, we find strong evidence in favor of smooth transition dynamics over a linear VECM using nonlinearity tests.[14] Therefore, we incorporate nonlinearity into the VECM, following recent developments in nonlinear models. Specifically, we incorporate a smooth transition mechanism into the VECM to allow for a nonlinear, which is called a smooth transition autoregressive vector error-correction model (hereafter STAR-VECM).[15] This model can be thought of as a special case of vector smooth transition autoregressive model (STARM).

In the followings, we explain the specifications of STAR-VECM based on the Far Eastern bloc out of the three blocs investigated. For the six integrated variables of the Far Eastern Region with China, Japan, and Korea – log of China-Japan trade ($y_t^1$), log of China-Korea trade ($y_t^2$), log of Japan-Korea trade ($y_t^3$), log of China's stock market index (Shang Hai Composite Index, $y_t^4$), log of Japan's stock market index (Nikkei Index, $y_t^5$), and log of Korea's stock market index (KOSPI index, $y_t^6$), – a smooth transition vector error-correction model (STAR-VECM) is given in a general form by:

$$\Delta y_t^k = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j\right] \cdot F(\Delta y_{t-d}^c) + \varepsilon_t^k, \quad \text{for k} = 1, \dots, 6. \qquad (1)$$

where $\Delta y_t^k$ is the log difference (or growth rate) of each variable for $\text{k} = 1, \dots, 6$; $z_t = \beta v_t$, for some vector $\beta$, denotes an error-correction term; and the $v_t$ is defined as $v_t' = \{1, y_t^4, y_t^5, y_t^6\}$. That is, $z_t$ is the deviation from the equilibrium relation given by $\beta' v_t = 0$. $F(\Delta y_{t-d}^c)$ is the transition function, and $\Delta y_{t-d}^c$ is a *common* transition variable. The error correction term of $z_t = \beta v_t$ is constructed by the relation among stock market indexes because this co-integration relation is found to be the most significant variable as a *common* transition variable ($\Delta y_{t-d}^c$). In the case of the Far Eastern bloc, the $v_t$ is defined as follows: $v_t' = \{1, y_t^4, y_t^5, y_t^6\}$ where $y_t^4$ is log of China's stock market index (Shang Hai Composite Index); $y_t^5$ is log of Japan's stock market index (Nikkei Index); and $y_t^6$ is log of Korea's stock market index (KOSPI index).

According to the specification of the STAR model, $\Delta y_{t-d}^c$ is the common transition variable triggering regime changes. Among quite a few candidates for common transition variable ($\Delta y_{t-d}^c$), we employ the error correction term ($z_t$) of cointegration between stock market indexes, $\{1, y_t^4, y_t^5, y_t^6\}$, because it is found to be the most significant variable to change regimes.

For the STAR-VECM, two types of the transition function specification, $F(\Delta y_{t-d}^c)$, are available: the logistic smooth transition vector error correction model (LSTAR-VECM) and the exponential smooth transition vector error correction model (ESTAR-VECM). The LSTAR-VECM is useful in describing a stochastic process that is characterized by an

[14] Linearity test result is reported in appendix.

[15] Refer to Granger and Swanson (1996) for a more general discussion, and Escribano (1987) and Escribano and Pfann (1998) for an early empirical example of nonlinear error-correcting mechanisms.

alternative set of dynamics of either the large or small value of the transition function. In the LSTAR-VECM, the transition function is given by the following logistic function:[16]

$$F(\Delta y_{t-d}^{c}) = [1 + \exp\{-\gamma(\Delta y_{t-d}^{c} - C)\}]^{-1}, \gamma > 0. \quad (2.1)$$

In contrast, the ESTAR-VECM is more appropriate in generating another dynamics of both large and small magnitudes of the transition variable. In the ESTAR-VECM, the transition function is given by:[17]

$$F(\Delta y_{t-d}^{c}) = 1 - \exp\{-\gamma(\Delta y_{t-d}^{c} - c)^2\}, \gamma > 0. \quad (2.2)$$

The adjustment parameter, $\gamma$, in both models represents the speed of transition between the two regimes: the greater the value of $\gamma$, the faster the transition between the regimes. In the limit, as the value of $\gamma$ approaches infinity, the model degenerates to the conventional threshold autoregressive model (TARM) of Tsay (1989). Alternatively, if $\gamma$ approaches zero so that the value of the transition function $F(\Delta y_{t-d}^{c})$ approaches zero, then the model degenerates to a linear AR model, with $\rho_j^i$ parameters unidentifiable.

In specifying the STAR-VECM, the *cet* (or error correction term) is selected as the common transition variable in $F(\Delta y_{t-d}^{c})$. Thus, in equation (3), we redefine $z_{t-d}$ as $cet_{t-d}$ following Lettau and Ludvigson's (2001, 2004) "*cay*" to emphasize the role of $cet_{t-d}$ in STAR-VECM estimation. The property of the *cet* or the error correction term's common transition variable has been discussed in several studies including Granger and Swanson (1996), Anderson and Vahid (1998), and Dijk et al. (2002). We also notice that Lettau and Ludvigson's (2001, 2004) "*cay*" corresponds to the "common transition variable" $(\Delta y_{t-d}^{c})$ in the STAR-VECM model.

In accordance with the above discussions on STAR-VECM model specification, common transition variable selection, co-integration test, nonlinearity test, and model selection test, we specify our STAR-VECM as follows:

---

[16] The logistic function, $F(\Delta y_{t-d}^{c})$, takes a value from the range between 0 and 1, depending on the degree and direction by which $\Delta y_{t-d}^{c}$ deviates from c, the switching value of the transition variable. The estimated value of c defines a transition between the two regimes: $0 < F(\Delta y_{t-d}^{c}) < 0.5$ (a lower regime) for $\Delta y_{t-d}^{c} < c$; and $0.5 < F(\Delta y_{t-d}^{c}) < 1$ (an upper regime) for $\Delta y_{t-d}^{c} > c$. When $\Delta y_{t-d}^{c} = c$, $F(\Delta y_{t-d}^{c}) = 0.5$ so that the current dynamics of $\Delta y$ (or growth rate) is the halfway between the upper and lower regimes; especially when $\Delta y_{t-d}^{c}$ takes a large value (i.e., $\Delta y_{t-d}^{c} \gg c$), $\exp\{-\gamma(\Delta y_{t-d}^{c} - c)\}$ is close to zero. As a result, the value of $F(\Delta y_{t-d}^{c})$ approaches one; and the dynamics of $\Delta y$ is generated by both $\phi_j^i$ and $\rho_j^i$ in equation (1). In addition, for a small value of $\Delta y_{t-d}^{c}$ (i.e., $\Delta y_{t-d}^{c} \ll c$), $\exp\{-\gamma(\Delta y_{t-d}^{c} - c)\}$ is close to a big number. Then, the value of the transition function $F(\Delta y_{t-d}^{c})$ approaches zero; and the dynamics of $\Delta y_t$ is generated by only the $\phi_j^i$ parameter in equation (1).

[17] For a large or small value of $\Delta y_{t-d}^{c}$, the value of $\exp\{-\gamma(\Delta y_{t-d}^{c} - c)^2\}$ approaches 0, and the value of the transition function approaches 1. The dynamics of $\Delta y_t$ is generated by both $\phi_j^i$ and $\rho_j^i$ in equation (1). When the value of $\Delta y_{t-d}^{c}$ is close to c, the value of $\exp\{-\gamma(\Delta y_{t-d}^{c} - c)^2\}$ approaches 1 and the value of the transition function approaches 0. In these cases, the dynamics of $\Delta y_t$ is generated only by the $\phi_j^i$ parameters in equation (1).

$$\Delta y_t^k = \left[\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\phi_i^j \Delta y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\rho_i^j \Delta y_{t-i}^j\right]\cdot F(cet_{t-d}) + \varepsilon_t^k, \quad \text{for k=1,…,6} \qquad (3)$$

With an example of the Far Eastern bloc, the variables in equation (3) can be defined as following: $\Delta y_t^1$ is trade growth between China and Japan; $\Delta y_t^2$ is between China and Korea; $\Delta y_t^3$ is between Japan and Korea; $\Delta y_t^4$ is stock return of China (Shang Hai Composite Index); $\Delta y_t^5$ is that of Japan (Nikei Index); $\Delta y_t^6$ is that of Korea (KOSPI Index); and $cet_{t-d}$ = common transition variable.[18] In the Appendix, we discuss the linearity test procedure and the choice of the STAR model between LSTAR and ESTAR.

## 3.2. Data

We employ monthly stock market index data from Bloomberg for eight Asian-Pacific markets covering Australia (AS51), China (SHANGHAI Composite), Hong Kong (Hang Seng), Japan (Nikkei 225), Korea (KOSPI), New Zealand (NZSE50 FG), Singapore (FSSTI), and Taiwan (TWSE). Monthly bilateral trade data between each pair of the countries are obtained from CEIC and IMF's Direction of Trade Statistics (DOTs).[19] The stock market index and bilateral trade values are deflated using Consumer Price Index (CPI) of each country. We choose the data range starting from January 2000 to December 2013 for all countries except New Zealand (from January 2001) due to data availability. Each variable is transformed into value in logarithm, and the monthly change of each variable is obtained as log difference.[20] In conducting empirical work, the whole Asia-Pacific region is divided into three regional blocs depending on geographical closeness, trade relation, and shared cultural backgrounds. They are *a*) *Far Eastern Asian bloc*: China, Japan and Korea, *b*) *Chinese bloc*: China, Hong Kong and Taiwan, *c*) *Australian bloc*: Australia, New Zealand and Singapore.

Table 1 presents summary statistics for log of real stock market indexes, log of real bilateral trade values and their monthly changes. In the Far Eastern bloc, Korea records the highest average monthly growth of real stock returns at 0.21% while Japan records the lowest average at -0.01% over the period from 2000 to 2013. China shows the most volatile monthly

[18] This notation is based on the Far Eastern Asian bloc. We divide the whole Asia-Pacific region into three regional blocs depending on geographical vicinity, economic relationship and shared cultural backgrounds. They are a) Far Eastern Asian bloc: China, Japan and Korea, b) Chinese bloc: China, Hong Kong and Taiwan, c) Australian bloc: Australia, New Zealand and Singapore.

[19] Bilateral trade values (the sum of import and export values) in each country's domestic currency are directly obtained from CEIC; but in the case of China and Korea, their trade values in USD from DOTs are converted to domestic currency using monthly end exchange rates. In each pair of countries, there are the two series of total trade values represented by each country's currency; thus we choose the trade value represented by the currency of a more influential country in terms of economic size in the bloc to take more representative data into account.

[20] The data used in this analysis are not seasonally adjusted to utilize full information on each data, given that the STAR methodology intrinsically takes into account the regime change over the economic cycle. For each time-series, Dicky-Fuller test is conducted to confirm the non-stationarity of the data; and the results are available upon request since they are not reported in the paper due to a space limitation.

stock return with its standard deviation of 0.08, while Japan shows the least volatile with the standard deviation of 0.06. For the monthly growth of real bilateral trade values, trade between China and Korea shows the highest growth of 1.03% while trade between Japan and Korea shows the lowest of 0.42%. The China-Japan trade indicates the highest standard deviation of 0.15 while Japan-Korea trade records the lowest of 0.08.

In the Chinese bloc, Hong Kong shows the highest average real stock return growth at 0.13% while Taiwan shows the lowest at -0.16% during the whole sample period. Average trade between China and Taiwan grows largest by 0.86%, compared to other two country pairs, with the highest standard deviation of 0.16, but the Hong Kong-Taiwan trade only grows by 0.4% on average during the same period with the lowest standard deviation of 0.13.

Finally, in the Australian bloc, New Zealand shows the highest growth of real stock returns at 0.41% with the smallest standard deviation of 0.04 while Singapore shows the lowest growth at 0.03% with the largest standard deviation of 0.06. The monthly growth of real trade between Singapore and New Zealand is 0.77% on average with the highest volatility while the growth of real trade between Australia and New Zealand is 0.2% with the lowest volatility.

**Table 1. Summary Statistics**

| | | Mean | Standard Deviation |
|---|---|---|---|
| **Far Eastern Bloc** (China, Japan and Korea) | Stock return of China (SHANGHAI Composite) | 0.00004 | 0.0812 |
| | Stock return of Japan (Nikkei 225) | -0.00098 | 0.0596 |
| | Stock return of Korea (KOSPI) | 0.0021 | 0.0711 |
| | Trade growth between China and Japan | 0.0061 | 0.1480 |
| | Trade growth between China and Korea | 0.0103 | 0.1310 |
| | Trade growth between Japan and Korea | 0.0042 | 0.0772 |
| **Chinese Bloc** (China, Hong Kong and Taiwan) | Stock return of China (SHANGHAI Composite) | 0.0004 | 0.0812 |
| | Stock return of Hong Kong (Hang Seng) | 0.0013 | 0.0634 |
| | Stock return of Taiwan (TWSE) | -0.0016 | 0.0725 |
| | Trade growth between China and Hong Kong | 0.0100 | 0.1881 |
| | Trade growth between China and Taiwan | 0.0086 | 0.1562 |
| | Trade growth between Hong Kong and Taiwan | 0.0043 | 0.1272 |
| **Australian Bloc** (Australia, New Zealand and Singapore) | Stock return of Australia (AS51) | 0.0009 | 0.0378 |
| | Stock return of New Zealand (NZSE50 FG) | 0.0041 | 0.0361 |
| | Stock return of Singapore (FSSTI) | 0.0003 | 0.0590 |
| | Trade growth between Australia and New Zealand | 0.0020 | 0.1227 |
| | Trade growth between Australia and Singapore | 0.0038 | 0.1867 |
| | Trade growth between New Zealand and Singapore | 0.0077 | 0.3180 |

# 4. Estimation Results

## 4.1. STAR-VECM Estimation Results

First, we present the estimation results of main parameters of the Far Eastern bloc STAR-VECM of equation (3) in Table 2.[21] It needs to be noted that the significance of the $\gamma$-parameter is crucial in estimating STAR model because its significance is evidence of STAR model specification, compared to the other regime switching models such as Markow switching model.[22]

Panel A in Table 2 shows the results of the Far Eastern bloc. It shows that the value of the $\gamma$-parameter, representing the speed of regime shifting, is positive and significant at the 1% level for the trade growth between China and Japan ($\Delta y_t^1$), China and Korea ($\Delta y_t^2$) and Japan and Korea ($\Delta y_t^3$); and the stock return of Japan (Nikei Index) ($\Delta y_t^5$) and Korea (KOSPI index) ($\Delta y_t^6$), except the case of stock return of China (Shang Hai Composite Index) ($\Delta y_t^4$). The value of the $\gamma$-parameter shows that the growth of Japan-Korea trade and the growth of stock returns in Korea exhibit a relatively slow transition between the two regimes, while the growth of the China-Korea trade and the growth of stock returns in Japan display a relatively fast and more frequent transition between the two. Also, it needs to be pointed out that the *c*-parameter indicates a halfway point between the expansion and contraction phases of the *cet*. In all cases, the estimated values of *c* are close to zero, that is, the mean value of the *cet*. The *c*-parameter estimates, close to zero, imply that all variable regime changes are triggered when the *cet* stays away from zero.

Second, Panel B presents estimation results of equation (3) for the Chinese bloc. In the whole sample period (2000-2013), the value of the $\gamma$-parameter is positive and significant at the 10% level for the trade growth between China and Taiwan ($\Delta y_t^2$), and Taiwan and Hong Kong ($\Delta y_t^3$); and the stock return of China (Shang Hai Composite Index) ($\Delta y_t^4$), Hong Kong (Hang Seng Index) ($\Delta y_t^5$) and Taiwan (Taiwan Stock Exchange index) ($\Delta y_t^6$), except for the case of the trade growth between China and Hong Kong ($\Delta y_t^1$) where the $\gamma$-parameter is positive but not significant. The value of the $\gamma$-parameter shows that the speed of transition between two regimes is relatively slow in Hong Kong, but relatively fast in Taiwan during the growth in stock returns. The *c*-parameter indicates the halfway point between the expansion and contraction phases of the *cet*. Similar to the Far Eastern estimation results, in all cases, the estimated values of *c* are close to zero. That is, all variable regime changes are triggered when the *cet* stays away from zero.

Finally, Panel C reports the estimation results of equation (3) for the Australian bloc. The value of the $\gamma$-parameter is always positive and significant at the 10% level for all the

---

[21] Full estimation results are not reported in the paper due to a space limitation, but available upon request. According to the model selection test between LSTAR and ESTAR, the LSTAR is preferred significantly. We perform Ljung Box and ARCH-LM tests to check for misspecification. These results, which are available from the authors, indicate no evidence of misspecification.

[22] In the case of Markow switching model, the $\gamma$-parameter would be infinity while a linear model (or simple VECM)'s the $\gamma$-parameter is zero.

variables. The results show that the Singapore-New Zealand trade and the stock return growth in Singapore display a faster and more frequent transition between expansion and contraction regimes compared to other variables. Also, similar to the previous estimations, the *c*-parameter, indicating the halfway point between the two regimes of the *cet*, is estimated to be close to zero, except for the stock return growth in New Zealand. This result implies that regime changes of all variables, except for the New Zealand stock return growth, are triggered when the *cet* stays away from zero.

## Table 2. Estimation Results of Nonlinear STAR-VECM in Each Bloc

This table presents the estimation results of STAR-VECM for equation (3). Panel A, B, and C show the results of the Far Eastern bloc, the Chinese bloc, and the Australian bloc, respectively.

$$\Delta y_t^k = [\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p} \phi_i^j \Delta y_{t-i}^j] + [\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p} \rho_i^j \Delta y_{t-i}^j] \cdot F(cet_{t-d}) + \varepsilon_t^k, \text{ for k=1,…,6} \quad (3)$$

| **Panel A : Far Eastern Bloc (China, Japan, and Korea)** | | | | | | |
|---|---|---|---|---|---|---|
| | $\Delta y_t^1$ (growth of China-Japan trade) | $\Delta y_t^2$ (growth of China-Korea trade) | $\Delta y_t^3$ (growth of Japan -Korea trade) | $\Delta y_t^4$ (stock return of China) | $\Delta y_t^5$ (stock return of Japan) | $\Delta y_t^6$ (stock return of Korea) |
| $\gamma^j$ | 22.2005*** (2.9873) | 50.5157*** (4.3622) | 2.9449*** (3.6173) | -33.5891* (-1.9499) | 59.1585*** (37592) | 4.8164*** (2.6788) |
| $c^i$ | 0.1616*** (25.6678) | -0.2028*** (-48.3233) | 0.4320*** (20.3367) | 0.3047*** (14.0957) | 0.0663*** (9.5614) | 0.1810*** (8.2389) |
| | ESTAR | ESTAR | ESTAR | LSTAR | ESTAR | ESTAR |
| **Panel B : Chinese bloc (China, Hong Kong and Taiwan)** | | | | | | |
| | $\Delta y_t^1$ (growth of China-Hong Kong trade) | $\Delta y_t^2$ (growth of China-Taiwan trade) | $\Delta y_t^3$ (growth of Taiwan -Hong Kong trade) | $\Delta y_t^4$ (stock return of China) | $\Delta y_t^5$ (stock return of Hong Kong) | $\Delta y_t^6$ (stock return of Taiwan) |
| $\gamma^j$ | 37.8590 (1.3307) | 9.3889* (1.6637) | 5.0312* (1.8407) | 4.7471** (2.2474) | 2.6156** (2.2553) | 15.5731*** (3.0632) |
| $c^i$ | -0.0847*** (-12.8691) | 0.1208*** (7.4843) | 0.0142 (1.4051) | -0.0314*** (-2.8930) | -0.0921*** (-6.9688) | -0.0562*** (-9.0288) |
| | LSTAR | LSTAR | ESTAR | ESTAR | LSTAR | ESTAR |
| **Panel C : Australian Bloc (Australia, New Zealand, and Singapore)** | | | | | | |
| | $\Delta y_t^1$ (growth of Australia-New Zealand trade) | $\Delta y_t^2$ (growth of Singapore-Australia trade) | $\Delta y_t^3$ (growth of Singapore-New Zealand trade) | $\Delta y_t^4$ (stock return of Australia) | $\Delta y_t^5$ (stock return of New Zealand) | $\Delta y_t^6$ (stock return of Singapore) |
| $\gamma^j$ | 3.8737** (2.0883) | 6.8614** (2.1000) | 21.4005** (2.1016) | 2.8165* (1.9982) | 2.3427* (1.9720) | 17.1223*** (4.7183) |
| $c^i$ | -0.1568*** (-5.7005) | -0.0366 (-1.4724) | 0.0879*** (8.5745) | 0.0173* (1.8730) | 13.5284*** (3.1741) | 0.0104*** (7.8411) |
| | ESTAR | LSTAR | LSTAR | ESTAR | LSTAR | LSTAR |

Notes: Values under regression coefficients in parenthesis are heteroskedasticity robust t-statistics. * : significant at 10% level and **: significant at 5% level. Full estimation results for all parameter estimates are not presented due to a space limitation, but available upon request.

## 4.2. Cumulative Net Effects and Granger-Causality

Given the estimation results of the STAR-VECM in the previous section, we are interested in gauging the cumulative net effect to evaluate the total net effect of a Granger-causing variable on the Granger-caused variable throughout a certain time period. In the STAR-VECM estimation results, we obtain the cumulative net effect in the following way. The cumulative net effect of $y_t^1$ on $y_t^2$ can be measured by adding up the coefficients in the estimation equation of $\Delta y_t^2 = [\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\phi_i^j \Delta y_{t-i}^j] + [\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\rho_i^j \Delta y_{t-i}^j] \cdot F(cet_{t-d}) + \varepsilon_t^2$. Under the condition that $y_t^1$ significantly Granger-causes $y_t^2$, we test the null hypothesis $H_0\colon \phi_1^1 + \phi_2^1 + \cdots + \phi_p^1 = 0$. For the cases where the null hypothesis is not accepted at least at the 10% significance level, we assess the cumulative net effect by adding up the coefficients of the Granger causing variable$(y_t^1)\sum_{i=1}^{p}\phi_i^1$ in the contraction regime and $\sum_{i=1}^{p}\phi_i^1 + \rho_i^1$ in the expansionary regime. In our estimation results, the null hypothesis is not accepted and the cumulative net effects can be obtained in the model of each bloc as presented in Tables 3-5.

Based on the cumulative net effect, we examine whether trade growth significantly Granger-causes an increase or decrease in stock returns depending on country pairs; and whether the effect varies according to regime changes in each bloc.

### 4.2.1. Far Eastern Bloc (China, Japan, and Korea)

We find evidence that trade effect on stock markets significantly changes over regimes in most countries. The China-Japan trade $(y_t^1)$'s net effect on the Chinese and Japanese stock market is presented in the first and second rows in Table 3. We find that the China-Japan trade has a positive effect on each country's stock market ($y_t^4$ and $y_t^5$) in the contractionary regime by the net effects of 2.9981 and 0.0846, respectively. However this complementary effect is weakened in the expansionary regime with the net effects of 0.0165 and 0.0598. The China-Korea trade $(y_t^2)$ only reveals a complementary effect on the Korean stock return $(y_t^6)$ during the expansionary regime with the net effect of 0.0544.

The Japan-Korea trade $(y_t^3)$ has a conflicting effect on each country's stock market; it has a significant complementary effect in the Japanese stock market $(y_t^5)$'s boom regime (net effect of 0.7516) and the Korean stock market $(y_t^6)$'s contractionary regime (net effect of 0.0638). This conflicting pattern may be attributed to the asymmetric trade structure in which exports from Japan to Korea always exceed exports from Korea to Japan; thus the trade growth between the two has a positive effect only on Japan during the boom period. As pointed out in Bracker et al. (1999), when a country has a considerable import dependence on its trading partner, the competitions of the two countries' exporters in international markets can negatively affect their stock returns. This argument provides a possible explanation for the negative relation between trade growth and stock returns. Overall, in the Far Eastern bloc, we find a complementary relationship between trade growth and stock returns, due to the positive effect of the China-Japan trade on both countries' stock returns as well as the positive effect of the Japan-Korea trade on Japanese stock returns during the expansionary phase.

### Table 3. (Cumulative) Net effect results of Far Eastern Bloc (China, Japan, and Korea)

The net effect of $y_t^1$ on $y_t^2$ is measured by adding up the coefficients in the following estimation equation $\Delta y_t^2 = [\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\phi_i^j \Delta y_{t-i}^j] + [\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\rho_i^j \Delta y_{t-i}^j] \cdot F(cet_{t-d}) + \varepsilon_t^2$, where $\Delta y_t^1$ is the growth rate of trade between China and Japan; $\Delta y_t^2$ is the growth rate of trade between China and Korea; $\Delta y_t^3$ is the growth rate of trade between Japan and Korea; $\Delta y_t^4$ is equity market index return of China (Shang Hai Composite Index); $\Delta y_t^5$ is equity market index return of Japan (Nikkei Index); and $\Delta y_t^6$ is equity market index return of Korea (KOSPI index). Under the condition that $y_t^1$ significantly Granger causes $y_t^2$, we test the null hypothesis $H_0: \phi_1^1 + \phi_2^1 + \cdots + \phi_p^1 = 0$. When the null hypothesis is rejected at least at the 10% significance level, we assess the cumulative net effect by adding up the coefficients of the Granger causing variable ($y_t^1$) $\sum_{i=1}^{p}\phi_i^1$ in the contraction regime and $\sum_{i=1}^{p}\phi_i^1 + \rho_i^1$ in the expansionary regime. For each pair, the (cumulative) net effects in the expansionary regime when F(·) = 1 and in the contractionary regime when F(·) = 0 are reported, respectively.

| | | | **Granger caused variables** | | |
|---|---|---|---|---|---|
| | | | $\Delta y_t^4$ (stock return of China) | $\Delta y_t^5$ (stock return of Japan) | $\Delta y_t^6$ (stock return of Korea) |
| **Granger causing variables** | $\Delta y_t^1$ (trade growth between China and Japan) | Contractionary regime | **2.9981**** | **0.0846**** | --- |
| | | Expansionary regime | **0.0165*** | **0.0598*** | --- |
| | $\Delta y_t^2$ (trade growth between China and Korea) | Contractionary regime | **-3.3799***** | --- | **-1.8579**** |
| | | Expansionary regime | **-0.3031**** | --- | **0.5044*** |
| | $\Delta y_t^3$ (trade growth between Japan and Korea) | Contractionary regime | --- | **-1.0745**** | **0.0638**** |
| | | Expansionary regime | --- | **0.7516*** | **-0.2335***** |

#### 4.2.2. Chinese Bloc (China, Hong Kong, and Taiwan)

In Table 4, the estimation results of cumulative net effects for the Chinese bloc are reported: the effect of China-Hong Kong ($y_t^1$) trade on the Chinese stock market ($y_t^4$) in the contractionary phase (net effect of 0.8672); the effect of China-Taiwan ($y_t^2$) trade on Taiwan's stock market ($y_t^6$) in the expansionary regime (net effect of 0.7016); and the effect of Hong Kong-Taiwan ($y_t^3$) trade on Taiwan's stock market ($y_t^6$) in the contractionary phase (net effect of 1.6125) and on Hong Kong's stock market ($y_t^5$) in the expansionary regime (net effect of 0.2726). This irregular pattern can be partly attributed to asymmetric trade structure in each trading pair as China records trade surplus with Hong Kong, and Taiwan records trade surplus with China and Hong Kong. Thus, the positive effect of trade on stock markets may tend to be revealed in trade-surplus countries in each bilateral trade relationship even though the degree of the positive effect varies across cases. Also, Hong Kong, as a financial hub in Asia, has a more developed financial market compared to other countries in the bloc, with relatively less importance of trade in goods. Accordingly, this particular case may affect the unbalanced linkage between trade and stock markets in this region.

**Table 4. (Cumulative) Net effect results of Far Eastern Bloc (China, Japan, and Korea)**

The net effect of $y_t^1$ on $y_t^2$ is measured by adding up the coefficients in the following estimation equation $\Delta y_t^2 = [\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\phi_i^j \Delta y_{t-i}^j] + [\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\rho_i^j \Delta y_{t-i}^j] \cdot F(cet_{t-d}) + \varepsilon_t^2$, where $\Delta y_t^1$ is the growth rate of trade between China and Hong Kong; $\Delta y_t^2$ is the growth rate of trade between China and Taiwan; $\Delta y_t^3$ is the growth rate of trade between Taiwan and Hong Kong; $\Delta y_t^4$ is equity market index return of China (Shang Hai Composite Index); $\Delta y_t^5$ is equity market index return of Hong Kong (Hang Seng Index); and $\Delta y_t^6$ is equity market index return of Taiwan (Taiwan Stock Exchange index). The numbers reported are the (cumulative) net effects. For example, the net effect of $y_t^1$ on $y_t^2$ is measured by adding up the coefficients in the following estimation equation $\Delta y_t^2 = [\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\phi_i^j \Delta y_{t-i}^j] + [\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^{6}\sum_{i=1}^{p}\rho_i^j \Delta y_{t-i}^j] \cdot F(cet_{t-d}) + \varepsilon_t^2$. Under the condition that $y_t^1$ significantly Granger causes $y_t^2$, we test the null hypothesis $H_0: \phi_1^1 + \phi_2^1 + \cdots + \phi_p^1 = 0$. If the null hypothesis is rejected at least at the 10% significance level, we assess the cumulative net effect by adding up the coefficients of the Granger causing variable $(y_t^1)\sum_{i=1}^{p}\phi_i^1$ in the contraction regime and $\sum_{i=1}^{p}\phi_i^1 + \rho_i^1$ in the expansionary regime. For each pair, the (cumulative) net effects in the expansionary regime when F(·) = 1 and in the contractionary regime when F(·) = 0 are reported, respectively.

| | | | **Granger caused variables** | | |
|---|---|---|---|---|---|
| | | | $\Delta y_t^4$ (stock return of China) | $\Delta y_t^5$ (stock return of HK) | $\Delta y_t^6$ (stock return of Taiwan) |
| **Granger causing variables** | $\Delta y_t^1$ (trade growth between China and HK) | Contractionary regime | **0.8672**** | **-1.3052*** | --- |
| | | Expansionary regime | **-0.2457***** | **-0.4445**** | --- |
| | $\Delta y_t^2$ (trade growth between China and Taiwan) | Contractionary regime | **-1.4204**** | --- | **-4.2994***** |
| | | Expansionary regime | **-0.8284**** | --- | **0.7016**** |
| | $\Delta y_t^3$ (trade growth between Taiwan and HK) | Contractionary regime | --- | **-0.1501*** | **1.6125**** |
| | | Expansionary regime | --- | **0.2726**** | **-0.4012*** |

### 4.2.3. Australian Bloc (Australia, New Zealand, and Singapore)

The results of the Australian bloc are presented in Table 5. We find significant complementary effects of intra-regional trade on stock markets in the following cases: the Australia-New Zealand ($y_t^1$) trade on New Zealand stock market ($y_t^5$) in the expansionary regime (the net effect of 0.5758), the Singapore-Australia ($y_t^2$) trade on Australian and Singapore stock markets in the contractionary phase ($y_t^4$ and $y_t^6$ with the net effects of 0.0125 and 0.1140, respectively), and the Singapore-New Zealand trade ($y_t^3$) on New Zealand stock market ($y_t^5$) in both regimes (the net effect of 0.0127 in the contractionary regime and net effect of 0.0096 in the expansionary regime) and on Singapore stock market ($y_t^6$) in the expansionary regime (the net effect of 1.8490). Due to the high importance of Australia in the New Zealand economy, trade between Australia and New Zealand appears to considerably and positively affect the New Zealand stock market during the expansionary regime.[23] However, our findings do not reveal the positive effect of Australia-New Zealand trade on the Australian stock market, which may be partly attributed to a relatively low importance of New Zealand in the Australian economy. The positive effect of the Singapore-Australia trade on both countries' stock markets is found only during the contractionary regime, implying that the complementary relationship is seen only in the contractionary regime.

### Table 5. (Cumulative) Net effect results of Australian Bloc (Australia, New Zealand, and Singapore)

The net effect of $y_t^1$ on $y_t^2$ is measured by adding up the coefficients in the following estimation equation $\Delta y_t^2 = [\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^6 \sum_{i=1}^p \phi_i^j \Delta y_{t-i}^j] + [\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^6 \sum_{i=1}^p \rho_i^j \Delta y_{t-i}^j] \cdot F(cet_{t-d}) + \varepsilon_t^2$, where $\Delta y_t^1$ is the growth rate of trade between Australia and New Zealand; $\Delta y_t^2$ is the growth rate of trade between Singapore and Australia; $\Delta y_t^3$ is the growth rate of trade between Singapore and New Zealand; $\Delta y_t^4$ is equity market index return of Australia (AS51); $\Delta y_t^5$ is equity market index return of New Zealand (NZSE50 FG); and $\Delta y_t^6$ is equity market index return of Singapore (FSSTI). The numbers reported are the (cumulative) net effects. For example, the net effect of $y_t^1$ on $y_t^2$ is measured by adding up the coefficients in the following estimation equation $\Delta y_t^2 = [\phi_0 + \alpha_1^1 z_{t-1} + \sum_{j=1}^6 \sum_{i=1}^p \phi_i^j \Delta y_{t-i}^j] + [\rho_0 + \alpha_2^1 z_{t-1} + \sum_{j=1}^6 \sum_{i=1}^p \rho_i^j \Delta y_{t-i}^j] \cdot F(cet_{t-d}) + \varepsilon_t^2$. Under the condition that $y_t^1$ significantly Granger causes $y_t^2$, we test the null hypothesis $H_0: \phi_1^1 + \phi_2^1 + \cdots + \phi_p^1 = 0$. If the null hypothesis is rejected at least at the 10% significance level, we assess the cumulative net effect by adding up the coefficients of the Granger causing variable $(y_t^1) \sum_{i=1}^p \phi_i^1$ in the contraction regime and $\sum_{i=1}^p \phi_i^1 + \rho_i^1$ in the expansionary regime. For each pair, the (cumulative) net effects in the expansionary regime when F(·) = 1 and in the contractionary regime when F(·) = 0 are reported, respectively.

| | | | Granger caused variables | | |
|---|---|---|---|---|---|
| | | | $\Delta y_t^4$ (stock return of Australia) | $\Delta y_t^5$ (stock return of NZ) | $\Delta y_t^6$ (stock return of Singapore) |
| **Granger causing variables** | $\Delta y_t^1$ (trade growth between Australia and NZ) | Contractionary regime | **-0.0455**** | **-0.1620**** | --- |
| | | Expansionary regime | **-0.1061**** | **0.5758*** | --- |
| | $\Delta y_t^2$ (trade growth between Singapore and Australia) | Contractionary regime | **0.0125***** | --- | **0.1140**** |
| | | Expansionary regime | **-0.1989***** | --- | **-1.6270***** |
| | $\Delta y_t^3$ (trade growth between Singapore and New Zealand) | Contractionary regime | --- | **0.0127**** | **-0.0770***** |
| | | Expansionary regime | --- | **0.0096*** | **1.8490*** |

23 For New Zealand, Australia has been the largest trading partner until 2012 and the 2nd largest since 2013 following China.

### 4.2.4. Cross-bloc Comparison

To summarize empirical evidence, the results show that the effect of trade growth on stock returns could be either positive or negative depending on country pairs; and the magnitude or sign of the effect varies with regime changes. In addition, we also find that the effect of trade growth on stock returns tends to be larger during the contractionary regime than the expansionary regime in the both Far Eastern and Chinese bloc, regardless of the sign of the effect. This pattern indicates that the effect of trade growth on stock returns, either positive or negative, tends to have a larger impact during stock market's contractionary regime, suggesting that the effect of trade is more pronounced during the contractionary regime rather than the expansionary regime.

Based on the results of cumulative net effects, we further conduct the cross-bloc comparison of the extent to which trade growth affects stock returns. In terms of the complementary role of trade growth in stock returns, the Far Eastern bloc shows a more pronounced result with more positive coefficients than the other two blocs. This may be attributable to the fact that China, Japan, and Korea have a larger size of intra-regional trade compared to the other blocs where countries have a high degree of importance to each other's real economy.[24] Also, the Australian bloc displays a more complementary relationship between intra-regional trade and stock market integration with more positive coefficients than the Chinese bloc. Since Australia and New Zealand are closely located to each other but remotely from the rest of the world, their bilateral trade is relatively important, as well as the relationship with Singapore that has an advanced financial market. Therefore, these conditions could cause a positive linkage between intra-regional trade and stock market integration.

## 5. Conclusion

We provide new evidence on the relationship between intra-regional trade and stock market integration over the Asia-Pacific region. Using three regional blocs in the Asia-Pacific region – the Far Eastern bloc (China, Japan, and Korea), the Chinese bloc (China, Hong Kong, and Taiwan), and the Australian bloc (Australia, New Zealand, and Singapore), we examine whether trade linkages between countries affect their stock markets. By incorporating two distinct dynamic properties of regime shifting and co-integration in intra-regional trade and stock market returns, we employ the newly suggested multi-variable smooth transition autoregressive vector error correction model (STAR-VECM) model.

[24] Refer to Table A2 for more information on trade importance of each bloc. Even though the Chinese bloc also exhibits a high share of intra-regional trade relative to the world trade, it is mostly because of the high share of Hong Kong's intermediary trade. Trade of Hong Kong and Singapore is highly occupied with entrepot trade, mainly for re-export; and especially Hong Kong has been engaged in intermediate trade between China and the rest of the world by distributing a large fraction of China's exports. Excluding this exceptional case of intermediary trade, therefore, trade of the Far Eastern bloc is larger than the other blocs.

A series of tests reveal new evidence on the effect of intra-regional trade on stock returns in the Asia-Pacific region. Our main empirical results are as follows. The effect of bilateral trade growth on stock returns differs depending on country pairs; and its magnitude and sign varies with regime changes, showing asymmetric patterns between contractionary and expansionary regimes. Among the three blocs analyzed, however, the Far Eastern bloc displays the most pronounced result of the complementary relation (or positive relation) between trade growth and stock returns. In addition, the effect of trade growth on stock returns tends to be larger during the contractionary regime than expansionary regime in the Far Eastern bloc and Chinese bloc regardless of its sign.

For those cases where the relationship between trade and the stock market is ambiguous, factors such as bilateral trade patterns, economic dependence between trading partners, and relative importance between the financial and trade sectors within the country seem to matter. For more detailed verification of the role of these factors, further investigation will be needed.

## References

Anderson, Heather M. & FarshidVahid (1998) "Testing multiple equation systems for common nonlinear components," *Journal of Econometrics*, 84(1) 1-36.

Antras, Pol, and Ricardo J. Caballero (2009), "Trade and Capital Flows: A Financial Frictions Perspective," *Journal of Political Economy,* 117(4), pp. 701-744.

Azman-Saini, M. Azali, M.S. Habibullah, and K.G.P. Matthew (2002), "Financial integration and ASEAN-5 equity market," *Applied Economics,* 34(18), pp. 2283-2288.

Beine, Michel, Antonio Cosma, and Robert Vermeulen (2010), "The dark side of global integration: Increasing tail dependence," *Journal of Banking and Finance*, 34(1), pp.184-192.

Bracker, Kevin, Diane S. Docking, and Paul D. Koch (1999), "Economic determinants of evolution in international stock market integration," *Journal of Empirical Finance*, 6(1), pp.1-27

Burdekin, Richard C.K., and Pierre L. Siklos (2012), "Enter the dragon: interactions between Chinese, the US, and Asia-Pacific equity markets, 1995-2010," *Pacific-Basin Finance Journal,* 20(3), pp. 521-541.

Candelon, Bertrand, Jan Piplack, and Stefan Straetmans (2008), "On measuring synchronization of bulls and bears: The case of East Asia," *Journal of Banking & Finance*, 32(6), pp. 1022-1035.

Chambet, Anthony, and Rajna Gibson (2008), "Financial Integration, Economic Instability and Trade Structure in Emerging markets," *Journal of International Money and Finance*, 27(4), pp. 654-675.

Chen, Nai-fu, and Feng Zhang (1997) "Correlation, trades and stock returns of the Pacific-Basin markets," *Pacific-Basin Finance Journal*, 5(5), pp.559-577.

Chinn, Menzie D., and Kristin J. Forbes (2004), "A Decomposition of Global Linkages in Financial Markets over Time," *Review of Economics and Statistics*, 86(3), pp.705-722

Didier, Tatiana, Inessa Love, and Maria S. Martinez Peria (2012), "What Explains Comovement in Stock Market Returns during the 2007-2008 Crisis?" *International Journal of Finance and Economics*, 17(2), pp.182-202.

Edwards, S., Javier Gomez Biscarri, and Fernando Perez de Gracia (2003), "Stock market cycles, financial liberalization and volatility," *Journal of International Money and Finance*, 22, pp. 925-955.

Eichengreen, Barry, and Yung Chul Park (2005), "Why Has There Been Less Financial Integration in Asia than in Europe?," *The Ford Foundation*.

Engle, Robert F. & C. W. J. Granger (1987), "Co-Integration and Error Correction: Representation, Estimation, and Testing," *Econometrica,* 55(2), 251-276.

Escribano, Alvaro (1987) "Error-correction systems: nonlinear adjustments to linear long-run relationships," *CORE Discussion Papers* No. 1987030, Université catholique de Louvain

Escribano, Alvaro & Santiago Mira (2002), "Nonlinear Errer Correction Models," *Journal of Time Series Analysis*, 23(5), 509-522.

Escribanoa, Alvaro & Gerard A.Pfannb (1988) "Non-linear error correction, asymmetric adjustment and cointegration," *Economic Modelling*, 15(2), 197-216.

Feeney, J.A. (1994), "Goods and Asset Market Interdependence in a Risky World," *International Economic Review*, 35(3), pp.551-563.

Gallant, A. R. & H. White (1988), A unified theory of estimation and inference for nonlinear dynamic models, Blackwell.

Granger, C. W. J. & Norman Swanson (1996), "Future Developments in the Study of Cointegrated Variables," *Oxford Bulletin of Economics and Statistics*, 58(3), 537-553.

Hatanaka, Michio (1996), Time-Series-Based Econometrics: Unit Roots and Co-integrations, Oxford University Press.

Johansen, S (1995), Likelihood-based inference in cointegrated vector autoregressive models, Oxford University Press.

Johnson, Robert & Luc Soenen (2002), "Asian economic integration and stock market comovement," *Journal of Financial Research*, 25(1), pp. 141-157.

Kim, Sei-Wan, Y.M Kim, M.J. Choi (2015), "Asia-Pacific Stock Market Integration: New Evidence by Incorporating Regime Changes", Emerging Markets Finance and Trade, 51(Supplment 4), pp. S68-S88.

Lane, Philip R., and Gian Maria Milesi-Ferretti (2003), "International Financial Integration," *IMF Staff Paper*, 50, pp. 82-113.

Lettau, Martin & Sydney Ludvigson (2001) "Consumption, Aggregate Wealth, and Expected Stock Returns," *Journal of Finance,* 56(3), 815-849

Liu, Steven Zongshin, Kung-Cheng Lin, and Sophia M. Lai (2006), "Stock market interdependence and trade relations: a correlation test for the U.S. and its trading partners," *Economic Bulletin*, 7(5), pp. 1-15.

Luukkonen, R., Pentti Saikkonen, and Timo Teräsvirta (1988), "Testing linearity against smooth transition autoregressive models," *Biometrika*, 75(3), pp. 491-499.

Narayan, S., N. Doytch, T. T. Nguyen, K. Kluegel (2016), "Trade of goods and services and risk sharing ability in international equity markets: Are these substitutes or complements?" *International Review of Economics and Finance*, 45, pp. 485-503.

Narayan, S., S. Sriananthakumar, and S.Z. Islam (2014), "Stock market integration of emerging Asian economies: Patterns and causes," *Economic Modelling*, 39, pp. 19-31.

Obstfeld, Maurice and Kenneth Rogoff (2001), "The Six Major Puzzle in International Macroeconomics: Is There a Common Cause?," *NBER Macroeconomics Annual*, 15, pp. 339-390.

Pagan, A.P., and Kirill A. Sossounov (2003), "A simple framework for analyzing bull and bear markets," *Journal of Applied Econometrics*, 18(1), pp. 233-246.

Paramati, Shdharshan R., Eduardo Roca, and Rakesh Gupta (2016), "Economic integration and stock market dynamic linkages: evidence in the context of Australia and Asia," *Applied Economics*, pp.1-17.

Pretorius, Elna (2002), "Economic determinants of emerging stock market interdependence," *Emerging Market Review*, 3(1), pp.84-105

Phylaktis, Kate (1999), "Capital market integration in the Pacific Basin region: An impulse response analysis," *Journal of International Money and Finance*, 18(2), pp. 267-287.

Soydemir, Gokce (2000), "International transmission mechanism of stock market movements: Evidence from emerging equity markets," *Journal of Forecasting*, 19(3), pp.149-176.

Tavares, José (2009), "Economic integration and the comovement of stock returns," Economics Letters, 103(2), 65-67.

Tsay, R.S. (1989), "Testing and modeling threshold autoregressive processes," *Journal of the American Statistical Association*, 84, pp. 231-240.

Teräsvirta, T. (1994), "Specification, estimation and evaluation of smooth transition autoregressive models," *Journal of the American Statistical Association*, 89(425), pp. 208-218.

Teräsvirta, T., and H. M. Anderson (1992), "Characterizing nonlinearities in business cycles using smooth transition autoregressive models," *Journal of Applied Econometrics*, 7, pp. 119-136.

van Dijk, Dick, Timo Teräsvirta, & Philip Hans Franses (2002) "Smooth Transition Autoregressive Models – A Survey of Recent Developments," *Econometric Reviews,* 21(1), 1-47.

Valadkhani, Abbas, and Surachai Chancharat (2008), "Dynamic linkages between Thailand and international stock markets," *Journal of Economic Studies*, 35(5), pp. 425-441.

Walti, Sebastien (2011), "Stock market synchronization and monetary integration," *Journal of International Money and Finance*, 30(1), pp.96-110

Wooldridge, Jeffrey M. & Halbert White (1988), "Some Invariance Principles and Central Limit Theorems for Dependent Heterogeneous Processes," *Econometric Theory,* 4(2), pp. 210-230.

Yu, Ip-Wing, Kang-Por Fung, and Chi-Sang Tam (2010), "Assessing financial market integration in Asia equity markets," *Journal of Banking & Finance*, 34(12), pp. 2874-2885.

# Appendix

## Table A1. Trade Share and Value in Each Bloc

This table presents each country's share of within-bloc trade relative to its total trade and the value of bilateral exports and imports for the year of 2000, 2007, and 2013. The intra-regional trade relative to world's total trade indicates the share of total within-bloc trade relative to the bloc's total trade with the world. Export (import) indicates total export (import) value in USD (mil.) of the former country to (from) the latter country in each country pair.

| | Country | 2000 | | 2007 | | 2013 | |
|---|---|---|---|---|---|---|---|
| **Far Eastern Bloc** | Intra-regional trade share relative to each country's total trade | | | | | | |
| | China | 0.25 | | 0.18 | | 0.14 | |
| | Japan | 0.16 | | 0.24 | | 0.26 | |
| | Korea | 0.25 | | 0.31 | | 0.30 | |
| | Intra-regional trade relative to world's total trade | | | | | | |
| | | 0.026 | | 0.034 | | 0.036 | |
| | | Export | Import | Export | Import | Export | Import |
| | China-Japan | 41,611 | 41,520 | 102,116 | 133,903 | 149,912 | 149,912 |
| | China-Korea | 11,287 | 23,208 | 56,129 | 104,045 | 91,174 | 182,882 |
| | Japan-Korea | 30,703 | 20,454 | 54,269 | 27,300 | 56,503 | 35,839 |
| **Chinese bloc** | Intra-regional trade share relative to each country's total trade | | | | | | |
| | China | 0.18 | | 0.15 | | 0.14 | |
| | Hong Kong | 0.44 | | 0.52 | | 0.56 | |
| | Taiwan | 0.17 | | 0.31 | | 0.36 | |
| | Intra-regional trade relative to world's total trade | | | | | | |
| | | 0.025 | | 0.030 | | 0.038 | |
| | | Export | Import | Export | Import | Export | Import |
| | China-Hong Kong | 44,530 | 9,431 | 184,289 | 12,824 | 384,877 | 16,225 |
| | China-Taiwan | 5,040 | 25,497 | 23,480 | 100,986 | 40,650 | 156,512 |
| | Hong Kong-Taiwan | 5,112 | 15,975 | 6,794 | 26,324 | 9,985 | 33,784 |
| **Australian bloc** | Intra-regional trade share relative to each country's total trade | | | | | | |
| | Australia | 0.09 | | 0.085 | | 0.067 | |
| | New Zealand | 0.23 | | 0.248 | | 0.192 | |
| | Singapore | 0.02 | | 0.029 | | 0.029 | |
| | Intra-regional trade relative to world's total trade | | | | | | |
| | | 0.002 | | 0.002 | | 0.002 | |
| | | Export | Import | Export | Import | Export | Import |
| | Singapore-Australia | 3,222 | 2,298 | 11,191 | 3,166 | 15,805 | 4,153 |
| | Singapore-New Zealand | 370 | 192 | 1,558 | 469 | 1,883 | 849 |
| | Australia-New Zealand | 3,721 | 2,858 | 11,191 | 3,166 | 15,805 | 4,153 |

Source: IMF DOTS, KITA

## Table A2. Co-integration equation between stock indices

$$y_t^4 = \beta_0 + \beta_1 y_t^5 + \beta_2 y_t^6 + \varepsilon_t \qquad (4)$$

where $y_t^4$: log of equity market index of China (Shang Hai Composite Index), $y_t^5$: log of equity market index of Japan (Nikei Index), $y_t^6$: log of equity market index of Korea (KOSPI index) for the Far Eastern bloc; $y_t^4$: log of equity market index of China (Shang Hai Composite Index), $y_t^5$: log of equity market index of Hong Kong (Hang Seng), $y_t^6$: log of equity market index of Taiwan (TWSE) for the Chinese bloc; $y_t^4$: log of equity market index of Australia (AS51), $y_t^5$: log of equity market index of New Zealand (NZSE50 FG), $y_t^6$: log of equity market index of Singapore (FSSTI) for the Australian bloc.

| | **Far Eastern Bloc** | **Chinese Bloc** | **Australian Bloc** |
|---|---|---|---|
| | $y_t^4$ | $y_t^4$ | $y_t^4$ |
| $\beta_0$ | 2.9444***<br>(3.1219) | 0.3429<br>(0.3932) | 3.1748***<br>(10.2614) |
| $\beta_1$ | 0.2113**<br>(2.2055) | -0.1400<br>(-1.3048) | 0.3043***<br>(5.3340) |
| $\beta_2$ | 0.3590***<br>(5.4086) | 0.8625***<br>(8.0342) | 0.3676***<br>(5.3328) |
| **Adj. $R^2$** | 0.1823 | 0.3794 | 0.6793 |
| **SER** | 0.2912 | 0.2537 | 0.0979 |
| **LLV** | -29.6157 | -6.4420 | 142.6235 |

Notes: Values under regression coefficients in parenthesis are heteroskedasticity robust t-statistics; SER is standard error of regression; and LLV is log likelihood value. * : significant at 10% level and **: significant at 5% level

**Figure A1. Graphs of real stock index and real bilateral trade (Far Eastern Bloc)**
Left panel presents monthly real stock index in logarithm of each country in the Far Easter bloc and right panel presents monthly real trade value in logarithm of each country pair.

| **Log of real stock index** | **Log of real trade value between** |
|---|---|

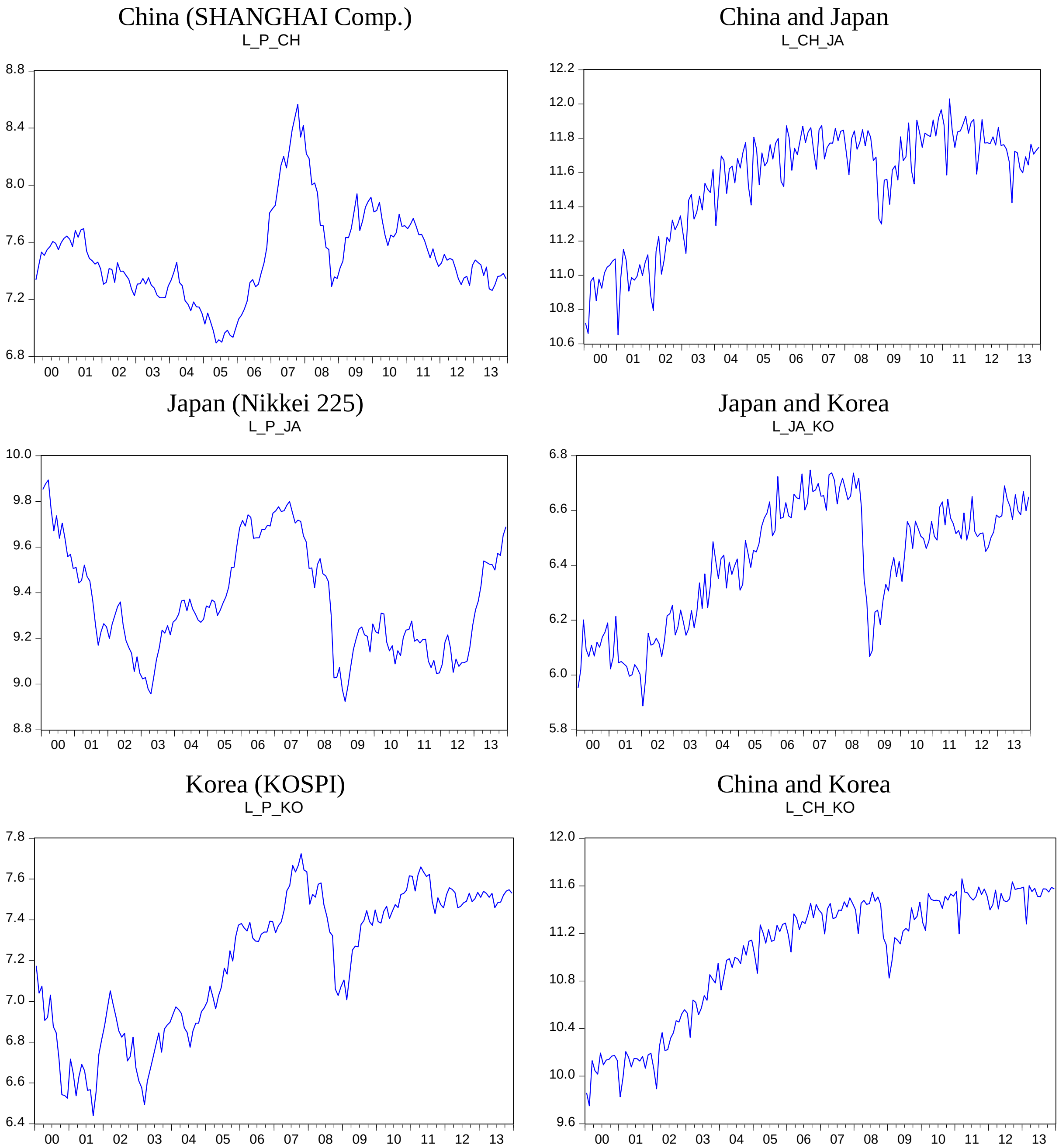

**Figure A2. Graphs of real stock index and real bilateral trade (Chinese Bloc)**

Left panel presents monthly real stock index in logarithm of each country in the Far Easter bloc and right panel presents monthly real trade value in logarithm of each country pair.

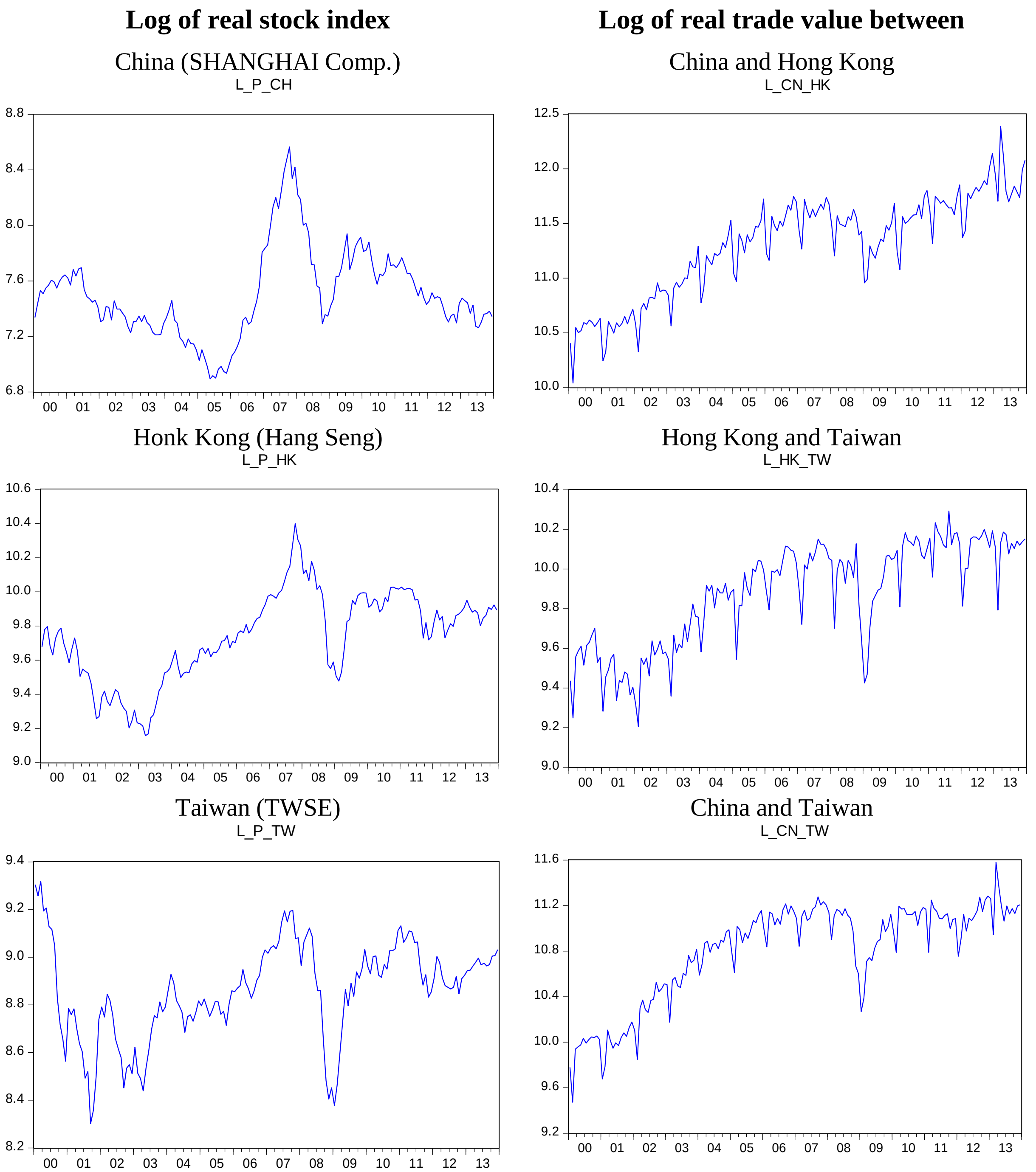

**Figure A3. Graphs of real stock index and real bilateral trade (Australian Bloc)**
Left panel presents monthly real stock index in logarithm of each country in the Far Easter bloc and right panel presents monthly real trade value in logarithm of each country pair.