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

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Contents

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We provide new evidence on the relationship between bilateral trade and stock market performance over Asia-Pacific region. Using three regional blocs in Asia-Pacific region – the Far Eastern bloc, the Chinese bloc, and the Australian bloc, we examine two main questions: whether trade linkages between countries affect stock returns of trading partners and whether stock markets of trading partners are interdependent. By incorporating two distinct dynamic properties of regime shifting and cointegration in intra-regional trade and stock market index, we employ a newly suggested multi-variable smooth transition autoregressive vector error correction model (STAR-VECM). A series of STAR-based tests reveals the evidence that bilateral trade significantly Granger-causes stock returns in Asia-Pacific region with the effect varying over regime changes. Among three blocs, Far Eastern bloc displays the most pronounced complementary relationship between trade growth and stock returns compared to other blocs. We also find evidence of stock market synchronization within each region.

Keywords: Stock market synchronization, Regional trade, Regime change, Smooth transition autoregressive model

JEL Classification: F15, G14, C40, C51

Ⅰ. Introduction

Due to the ongoing equity market liberalization and an increase in the market size, the global stock market has been undergoing regional synchronization. Particularly, after the Asian financial crisis of the late 1990s, increased intra-regional equity investments due to policy coordination and improved trading technology together have enhanced regional interdependence in Asian-Pacific financial markets.[1] In addition, as China's rapid economic growth and openness throughout the 1990s to 2000s enhance their financial effects on other regional stock markets compared to the U.S. and Japan's, these regional changes in Asian-Pacific financial markets have attracted the attention of international investors who are seeking opportunities to intensify international diversification of their portfolios. In this context, there have been many studies investigating such interconnectedness in the Asian-Pacific region in academics.[2] However, the empirical evidence is inconclusive as to whether stock market synchronization has intensified throughout the time and across different markets in the Asian-Pacific region as well as what determines of the financial market interdependence.

At the same time, intra-regional trade has consistently increased between Asian-Pacific countries as local economies are becoming more dependent on each other over different blocs of Asia-Pacific region.[3] The dependency in the real side of economies among Asian-Pacific countries has been strengthened along with the spread of global value chain in production and growth of vertical trade through intermediate goods trade. The substantial trade growth in Asia-Pacific region should link to business performance of firms in this area, ultimately having influence on their stock returns. A growing volume of studies also have been paying attention on

1) According to the Asia Development Bank, Asia's stock investments in other Asian economies have been increased from 10.7% in 2001 to 27.6% in 2007. However, after the Lehman Brothers shock in September 2008, the intra-regional share in total stock investment declined to 23.7% in 2010. Examples of policy coordination are stock exchange consolidation, the Chiang Mai Initiative and the Asian Bond Markets Initiative.

2) Yu et al. (2010) provides a good summary on this topic.

3) As shown in Table A2 in appendix, trade share of each bloc relative to the world's total trade increased from 2.6% in 2000 to 3.6% in 2013 for Far Eastern bloc, from 2.5% to 3.8% for Chinese bloc, and from 0.19% to 0.2% for Australian bloc. Over the same time period, world total trade value (in nominal) increased by 2.8 times in 2013 compared to in 2000.

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 that the growth of bilateral trade between two countries, by increasing cash flows between the countries, makes their stock markets more correlated. However, some studies point out that the effect of trade on stock market 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). More generally, the relationship between trade and cross-border capital flow has been discussed in trade and international finance theories. The neoclassical trade theory (Heckscher-Ohlin-Mundell model) views the relationship between trade and capital flows as substitutes, while recent studies (Antras and Caballero, 2009; Obstfeld and Rogoff, 2001) view the identical relationship as complements. Based on the theoretical and empirical evidence on the relationship between trade and financial markets across countries, we explore the effect of trade linkages on stock markets in Asia-Pacific countries.

Our analysis is largely composed of two questions: whether trade relation matters in stock return of trading partner countries and whether stock markets of trading partners are interdependent. For the 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. [4] We further divide these sample countries into three regional blocs considering their geographical vicinity, economic relationships, and shared cultural backgrounds as follows: 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.[5] These countries are the leading economies in the region with large share of trade and significant size of financial markets, thus our analysis is

4) In our analysis, ASEAN bloc is not included because their stock market size is relatively small with limited data even though their trade volume is quite sizable and important in the region.

5) In 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.

expected to focus more on implications specified for the region.

In investigating the relationship between stock markets and the regional trade in Asia-Pacific region, it is particularly important to identify and incorporate market states because these markets' cycles with booms and busts are characterized by more frequent regime changes and shorter regime staying compared to matured stock markets such as the G7 markets.[6] Without considering this dynamic property and co-movement of Asia-Pacific stock markets, there is a high probability of misspecification in the empirical framework. We, therefore, investigate the mutual relation between stock market interconnectedness and intra-regional trade by incorporating two distinct features of endogenous state changes and cointegration 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 (Edwards et al., 2003; Candelon et al., 2008; Yu et al., 2010) that determine stock market cycles through an ad hoc defined characteristics between stock markets.

The STAR-VECM estimation result reveals that the growth of bilateral trade and stock return exhibit non-linear movements with regime changes and that stock markets are cointegrated. The cumulative net effects show that the growth of bilateral trade Granger-causes changes of stock return in each country and that the effects differ in terms of magnitude and signs depending on the regime shifting, indicating that the relationship between trade growth and stock return can be both substitutes and complements with different magnitude depending on country pair and regime shifting. Among the three country blocs, however, the Far Eastern bloc displays the most frequent positive effects of trade on stock return with a large magnitude compared to the other two blocs, suggesting that the complementary relationship between trade growth and stock return is most pronounced in the Far Eastern bloc. We also find that stock return of one country significantly Granger-cause that of the other country in each bloc, suggesting that stock markets are interdependent across countries in the Asia-Pacific region.

6) Kim et al. (2015) find that Asia-Pacific equity markets' regimes changes are, on average, more frequent than that of G7 equity markets.

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 interpretation of empirical results on the relationship between trade linkages and stock market integration as well as the results on the stock market interdependence. Section 5 concludes the paper.

Ⅱ. Literature Review

The relation between trade linkages and stock market interdependence is examined by many empirical studies with various data coverage, and majority of them agree that trade relation are a significant determinant of stock market interdependence. Chen and Zhang (1997) show that countries with 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 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 of 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 market countries and find that trade openness positively contributes to stock market integration. Tavares (2009) finds that bilateral trade intensity increases the co-movement in stock return, by using panel data of 40 developed and emerging countries from the 1970s to 1990s. Beine et al. (2010) show that trade integration significantly increases 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 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.

While the studies above point to trade relation as a significant determinant of stock market interconnectedness, some studies provide evidence showing 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 the negative effect of competition between exporting firms from trading partners in international markets on their stock return can offset the positive effect of import growth between the trading partners on their stock market performance. Similarly, Johnson and Soenen (2002), using daily return data from 1988 to 1998 for 12 Asian-Pacific countries, show that higher import share has a negative effect on stock market co-movements between country pairs while higher export share has a positive effect. Liu et al. (2006) show that positive effects of trade relations on stock market co-movements are significantly revealed only in Europe, not in Asia. Narayan et al. (2014) find positive effects of bilateral trade relation on stock market co-movements only for some country pairs but negative effects for other country pairs in their sample.[7)]

More broadly, the relationship between trade and cross-border capital flows has also been explored in trade and international finance theories. The neoclassical trade theory (Heckscher-Ohlin-Mundell model) views trade and capital flows as substitutes, but recent studies provide evidence that trade and capital mobility are complements. Antras and Caballero (2009) theoretically show that trade and capital mobility are complements in financially underdeveloped economies. Also, Obstfeld and Rogoff (2001) show that financial asset holding across countries increases with the extent of goods traded. Lane and Milesi-Ferretti (2003) empirically find that the growth in international asset trade is significantly associated with the growth in goods trade by analyzing data of 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.

In investigating stock market interconnectedness, there is not yet a single

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

accepted assessment of stock market integration particularly in an empirical testing perspective. Most of the price-(or return) based measurements of stock market integration have employed the Granger causation test of aggregate stock price (or return).[8] For example, Phylaktis (1999) uses the Granger-causality tests among the U.S. and six Pacific Basin countries' interest rates and provides evidences that these countries are closely connected with global financial markets and more so with the Japanese market than with the U.S. market. Azman-Saini et al. (2002) test whether the stock markets in the ASEAN 5 countries are integrated by employing Granger causality, cointegration and impulse response analysis. They show that these stock markets are cointegrated in the long run and bilaterally Granger-caused. Further evidence of Asian stock market synchronization is revealed in a study by Valadkhani and Chancharat (2008). They also find significant cointegration and Granger causation among Asian stock market indexes in the 2000s and argue that this empirical evidence supports the leading role of some stock markets in Asia. Recently, Burdekin and Siklos (2012) show that the enormous growth of the Shanghai market in the new millennium has been accompanied by a meaningful level of integration with other regional and world markets in spite of ongoing capital controls.

Along with the simple linear estimation and its Granger causality tests, another influential empirical framework employed in a price-based approach is the "synchronization of financial market cycle" which assesses the integration of markets by measuring whether different markets are in the same phase of a cycle.[9] Particularly, Edwards et al. (2003) construct a stock market cycle formula using five characteristics of its phases, such as duration, amplitude and volatility. They find that cycles of the Asian stock market have become more dissimilar to those of stock markets in developed countries, and tend to have shorter regime duration and larger amplitude and volatility than in the markets of developed countries. Candelon et al. (2008) implement Bry and Boschan (1971)'s dating algorithm over a six-month time interval by employing the generalized method

8) There are also other approaches assessing stock market integration such as measuring 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).

of moments (GMM) approach to measure Asian markets' synchronization, and hypothesize a rise in Asian stock market synchronization after the Asian financial crisis in 1997. Yu et al. (2010) also identify the peaks and troughs of stock markets by comparing the natural logs of stock indexes over approximately eight months and find that the integration process in Asian equity markets has picked up again since late 2007 although this process is not complete. However, these empirical frameworks include boom and bust periods of stock markets determined by ad hoc defined characteristics between stock markets not determined by individual markets' endogenous characteristics. For employing a more appropriate empirical framework against weak points in previous studies, Kim et al. (2015) uses the smooth transition autoregressive (STAR) model because this model incorporates endogenous changes of stock market states in the traditional Granger causality test in a single empirical model. They find a significantly different degree of financial market integration in expansionary and contractionary regimes over Asia-Pacific regions.

Ⅲ. Empirical Model and Data

1. Smooth transition autoregressive (STAR) model

Given the significant evidence on cointegrations between endogenous variables for countries in each bloc,[10] a model of particular interest is the one in which the endogenous variables are linked by a linear long-run equilibrium relation, while adjustment toward the equilibrium is nonlinear and can be characterized by a slow regime switch triggered by the long run relation between bloc member countries.[11]

10) For each bloc of Asia-Pacific region, there are two groups of endogenous variables, bilateral trade between member countries and stock market index of each country. Cointegration relationship between stock market indices in each bloc is reported in Table A3, A5, and A7 in appendix.

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.

Here, the regimes are determined by the size and sign of the deviation from the equilibrium relation. Therefore, in our empirical analysis, we fully take into account non-linearity, cointegration, and regime changes.

In linear time series, this type of behavior is captured by a cointegration 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]

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

In the followings, we explain specifications of STAR-VECM based on the Far Eastern bloc out of three blocs investigated. For the six integrated variables in the case 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), and 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 (Nikei Index, y_t^5), 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:[15]

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

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

14) 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.

15) All variables are log valued.

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

where $\triangle y_t^k$ is the log difference (or growth rate) of each variable for $k = 1, \ldots, 6$. $z_t = \beta v_t$, for some vector β, denotes an error-correction term, and the v_t is defined as follows: $v_t{}' = \{1, y_t^4, y_t^5, y_t^6\}$. That is, z_t is the deviation from the equilibrium relation given by $\beta' v_t = 0$. $F(\triangle y_{t-d}^c)$ is the transition function, and $\triangle y_{t-d}^c$ 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 cointegration relation is found as the most significant variable as a common transition variable ($\triangle y_{t-d}^c$). In the case of the Far Eastern bloc, therefore, 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 (Nikei Index), and y_t^6 is log of Korea's stock market index (KOSPI index).

According to specification of STAR model, $\triangle y_{t-d}^c$ is the common transition variable that triggers regime changes. There are quite a few candidates for common transition variable ($\triangle y_{t-d}^c$). 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 we found that it is the most significant variable to change regimes.

For the STAR-VECM, two types of the transition function specification, $F(\triangle y_{t-d}^c)$, 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 alternative set of dynamics for 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)]

16) The logistic function, $F(\triangle y_{t-d}^c)$ takes a value from the range between 0 and 1, depending on the degree and direction by which $\triangle y_{t-d}^c$ deviates from c, the switching value of the transition variable. The estimated value for c defines a transition between the two regimes: $0 < F(\triangle y_{t-d}^c) < 0.5$ (a lower regime)

$$F(\triangle y^c_{t-d}) = \left[1 + \exp\left\{-\gamma(\triangle y^c_{t-d} - c)\right\}\right]^{-1}, \gamma > 0. \quad (2.1)$$

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

$$F(\triangle y^c_{t-d}) = 1 - \exp\left\{-\gamma(\triangle y^c_{t-d} - c)^2\right\}, \gamma > 0. \quad (2.2)$$

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

In specifying the STAR-VECM, the cet (or error correction term) is selected as the common transition variable in $F(\triangle y^c_{t-d})$. Thus, in equation (3), we redefine z_{t-d} as cet_{c-d} by following Lettau and Ludvigson's (2001, 2004) "cay" to emphasize the role of cet_{c-d} in STAR-VECM estimation. The property of the cet or the error correction term's common transition variable has been discussed by 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)

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for $\triangle y^c_{t-d} < c$ and $0.5 < F(\triangle y^c_{t-d}) < 1$ (an upper regime) for $\triangle y^c_{t-d} > c$. When, $\triangle y^c_{t-d} = c$, $F(\triangle y^c_{t-d}) = 0.5$ so that that the current dynamics of $\triangle y$ (or growth rate) is half-way between the upper and lower regimes, especially when $\triangle y^c_{t-d}$ takes a large value (i.e., $\triangle y^c_{t-d} \gg c$), $\exp\{-\gamma(\triangle y^c_{t-d} - c)\}$ is close to zero. As a result, the value of $F(\triangle y^c_{t-d})$ approaches one, and the dynamics of $\triangle y$, are generated by both ϕ^i_j and ρ^i_j in equation (1). In addition, for a small value of $\triangle y^c_{t-d}$ (i.e., $\triangle y^c_{t-d} \ll c$), $\exp\{-\gamma(\triangle y^c_{t-d} - c)\}$ is close to a big number. Then, the value of the transition function $F(\triangle y^c_{t-d})$ approaches zero, and the dynamics of $\triangle y_t$ are generated by only the ϕ^i_j parameter in equation (1).

17) For a large or small value of $\triangle y^c_{t-d}$, the value of $\exp\{-\gamma(\triangle y^c_{t-d} - c)^2\}$ approaches 0, and the value of the transition function approaches 1. The dynamics of $\triangle y_t$ are generated by both ϕ^i_j and ρ^i_j in equation (1). When the value of $\triangle y^c_{t-d}$ is close to c, the value of $\exp\{-\gamma(\triangle y^c_{t-d} - c)^2\}$ approaches 1 and the value of the transition function approaches 0. In these cases, the dynamics of $\triangle y_t$ are generated only by the ϕ^i_j parameters in equation (1).

"cay" corresponds to the "common transition variable" ($\triangle y_{t-d}^{c}$) in the STAR-VECM model.

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

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

with an example of the Far Eastern bloc, $\triangle y_t^1$: growth rate of trade between China and Japan, $\triangle y_t^2$: growth rate of trade between China and Korea, $\triangle y_t^3$: growth rate of trade between Japan and Korea, $\triangle y_t^4$: equity market index return of China (Shang Hai Composite Index), $\triangle y_t^5$: equity market index return of Japan (Nikei Index), $\triangle y_t^6$: equity market index return of Korea (KOSPI Index), and cet_{c-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.

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

18) This notation is based on the Far Eastern Asian bloc. We divide the whole Asia-Pacific region into three regional blocs depending on the geographical vicinity, economic relationships 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

deflated using Consumer Price Index (CPI). We choose the data range starting from January 2000 and ending in December 2013 for all countries except New Zealand (starting from January 2001) due to the 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 the geographical vicinity, economic relationships, 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 A1 in appendix 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 return 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 stock return with its standard deviation of 0.08 while Japan shows the least volatile stock return with its 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 growth of 0.42%. Trade between China and Japan indicates the highest standard deviation of 0.15 while trade between Japan and Korea records the lowest standard deviation 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% for the whole sample period. Average trade between China and Taiwan, relative to other two country pairs, grew fastest by 0.86% with highest standard deviation at 0.16, but the trade between Hong Kong and Taiwan only grew by 0.4% on average during the same period with lowest standard deviation at 0.13.

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directly obtained from CEIC, but for 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 two series of total trade values represented by each country's currency, thus we choose the trade values represented by the currency of 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 of each data given that the STAR methodology intrinsically takes into account the regime changes over the economic cycles.

Finally, in the Australian bloc, New Zealand shows the highest growth of real stock return at 0.41% with the smallest standard deviation at 0.04 while Singapore shows the lowest growth at 0.03% with the largest standard deviation at 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.

Ⅳ. Results

1. STAR-VECM estimation results

First, we present estimation results for main parameters of the Far Eastern bloc STAR-VECM of equation (3) in Table 1.[21] It needs to be noted that significance of the γ-parameter is crucial in estimating STAR model because its significance is an evidence of STAR model specification compared to the other regime switching models such as Markow switching model.[22]

In the whole sample period (2000-2013), the value of the γ-parameter that governs the speed of regime shifting is positive and statistically significant at the 1% level for the growth rate of trade between China and Japan ($\triangle y_t^1$), growth rate of trade between China and Korea ($\triangle y_t^2$), growth rate of trade between Japan and Korea ($\triangle y_t^3$), equity market index return of Japan (Nikei Index) ($\triangle y_t^5$), and equity market index return of Korea (KOSPI index) ($\triangle y_t^6$), except the case of equity market index return of China (Shang Hai Composite Index) ($\triangle y_t^4$). The value of the γ-parameter shows that the growth of the trade between Japan and Korea and the growth of stock return in Korea exhibit a relatively slow transition between the

21) According to the model selection test between LSTAR and ESTAR, as reported in the Appendix, 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. Also, full estimation results for equation (3) are reported in the Appendix.

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

two regimes while growth of the trade between China and Korea and the growth of stock return in Japan display a relatively fast and more frequent transition between the two regimes. 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 that are close to zero imply that all variable regime changes are triggered when the cet stays away from zero.

Secondly, we present estimation results of the Chinese bloc STAR-VECM of equation (3) in Table 2. In the whole sample period (2000-2013), the value of the γ-parameter is positive and statistically significant at the 10% level for growth rate of trade between China and Taiwan ($\triangle y_t^2$), growth rate of trade between Taiwan and Hong Kong ($\triangle y_t^3$), equity market index return of China (Shang Hai Composite Index) ($\triangle y_t^4$), equity market index return of Hong Kong (Hang Seng Index) ($\triangle y_t^5$), and equity market index return of Taiwan (Taiwan Stock Exchange index) ($\triangle y_t^6$), except for the case of the growth rate of trade between China and Hong Kong ($\triangle y_t^1$) where the γ-parameter is positive but not significant. The value of the γ-parameter shows that the speed of transition between two regimes is relatively slow in the stock return growth in Hong Kong but relatively fast in the stock return growth in Taiwan. 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, we report the estimation results of the Australian bloc STAR-VECM of equation (3) in Table 3. The value of the γ-parameter is always positive and statistically significant at the 10% level for the growth rate of trade between Australia and New Zealand ($\triangle y_t^1$), growth rate of trade between Singapore and Australia ($\triangle y_t^2$), growth rate of trade between Singapore and New Zealand ($\triangle y_t^3$), equity market index return of Australia (AS51) ($\triangle y_t^4$), equity market index return of New Zealand (NZSE50 FG) ($\triangle y_t^5$), and equity market index return of Singapore (FSSTI) ($\triangle y_t^6$). The results show that the trade between Singapore and New Zealand and the stock return growth in Singapore display a faster and more

Table 1: Estimation of Nonlinear STAR in the Far Eastern Region: China, Japan, Korea

Selected stimation results of equation (3) where $\triangle y_t^1$: growth rate of trade between China and Japan, $\triangle y_t^2$: growth rate of trade between China and Korea, $\triangle y_t^3$: growth rate of trade between Japan and Korea, $\triangle y_t^4$: equity market index return of China (Shang Hai Composite Index), $\triangle y_t^5$: equity market index return of Japan (Nikei Index), $\triangle y_t^6$: equity market index return of Korea (KOSPI index). Please refer to appendix for full estimation results.

	$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
γ^i	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

Notes: Values under regression coefficients in parenthesis are heteroskedasticity robust t-statistics. * : significant at 10% level and **: significant at 5% level.

Table 2. Estimation of Nonlinear STAR in the Chinese Bloc: China, Taiwan, Hong Kong

Estimation of equation (3) where $\triangle y_t^1$: growth rate of trade between China and Hong Kong, $\triangle y_t^2$: growth rate of trade between China and Taiwan, $\triangle y_t^3$: growth rate of trade between Taiwan and Hong Kong, $\triangle y_t^4$: equity market index return of China (Shang Hai Composite Index), $\triangle y_t^5$: equity market index return of Hong Kong (Hang Seng Index), $\triangle y_t^6$: equity market index return of Taiwan (Taiwan Stock Exchange index). Please refer to appendix for full estimation results.

	$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
γ^i	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

Notes: Please refer to Notes in Table 1. Full estimation results are reported in Appendix.

Table 3: Estimation of Nonlinear STAR in the Australian Bloc: Australia, New Zealand, Singapore

Estimation of equation (3) where $\triangle y_t^1$: growth rate of trade between Australia and New Zealand, $\triangle y_t^2$: growth rate of trade between Singapore and Australia, $\triangle y_t^3$: growth rate of trade between Singapore and New Zealand, $\triangle y_t^4$: equity market index return of Australia (AS51), $\triangle y_t^5$: equity market index return of New Zealand (NZSE50 FG), $\triangle y_t^6$: equity market index return of Singapore (FSSTI). Please refer to appendix for full estimation results.

	$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
γ^i	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: Please refer to Notes in Table 1. Full estimation results are reported in Appendix.

frequent transition between expansion and contraction regimes compared to the 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 4: Each Country's Foreign Dependence (Trade/GDP, % in 2015)

Asian–Pacific countries

China	Japan	Korea	Hong Kong	Taiwan	Australia	New Zealand	Singapore	Average
36.79	30.86	69.84	318.81	95.32	31.75	41.12	219.59	105.51

G7 countries

Canada	France	Germany	Italy	Japan	U.K	U.S	Average
53.97	43.76	70.78	47.76	30.86	37.36	21.10	43.65

2. Cumulative net effects and granger-causality

In the STAR-VECM estimation results, we obtain the cumulative net effect in the following way: for example, the cumulative net effect of y_t^1 on y_t^2 can be measured by adding up the coefficients in the following estimation equation.

$$\triangle y_t^2 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \Sigma_{j=1}^6 \Sigma_{i=1}^p \phi_i^j \triangle y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \Sigma_{j=1}^6 \Sigma_{i=1}^p \rho_i^j \triangle y_{t-i}^j\right] \cdot F(cet_{t-d}) + \varepsilon_t^2$$

Under the condition that y_t^1 significantly Granger causes y_t^2, we test the null hypothesis $H_0 : \phi_1^1 + \phi_2^1 + \cdots + \phi_p^1 = 0$. 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) $\Sigma_{i=1}^p \phi_i^1$ in the contraction regime and $\Sigma_{i=1}^p \phi_i^1 + \rho_i^1$ 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 Table 5-7.

2.1. Intra-regional trade's effect on regional stock markets

Given the estimation results of the STAR-VECM in the previous section, we are particularly interested in the relationship between stock markets and intra-regional trade. The eight Asian-Pacific countries that we are interested in are relatively more dependent on foreign trade than advanced countries including the G7 countries. In the following Table 4, we report Asian-Pacific countries and the G7 countries' foreign dependence in terms of the ratio of trade to GDP. The average of foreign dependence is 105.51 for Asian-Pacific countries while that of the G7 is 43.65.[23] In these countries with high dependence on trade, it will be more likely that trade growth links to business performance of companies, thereby affecting their stock returns. Therefore, we expect that regional trade's effect on the stock market is

23) The ratio of trade to GDP for Hong Kong and Singapore are exceptionally high because their trade are mainly intermediating trade with large share of re-export. Even without these two countries' foreign dependence, the average of the rest of 6 countries in the sample is 50.95%, which is higher than the average of G7 countries.

more important and intensified in Asian-Pacific countries.

The STAR-VECM cumulative net effects can be employed in understanding the complementary effect of intra-regional trade on regional stock markets because the complementary effect would be represented by a positive cumulative net effect. In Table 5 through Table 7, the upper right panel of the tables highlighted in the dashed box indicates the cumulative net effect of bilateral trade on each country's stock return based on the STAR-VECM estimation results.

In the Far Eastern bloc, China-Japan trade (y_t^1)'s net effect on the Chinese and the Japanese stock markets is estimated in Table 5's sub-table which is highlighted in the dashed box. We find that 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. 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 in the boom period only on Japan. Overall, in the Far Eastern bloc, we find a complementary relationship between trade growth and stock return from the positive effect of trade between China and Japan on both countries' stock return and the positive effect of trade between Japan and Korea on the Japanese stock returns during the expansionary phase.

Secondly, in the Chinese bloc, China-Hong Kong trade (y_t^1)'s net effect on China's and Hong Kong's stock markets is estimated in Table 6's sub-table which is highlighted in dashed box. We find significant complementary effects of trade on stock markets; 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; 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 phase of the positive effects 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 of goods. Thus, this particular case may affect the unbalanced linkage between trade and stock markets in this region.

Finally, the results from the Australian bloc are presented in Table 7's sub-table which is highlighted in the dashed box. We find significant complementary effects of intra-regional trade on stock markets in the following cases: Australia-New Zealand (y_t^1) trade on New Zealand's stock market (y_t^5) in the expansionary regime (the net effect of 0.5758), Singapore-Australia (y_t^2) trade on Australia's and Singapore's 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 Singapore-New Zealand trade (y_t^3) on New Zealand's 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's 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[24)], trade between Australia and New Zealand appears to have a large influence on the New Zealand stock market with a positive effect during the expansionary regime. However, our findings do not reveal a positive effect of Australia-New Zealand trade on Australia's stock market, and this may be partly attributed to a relatively low

24) For New Zealand, Australia has been the largest trading partner until 2012 and the 2nd largest trading partner followed by China since 2013.

importance of New Zealand in the Australian economy. The positive effect of Singapore-Australia trade on both countries' stock markets is found only during the contractionary regime, implying that the complementary relationship is shown only in the contractionary regime.

In sum, we partly find a complementary relationship between trade growth and stock return in each bloc, and the results seem to rely on the specific conditions of each pair of countries such as bilateral trade pattern, relative importance of trade and financial sector in the corresponding country, and relative importance of the trading partner.

Based on the results of cumulative net effects, we further conduct the cross-bloc comparison on 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 relative to 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 with a high degree of importance to each other's real economy.[25] Also, the Australian bloc displays relatively more complementary relationship between intra-regional trade and stock market integration with more positive coefficients than in the Chinese bloc. The geographical condition of Australia and New Zealand, which are located relatively remote from the rest of the world, makes their intra-regional trade more important and also makes their relationship with Singapore, which has a financially advanced environment, more important. Therefore, these conditions could cause the positive linkage between intra-regional trade and stock market integration.

25) 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 are highly occupied with entrepot trade which is 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 are larger than the other blocs.

Table 5: (Cumulative) Net Effect Results in the Far Eastern Bloc: China, Japan, Korea

$\triangle y_t^1$: growth rate of trade between China and Japan, $\triangle y_t^2$: growth rate of trade between China and Korea, $\triangle y_t^3$: growth rate of trade between Japan and Korea, $\triangle y_t^4$: equity market index return of China (Shang Hai Composite Index), $\triangle y_t^5$: equity market index return of Japan (Nikei Index), $\triangle y_t^6$: equity market index return of Korea (KOSPI index). The numbers reported are (cumulative) net effects. For example, the net effect of $\triangle y_t^1$ on $\triangle y_t^2$ is measured by adding up the coefficients in the following estimation equation $\triangle y_t^2 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \Sigma_{j=1}^6 \Sigma_{i=1}^p \phi_i^j \triangle y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \Sigma_{j=1}^6 \Sigma_{i=1}^p \rho_i^j \triangle y_{t-i}^j\right] \cdot F(cet_{t-d}) + \varepsilon_t^2$. Under the condition that y_t^1 significantly Granger causes y_t^2, we test the null hypothesis $H_0 : \phi_1^1 + \phi_2^1 + \cdots + \phi_p^1 = 0$. 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) $\Sigma_{i=1}^p \phi_i^1$ in the contraction regime and $\Sigma_{i=1}^p \phi_i^1 + \rho_i^1$ in the expansionary regime. The highlighted values with gray are (cumulative) net effect in the expansionary regime when F(·) = 1 and not-highlighted values are (cumulative) net effect in the contractionary regime when F(·) = 0 respectively.

		Granger caused variables					
		$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
Granger causing variables	$\triangle y_t^1$	−3.1722 −1.7914	−19.9008 −0.3997	1.7499 −1.1087	2.9981 0.0165	0.0846 0.0598	2.0104 −0.1491
	$\triangle y_t^2$	3.3582 0.0105	24.7907 −1.0206	−2.5657 1.0260	−3.3799 −0.3031	−1.3348 −0.2914	−1.8579 0.5044
	$\triangle y_t^3$	−2.9506 0.6822	0.2041 0.5330	−0.8048 −0.5708	3.6997 −0.2590	−1.0745 0.7516	0.0638 −0.2335
	$\triangle y_t^4$	3.2106 −0.3432	−3.9125 0.0106	−0.4210 0.2332	−2.1539 0.5767	1.0605 0.0509	0.4636 −0.3263
	$\triangle y_t^5$	1.1291 −0.3405	−8.0928 0.5338	1.5299 0.2497	−13.7395 −0.1486	−1.7206 −0.2284	−0.8117 −0.0439
	$\triangle y_t^6$	−3.0694 1.3244	3.4403 0.0957	−0.7772 0.3583	12.8021 0.0708	1.3146 0.0356	0.8711 −0.0309

Table 6: (Cumulative) Net Effect Results in the Chinese Bloc: China, Hong Kong, Taiwan

$\triangle y_t^1$: growth rate of trade between China and Hong Kong, $\triangle y_t^2$: growth rate of trade between China and Taiwan, $\triangle y_t^3$: growth rate of trade between Taiwan and Hong Kong, $\triangle y_t^4$: equity market index return of China (Shang Hai Composite Index), $\triangle y_t^5$: equity market index return of Hong Kong (Hang Seng Index), $\triangle y_t^6$: equity market index return of Taiwan (Taiwan Stock Exchange index). The numbers reported are the (cumulative) net effects. For example, the net effect of $\triangle y_t^1$ on $\triangle y_t^2$ is measured by adding up the coefficients in the following estimation equation $\triangle y_t^2 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \Sigma_{j=1}^6 \Sigma_{i=1}^p \phi_i^j \triangle y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \Sigma_{j=1}^6 \Sigma_{i=1}^p \rho_i^j \triangle y_{t-i}^j\right] \cdot F(cet_{t-d}) + \varepsilon_t^2$. 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) $\Sigma_{i=1}^p \phi_i^1$ in the contraction regime and $\Sigma_{i=1}^p \phi_i^1 + \rho_i^1$ in the expansionary regime. The highlighted values with gray are (cumulative) net effect in the expansionary regime when F(·) = 1 and not-highlighted values are (cumulative) net effect in the contractionary regime when F(·) = 0 respectively.

		Granger caused variables					
		$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
Granger causing variables	$\triangle y_t^1$	−4.3873 −2.1712	−0.8538 5.6040	0.0360 −5.6646	0.8672 −0.2457	−1.3052 −0.4445	2.9331 −0.5249
	$\triangle y_t^2$	1.7326 1.1588	−0.7046 −3.5378	0.6883 2.9573	−1.4204 −0.8284	1.0628 0.4633	−4.2994 0.7016
	$\triangle y_t^3$	2.4844 −0.0261	0.8009 −3.6763	−1.8502 0.9224	0.9618 0.0535	−0.1501 0.2726	1.6125 −0.4012
	$\triangle y_t^4$	−0.8521 −0.1333	−0.1592 −3.7640	0.0223 0.4227	−0.1870 1.2806	−0.1713 0.4621	−0.9361 0.6320
	$\triangle y_t^5$	2.2795 0.8128	1.0884 −0.4572	−0.2170 1.6990	−0.3000 1.2862	1.0693 −0.8528	0.7797 −0.5563
	$\triangle y_t^6$	−2.5308 −0.0646	0.2656 −2.0435	1.1149 −4.1466	0.7644 −0.7746	1.2557 0.3313	0.3688 0.2359

Table 7: (Cumulative) Net Effect Results in the Australian Bloc: Australia, New Zealand, Singapore

$\triangle y_t^1$: growth rate of trade between Australia and New Zealand, $\triangle y_t^2$: growth rate of trade between Singapore and Australia, $\triangle y_t^3$: growth rate of trade between Singapore and New Zealand, $\triangle y_t^4$: equity market index return of Australia (AS51), $\triangle y_t^5$: equity market index return of New Zealand (NZSE50 FG), $\triangle y_t^6$: equity market index return of Singapore (FSSTI). The numbers reported are the (cumulative) net effects. For example, the net effect of $\triangle y_t^1$ on $\triangle y_t^2$ is measured by adding up the coefficients in the following estimation equation $\triangle y_t^2 = \left[\phi_0 + \alpha_1^1 z_{t-1} + \Sigma_{j=1}^6 \Sigma_{i=1}^p \phi_i^j \triangle y_{t-i}^j\right] + \left[\rho_0 + \alpha_2^1 z_{t-1} + \Sigma_{j=1}^6 \Sigma_{i=1}^p \rho_i^j \triangle y_{t-i}^j\right] \cdot F(cet_{t-d}) + \varepsilon_t^2$. 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) $\Sigma_{i=1}^p \phi_i^1$ in the contraction regime and $\Sigma_{i=1}^p \phi_i^1 + \rho_i^1$ in the expansionary regime. The highlighted values with gray are (cumulative) net effect in the expansionary regime when F(·) = 1 and not-highlighted values are (cumulative) net effect in the contractionary regime when F(·) = 0 respectively.

		Granger caused variables					
		$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
Granger causing variables	$\triangle y_t^1$	−0.0889 −1.1349	−0.5435 −0.3621	1.6585 0.8962	−0.0455 −0.1061	−0.1620 0.5758	−0.0610 0.8104
	$\triangle y_t^2$	−0.9460 0.1958	−0.3106 −0.1855	−1.3518 −1.0031	0.0125 −0.1989	0.0548 −1.9152	0.1140 −1.6270
	$\triangle y_t^3$	0.4111 0.7953	0.5471 1.3203	−0.3183 −1.2273	−0.0126 −0.0894	0.0127 0.0096	−0.0770 1.8490
	$\triangle y_t^4$	1.6910 −2.7870	1.6096 −0.2555	−0.9282 1.8170	0.9951 2.3098	0.7523 −4.5070	0.5060 −35.4370
	$\triangle y_t^5$	0.8001 −0.2783	−1.6644 −0.9245	9.3730 20.7372	−1.0520 1.6794	−0.7230 −1.1077	−0.5429 31.7679
	$\triangle y_t^6$	−0.8348 2.8572	−0.0654 5.0945	5.9114 6.8972	0.2821 −0.1123	0.0365 1.2469	0.3677 5.6982

2.2. Stock market synchronization within each bloc

In this section, we discuss stock market synchronization in each bloc of Asia-Pacific region. In our empirical framework of VECM, stock market integration is empirically tested by Granger causality in literature (Phylaktis (1999), Valadkhani and Chancharat (2008), and Burdekin and Siklos (2012) to list a few). Thus we employ STAR-VECM based Granger causality test and cumulative net effect to assess the degree of regional stock market integration. The extent to which stock markets are integrated depending on regime shifting is presented in the sub-table which is highlighted in solid box in Table 5 through Table 7.

First, the results of the Far Eastern bloc are reported in Table 5. We find that the Chinese stock return (y_t^4)'s effect on the Japanese and the Korean stock return is intensified from the expansionary regime to the contractionary regime (or from 0.0509 and -0.3263 to 1.0605 and 0.4636 respectively). The Japanese stock return (y_t^5)'s effect on the other two countries' stock return is represented by the net effects of -13.7395 and -0.8117 in the contractionary regime of each country's stock market and -0.1486 and -0.0439 in the expansionary regime of stock markets, suggesting that the Japanese stock return has negative effects on the other two countries' stock markets, but the negative effects are mitigated under the expansionary regime. Lastly, the Korean stock return (y_t^6)'s effect on the Chinese and the Japanese stock markets are estimated as 12.8021 and 1.3146 in the contractionary regime and 0.0708 and 0.0356 in the expansionary regime, showing more intensified effects in the expansionary regime, implying that the Korean stock market return has positive effects on the other two countries' stock markets, but the effects are weakened during the expansionary regime. The negative effect of Japanese stock return on the other two countries' stock return, which is quite opposite to the other two countries cases, might be explained by the following reasons. One possibility is that the Japanese stock market is more advanced with greater openness to foreign investors relative to the Korean and Chinese markets and the stock return of the Japanese market is less volatile than that of the Korean and Chinese markets;[26] therefore, if international investors tend to replace their investment in the Korean and Chinese markets with investment in the Japanese market during the contractionary regime, the Japanese stock return may have a negative effect on Korean and Chinese stock return. Another possibility is that, as suggested by Bracker et al. (1999), if exporting companies of two countries are competitors in global markets, high stock return of Japanese companies may have a negative effect on that of the other country's companies.[27] The effect of the Japanese and Korean stock markets on the Chinese stock market during their contractionary regime exhibits different patterns, implying that the Chinese stock market tends to co-move with the Korean stock market rather than the Japanese stock market in both regimes. Also, the Chinese and Korean stock markets have a positive effect on the Japanese stock market during the contractionary regime, suggesting that the Japanese stock market co-moves with the other stock markets during the contractionary phase.

Second, results for the Chinese bloc stock market synchronization are reported in Table 6 sub-table which is highlighted in solid box. We find that Chinese stock return (y_t^4)'s effect on Hong Kong and Taiwan's stock market return is intensified in the contractionary regime compared to expansionary regime (from -0.1713 and -0.9361 to 0.4621 and 0.6320 respectively), meaning that Chinese stock market return growth has a negative effect on Hong Kong and Taiwan's stock return growth during the contractionary phase but has a positive effect during the expansionary phase. Hong Kong's stock market return (y_t^5) has a conflicting effect on Chinese

26) According to MSCI Index, Japanese stock market is included in MSCI World Index, classified as a developed market, while Chinese and Korean stock markets are included in MSCI Emerging Market Index, classified as emerging markets. In the summary statistics, Japanese stock return's variance is less than Chinese and Korean stock returns', suggesting that Japanese stock could be relatively safer option with less volatility for international investors.

27) As mentioned in literature review section, Bracker et al. (1999) show that the effect of import dependence between trading partners on the stock market integration can be ambiguous because the negative effect of competition between exporting firms of the trading partners in global markets can offset the positive effect of import growth between two countries on stock market performance when one country has large import dependence on the other country. Thus, as Korea and China maintains high import dependence on Japan, the effect of trade growth on stock returns can be negative if the competition effect is substantial.

stock market and Taiwan's stock market over regime changes. That is, Hong Kong's stock return growth has a negative effect (-0.3000) on the Chinese stock return during the contractionary phase, but the effect changes to positive (1.2862) during the expansionary phase, while the opposite appears to Taiwan's stock return (from 0.7797 to -0.5563). This might be attributable to the fact that investors prefer Hong Kong's highly developed and globalized stock market to China's stock market during the contractionary phase with a negative effect on Chinese stock market return, but this negative effect weakens during the expansionary phase. However, Taiwan's stock market shows co-movement with Hong Kong's stock market. Taiwan's stock return (y_t^6)'s effect on China and Hong Kong stock markets are estimated as 0.7644 and 1.2557 in contractionary regime and -0.7746 and 0.3313 in expansionary regime, showing that the positive effects of Taiwanese stock return on the other two markets are weakened in expansionary regime of stock markets. This finding suggests that investment in Taiwan's stock market during its contractionary regime is substituted by the other two markets having a positive effect, but the effect is mitigated during expansionary regime. Overall, in the Chinese bloc's stock markets, Hong Kong's positive influence on the Chinese stock market during the expansionary regime and Taiwan's positive influence on Hong Kong's stock market during the contractionary regime is estimated to be relatively large.

Finally, the Australian bloc stock market synchronization is presented in Table 7 sub-table which is highlighted with solid box. We find that Australia's stock return (y_t^4)'s effect on New Zealand's and Singapore's stock return is positive during the contractionary phase but turns to be negative during the expansionary phase. New Zealand's stock return (y_t^5)'s effect on Australia and Singapore's stock return is negative during contractionary regime but turns positive during expansionary regime. Singapore's stock return (y_t^6)'s effect on Australia's and New Zealand's stock return displays a conflicting pattern; the positive effect of Singapore's stock return on the other two countries' stock return during the contractionary regime turns to be negative for Australia's stock return and more positive for New Zealand's stock return during the expansionary regime. Overall, in terms of the magnitude of the effects, the effects of Australia's and New Zealand's stock return on Singapore's stock return are the largest in this bloc and show that Australia's stock return have a negative effect and New Zealand's stock return have a positive effect on Singapore's stock return during the expansionary regime.

Ⅴ. Conclusion

We provide new evidence on the relationship between intra-regional trade and the stock market integration over Asia-Pacific region. Using three regional blocs in 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 two main questions: whether trade linkages between countries affect stock markets of trading partners and whether stock markets of trading partners are interdependent. By incorporating two distinct dynamic properties of regime shifting and cointegration in intra-regional trade and stock market index, we employ the newly suggested multi-variable smooth transition autoregressive (STAR) model. A series of STAR-based tests reveals new evidence on the effect of intra-regional trade on stock return in Asia-Pacific region and the evidence on stock market synchronization within each region. Our results show that intra-regional trade and stock markets display a complementary relationship in some country pairs in each region, not in all cases though, and the relationship changes over the regime shifting. Among the three blocs analyzed, the Far Eastern bloc displays the most pronounced result of the complementary relationship between trade growth and stock return. For those cases where the complementary relationship between trade and the stock market is ambiguous, factors such as bilateral trade patterns, economic dependence between trading partners, and a relative importance between the financial and trade sectors within the country seem to matter. For more detailed verification on the role of these factors, further investigation will be needed.

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Appendix

Table A1: Summary Statistics

	Mean	Standard Deviation		Mean	Standard Deviation
Far Eastern Bloc					
Log of real stock index			Log difference of real stock index		
China	7.5053	0.3221	China	0.00004	0.0812
Japan	9.3618	0.2386	Japan	−0.00098	0.0596
Korea	7.1934	0.3444	Korea	0.0021	0.0711
Log of real trade value between			Log difference of real trade value between		
China and Japan	11.5534	0.3191	China and Japan	0.0061	0.1480
China and Korea	11.0434	0.5322	China and Korea	0.0103	0.1310
Japan and Korea	6.4080	0.2242	Japan and Korea	0.0042	0.0772

Correlation between real stock indices				Correlation between real stock index and bilateral trade		
	China	Japan	Korea	China–Japan	China–Korea	Japan–Korea
China	1			0.23	0.25	0.34
Japan	0.29	1		−0.06	−0.03	0.29
Korea	0.48	0.16	1	0.77	0.89	0.81

	Mean	Standard Deviation		Mean	Standard Deviation
Chinese Bloc					
Log of real stock index			Log difference of real stock index		
China	7.5053	0.3221	China	0.00004	0.0812
Hong Kong	9.7420	0.2576	Hong Kong	0.0013	0.0634
Taiwan	8.8587	0.2023	Taiwan	−0.0016	0.0725
Log of real trade value between			Log difference of real trade value between		
China and Hong Kong	11.2965	0.4602	China and Hong Kong	0.0100	0.1881
China and Taiwan	10.7989	0.4382	China and Taiwan	0.0086	0.1562
Hong Kong and Taiwan	9.8727	0.2618	Hong Kong and Taiwan	0.0043	0.1272

Correlation between real stock indices				Correlation between real stock index and bilateral trade		
	China	Hong Kong	Taiwan	China–Hong Kong	China–Taiwan	Hong Kong–Taiwan
China	1			0.15	0.24	0.24
Hong Kong	0.72	1		0.60	0.69	0.69
Taiwan	0.50	0.77	1	0.38	0.42	0.47

	Mean	Standard Deviation		Mean	Standard Deviation
Australian Bloc					
Log of real stock index			Log difference of real stock index		
Australia	8.4753	0.1677	Australia	0.0009	0.0378
New Zealand	7.9908	0.2034	New Zealand	0.0041	0.0361
Singapore	7.7828	0.2372	Singapore	0.0003	0.0590
Log of real trade value between			Log difference of real trade value between		
Australia and New Zealand	7.2052	0.1257	Australia and New Zealand	0.0020	0.1227
Australia and Singapore	7.1699	0.2814	Australia and Singapore	0.0038	0.1867
New Zealand and Singapore	5.0238	0.4327	New Zealand and Singapore	0.0077	0.3180

Correlation between real stock indices				Correlation between real stock index and bilateral trade		
	Australia	New Zealand	Singapore	Australia–New Zealand	Australia–Singapore	New Zealand–Singapore
Australia	1			0.30	0.51	0.45
New Zealand	0.80	1		0.07	0.67	0.59
Singapore	0.81	0.81	1	0.01	0.70	0.66

Table A2: Trade Share and Values within Each Bloc

This table presents each country's share of within-bloc trade relative to its total trade and the values of bilateral export 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 A3: Cointegration Equation between Stock Index Variables in the Far Eastern Bloc

$$y_t^4 = \beta_0 + \beta_1 y_t^5 + \beta_2 y_t^6 + \varepsilon_t \tag{4}$$

where : log y_t^4 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).

	y_t^4
β_0	2.9444*** (3.1219)
β_1	0.2113** (2.2055)
β_2	0.3590*** (5.4086)
Adj. R^2	0.1823
SER	0.2912
LLV	−29.6157

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.

Table A4: Estimation of Nonlinear STAR in the Far Eastern Region: China, Japan, Korea

Full estimation results for Table 1 of equation (3) where $\triangle y_t^1$: growth rate of trade between China and Japan, $\triangle y_t^2$: growth rate of trade between China and Korea, $\triangle y_t^3$: growth rate of trade between Japan and Korea, $\triangle y_t^4$: equity market index return of China (Shang Hai Composite Index), $\triangle y_t^5$: equity market index return of Japan (Nikei Index), $\triangle y_t^6$: equity market index return of Korea (KOSPI index).

	$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
α^i	−1.0811 (−1.3607)	1.6727 (0.9348)	0.0917 (0.7997)	−0.7980*** (−4.5551)	−0.0518 (−0.1561)	0.1889 (1.4586)
ϕ_0^i	0.2048* (1.7127)	0.2276 (0.6471)	0.0229 (0.5470)	−0.0648 (−0.3233)	−0.0088 (−0.3446)	−0.0328 (−1.2624)
ϕ_1^i	−0.2786 (−0.3307)	3.3213** (2.2107)	−0.4059 (−0.8078)	−7.0398*** (−4.9936)	−0.8340** (−2.0625)	0.1093 (0.5231)
ϕ_2^i	−0.3753 (−0.4445)	−11.4618** (−2.6065)	0.8234* (1.7636)	−2.1589 (−1.5131)	0.4679 (1.4641)	0.4620* (1.8687)

	$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
ϕ_3^i	−0.5644 (−0.6555)	−10.1488* (−1.7068)	1.4329*** (3.4324)	13.0484** (2.0866)	−0.4182 (−1.1125)	0.6082** (2.2830)
ϕ_4^i	−1.9539** (−2.0325)	−1.6115 (−0.5668)	−0.1005 (−0.2850)	−0.8516 (−0.4395)	0.8689*** (3.1641)	0.8309*** (3.3091)
ϕ_1^2	−0.3704 (−0.3754)	1.1552 (0.8772)	0.3762 (0.6561)	7.7528*** (4.5911)	0.6821** (2.1816)	−0.2961 (−1.2162)
ϕ_2^2	0.6665 (0.6381)	13.0826** (2.1569)	−1.4082*** (−2.9863)	−0.7874 (−0.4162)	−0.9425** (−2.4618)	−0.5126* (−1.8800)
ϕ_3^2	1.1345 (1.2099)	9.8309 (1.4233)	−1.7368*** (−3.7824)	−14.2880** (−2.4283)	−0.5005 (−1.1239)	−0.4455* (−1.7945)
ϕ_4^2	1.9276** (2.0959)	0.7220 (0.2028)	0.2031 (0.5557)	3.9427 (1.1277)	−0.5739* (−1.9198)	−0.6037*** (−2.6676)
ϕ_1^3	1.1113 (1.3605)	−12.9757* (−1.7333)	−0.3998 (−1.3267)	−0.9889 (−1.5460)	−0.3464 (−1.2945)	0.5557** (2.0844)
ϕ_2^3	−2.1846* (−1.7283)	4.0256 (0.9823)	−0.7111 (−1.5981)	6.0002*** (3.5954)	−0.1631 (−0.3046)	0.2762 (0.9243)
ϕ_3^3	−1.9604 (−1.5132)	4.3992* (1.8727)	−0.0328 (−0.0952)	−1.0931 (−0.8879)	0.7040** (2.0820)	−0.1761 (−0.6689)
ϕ_4^3	0.0831 (0.1457)	4.7550** (2.0736)	0.3389 (1.0216)	−0.2185 (−0.2738)	−1.2690*** (−3.6660)	−0.5920** (−2.2019)
ϕ_1^4	1.8242* (1.9609)	1.4518 (0.6288)	−0.0128 (−0.0704)	1.6360*** (3.8647)	−0.6984 (−1.4801)	0.0499 (0.2642)
ϕ_2^4	1.6013* (1.7803)	−9.5586** (−2.4522)	−0.2447 (−1.1038)	−2.0491* (−1.8979)	0.3559 (0.8750)	0.4235*** (3.3249)
ϕ_3^4	0.4750 (1.1674)	5.5601** (2.2245)	0.1705 (1.0493)	−1.0965 (−0.6775)	0.6336** (2.1827)	0.0270 (0.1641)
ϕ_4^4	−0.6899** (−2.1458)	−1.3658 (−0.8043)	−0.3340 (−1.4303)	−0.6443 (−1.3036)	0.7694*** (3.2795)	−0.0368 (−0.2988)
ϕ_1^5	1.0053 (1.3162)	−1.6723 (−0.3234)	0.3064 (0.9773)	0.6670 (0.7903)	−0.0202 (−0.0620)	−0.5205** (−2.1685)
ϕ_2^5	−0.0572 (−0.0910)	−8.9455 (−1.2620)	0.6602* (1.9178)	−0.1324 (−0.0846)	−0.3599 (−1.3205)	−0.2789 (−0.9815)
ϕ_3^5	−1.1577 (−1.5333)	5.1151 (1.5596)	−0.3444 (−0.8673)	−12.7199** (−2.2417)	−1.1474*** (−2.6395)	−0.1461 (−0.6027)
ϕ_4^5	1.3387 (1.5956)	−2.5901 (−1.2251)	0.9077** (2.4472)	−1.5542** (−2.5384)	−0.1931 (−0.4367)	0.1338 (0.6556)
ϕ_1^6	−2.2372*** (−3.3023)	−2.4623 (−1.1830)	−0.4082 (−1.4562)	−2.0774*** (−3.4684)	0.2166 (0.9823)	0.4803*** (2.8461)
ϕ_2^6	−0.4502 (−1.0601)	3.4487 (1.0487)	−0.6235* (−1.9608)	−0.1291 (−0.1206)	−0.1089 (−0.4939)	0.0763 (0.3983)
ϕ_3^6	0.9375* (1.6779)	−0.0600 (−0.0516)	0.2010 (0.7878)	7.6315* (1.8033)	0.8062*** (2.6752)	0.5461*** (3.1210)
ϕ_4^6	−1.3195* (−1.8474)	2.5139* (1.9089)	0.0535 (0.1877)	7.3771*** (3.6121)	0.4007 (1.2841)	−0.2316 (−1.0933)
α^i	1.0846 (1.3628)	−1.6538 (−0.9260)	−0.0906 (−0.7989)	0.7476*** (4.2358)	0.0093 (0.0279)	−0.2350* (−1.7957)
ρ_0^i	−0.2015 (−1.6495)	−0.2031 (−0.5712)	−0.0239 (−0.5217)	0.0693 (0.3418)	0.0123 (0.4688)	0.0321 (1.1017)
ρ_1^1	−0.1901 (−0.2087)	−3.4677** (−2.2260)	0.2198 (0.3953)	6.9900*** (4.8159)	0.7054* (1.6722)	−0.1284 (−0.4561)
ρ_2^1	−0.5785 (−0.5999)	11.2508** (2.5798)	−1.5807*** (−3.0539)	2.1977 (1.5204)	−0.4588 (−1.3103)	−0.3679 (−1.1440)
ρ_3^1	0.3436 (0.3657)	10.4084* (1.7480)	−1.5632*** (−3.4177)	−12.9728** (−2.0700)	0.4273 (1.0630)	−0.6268* (−1.8009)

	$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
ρ_4^1	1.8058* (1.7472)	1.3096* (0.4580)	0.0655 (0.1488)	0.8035 (0.4103)	−0.6987** (−2.2336)	−1.0364*** (−3.2040)
ρ_1^2	0.1539 (0.1441)	−1.7154 (−1.2328)	−0.2463 (−0.3883)	−7.8431*** (−4.5209)	−0.6557* (−1.8835)	0.3051 (0.9342)
ρ_2^2	−0.4293 (−0.3717)	−13.4129** (−2.2133)	2.0316*** (4.0762)	0.5992 (0.3162)	0.7108* (1.7085)	0.4893 (1.3663)
ρ_3^2	−1.0305 (−1.0308)	−10.1618 (−1.4634)	2.0023*** (4.0585)	14.1690** (2.4137)	0.5358 (1.1150)	0.6799** (2.0077)
ρ_4^2	−2.0418** (−2.0634)	−0.5212 (−0.1446)	−0.1959 (−0.4225)	−3.8483 (−1.0908)	0.4525 (1.4354)	0.8880*** (2.8165)
ρ_1^3	−0.7020 (−0.7719)	13.9307* (1.8613)	0.1839 (0.4756)	0.9426 (1.4442)	0.5532* (1.8079)	−0.5819* (−1.6640)
ρ_2^3	2.5810* (1.9676)	−4.0769 (−0.9791)	0.7062 (1.3397)	−6.0344*** (−3.6850)	0.5870 (1.0291)	−0.3660 (−0.8470)
ρ_3^3	1.9986 (1.4712)	−4.4381* (−1.8556)	−0.0352 (−0.0877)	1.1136 (0.8656)	−0.5067 (−1.3568)	0.0476 (0.1263)
ρ_4^3	−0.2448 (−0.3787)	−5.0868** (−2.1985)	−0.6209 (−1.6324)	0.0195 (0.0224)	1.1926*** (3.1501)	0.6030 (1.4991)
ρ_1^4	−2.0055** (−2.1496)	−1.3701 (−0.5905)	0.0362 (0.1517)	−1.5760*** (−3.7094)	0.8660* (1.8097)	−0.2556 (−1.0371)
ρ_2^4	−1.6199* (−1.7653)	9.5353** (2.4530)	0.4031 (1.5830)	2.2309** (2.1086)	−0.3388 (−0.8004)	−0.3756* (−1.9264)
ρ_3^4	−0.5309 (−1.0992)	−5.5127** (−2.2052)	−0.1754 (−0.8486)	1.1336 (0.6919)	−0.7027** (−2.3392)	−0.0676 (−0.3000)
ρ_4^4	0.6025 (1.5580)	1.2706 (0.7452)	0.3903 (1.3797)	0.9421* (1.7585)	−0.8341*** (−3.1357)	−0.0911 (−0.5029)
ρ_1^5	−1.4723* (−1.7139)	1.6525 (0.3193)	−0.2924 (−0.7179)	−0.6503 (−0.7196)	0.2370 (0.6270)	1.0949*** (2.8668)
ρ_2^5	−0.5805 (−0.7833)	9.0918 (1.2772)	−0.6311 (−1.4306)	0.1119 (0.0701)	0.0781 (0.2395)	0.0144 (0.0378)
ρ_3^5	1.7875** (2.1751)	−5.1403 (−1.5633)	0.5159 (1.1263)	12.4416** (2.1796	1.0884** (2.3295)	−0.1811 (−0.5000)
ρ_4^5	−1.2043 (−1.2512)	3.0226 (1.3690)	−0.8726** (−2.1102)	1.6877*** (2.7215)	0.0887 (0.1894)	−0.1604 (−0.5262)
ρ_1^6	2.9226*** (4.2007)	2.5527 (1.2010)	0.5838* (1.6756)	2.0465*** (3.0736)	−0.4905** (−2.0022)	−0.9377*** (−3.2216)
ρ_2^6	0.8463 (1.5770)	−3.4047 (−1.0338)	0.7364* (1.8409)	0.1316 (0.1225)	0.2852 (1.1281)	0.0326 (0.1190)
ρ_3^6	−1.1270* (−1.7077)	0.1219 (0.1019)	−0.1342 (−0.4199)	−7.4143* (−1.7475)	−0.7322** (−2.1691)	−0.4644* (−1.7297)
ρ_4^6	1.7519** (2.1514)	−2.6145* (−1.9507)	−0.0505 (−0.1463)	−7.4951*** (−3.6651)	−0.3415 (−1.0408)	0.4675 (1.5497)
γ^i	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)
Adj.R^2	0.4895	0.4792	0.5027	0.2548	0.3844	0.1741
SER	0.1054	0.0929	0.0538	0.0703	0.0463	0.0635
LLV	168.3332	188.8384	277.9827	234.3817	302.4783	250.7827
	ESTAR	ESTAR	ESTAR	LSTAR	ESTAR	ESTAR

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.

Table A5: Cointegration Equation between Stock Index Variables in the Chinese Bloc

Estimation of equation (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 Hong Kong (Hang Seng), y_t^6: log of equity market index of Taiwan (TWSE).

	y_t^4
β_0	0.3429 (0.3932)
β_1	−0.1400 (−1.3048)
β_2	0.8625*** (8.0342)
Adj. R^2	0.3794
SER	0.2537
LLV	−6.4420

Note: Please refer to Notes in Table A3.

Table A6: Estimation of Nonlinear STAR in the Chinese bloc: China, Taiwan, Hong Kong

Full estimation results for Table 2 of equation (3) where $\triangle y_t^1$: growth rate of trade between China and Hong Kong, $\triangle y_t^2$: growth rate of trade between China and Taiwan, $\triangle y_t^3$: growth rate of trade between Taiwan and Hong Kong, $\triangle y_t^4$: equity market index return of China (Shang Hai Composite Index), $\triangle y_t^5$: equity market index return of Hong Kong (Hang Seng Index), $\triangle y_t^6$: equity market index return of Taiwan (Taiwan Stock Exchange index).

	$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
α^i	0.0600 (0.0603)	−0.2442* (−1.8383)	−0.2843 (−0.9981)	−0.0743 (−0.3839)	0.6503* (1.9456)	−0.7041* (−1.7049)
ϕ_0^i	0.0653 (0.4879)	−0.0058 (−0.3986)	−0.0142 (−0.8057)	−0.0012 (−0.0951)	0.1478* (2.5234)	−0.0348 (−1.3587)
ϕ_1^i	−3.0182** (−2.3547)	0.2962 (1.5050)	0.6189 (1.6077)	0.1690 (0.7042)	−0.9239** (−2.4832)	0.8552* (1.8844)
ϕ_2^i	−1.2907 (−1.5828)	−0.4580** (−2.3252)	−0.7046*** (−2.8477)	0.0794 (0.3052)	−0.7267* (−1.8183)	1.0011** (2.1608)
ϕ_3^i	−0.2308 (−0.3233)	−0.4318*** (−2.6417)	0.0042 (0.0130)	0.5006* (1.8725)	0.2205 (0.7744)	1.0263** (2.2056)

	$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
ϕ_4^i	0.1524 (0.5095)	−0.2602* (−1.8379)	0.1175 (0.4183)	0.1182 (0.5152)	0.1249 (0.7332)	0.0505 (0.3417)
ϕ_1^2	2.2084 (1.6129)	−0.9279*** (−3.3497)	−0.2765 (−0.5807)	−0.2231 (−0.9258)	1.2614*** (3.0261)	−1.1652** (−2.4327)
ϕ_2^2	0.1674 (0.1639)	−0.2117 (−0.7108)	0.7952** (2.3295)	−0.2406 (−0.8091)	0.6191 (1.4480)	−1.4413*** (−2.8761)
ϕ_3^2	0.1502 (0.1687)	0.1608 (0.6044)	0.1799 (0.5314)	−0.5922** (−2.1474)	−0.5020 (−1.3293)	−1.4147*** (−2.6445)
ϕ_4^2	−0.7934* (−1.7374)	0.2742 (1.3109)	−0.0103 (−0.0306)	−0.3645 (−1.4328)	−0.3157 (−1.2643)	−0.2782 (−1.4164)
ϕ_1^3	0.5524** (2.1157)	0.2419 (1.6374)	−0.6345** (−2.3565)	0.1906 (1.3487)	−0.3265* (−1.8657)	0.2445* (1.7609)
ϕ_2^3	0.7552** (2.0378)	0.4091** (2.2790)	−0.5388** (−2.1796)	0.1604 (0.9605)	−0.1664 (−0.7598)	0.5290*** (3.0965)
ϕ_3^3	0.5280* (1.8417)	0.1385 (0.7455)	−0.4281* (−1.7892)	0.2889* (1.7991)	0.1359 (0.6714)	0.4787** (2.2803)
ϕ_4^3	0.6488** (2.4122)	0.0114 (0.0906)	−0.2488 (−1.3518)	0.3219** (2.4638)	0.2069 (1.5399)	0.3603** (2.2590)
ϕ_1^4	−0.5551* (−1.7726)	−0.0895 (−0.6826)	0.1379 (0.6788)	−0.0528 (−0.4146)	−0.6970*** (−3.3386)	−0.3105** (−2.0741)
ϕ_2^4	0.2614 (0.4596)	−0.0686 (−0.4174)	−0.1340 (−0.4737)	0.0089 (0.0592)	−0.2336 (−1.1001)	−0.0647 (−0.4992)
ϕ_3^4	−0.5327 (−1.1916)	0.2137 (1.5480)	−0.1653 (−0.5096)	−0.1399 (−0.8769)	0.3470* (1.8802)	−0.3640** (−2.3456)
ϕ_4^4	−0.0257 (−0.0447)	−0.2148 (−1.6167)	0.1837 (0.7516)	−0.0032 (−0.0192)	0.4123*** (2.9140)	−0.1969 (−1.3649)
ϕ_1^5	1.3847*** (2.6800)	0.5490 (1.5693)	0.3046 (0.6216)	0.1625 (0.5029)	0.4787 (1.2627)	−0.0881 (−0.3177)
ϕ_2^5	−1.2213* (−1.8637)	0.5739** (2.5633)	0.1225 (0.2965)	−0.2761 (−1.0462)	0.5370 (1.1173)	0.6198** (2.0009)
ϕ_3^5	1.5844*** (2.9030)	−0.4099 (−1.5745)	−0.3636 (−0.9994)	−0.2986 (−1.0402)	−0.0740 (−0.2446)	−0.2070 (−0.7481)
ϕ_4^5	0.5317 (0.8472)	0.3754 (1.4165)	−0.2805 (−0.6892)	0.1122 (0.4547)	0.1276 (0.4618)	0.4550 (1.5495)
ϕ_1^6	−0.8043** (−2.0025)	−0.2102 (−0.8084)	0.2840 (0.6458)	−0.1389 (−0.5119)	0.0900 (0.2807)	0.3658 (1.4077)
ϕ_2^6	0.5485 (0.5902)	−0.1187 (−0.5176)	−0.0451 (−0.1197)	0.5718** (1.9872)	0.4920** (2.4454)	−0.1387 (−0.4865)
ϕ_3^6	−2.0308*** (−3.9592)	0.3693 (1.5166)	0.6551* (1.9437)	0.6651** (2.5959)	0.4517* (1.9678)	0.4639 (1.6586)
ϕ_4^6	−0.2442 (−0.5703)	0.2252 (0.8305)	0.2209 (0.5448)	−0.3336 (−1.4783)	0.2220 (0.6870)	−0.3222 (−1.2334)
α^i	0.0166 (0.0164)	−0.6314 (−0.5719)	0.5811 (1.3654)	0.0527 (0.2163)	−0.5114 (−1.5947)	0.7543* (1.7795)
ρ_0^i	−0.0606 (−0.4499)	0.0933 (0.3923)	0.0949 (1.6434)	0.0199 (0.9111)	−0.1654** (−2.5460)	0.0274 (0.9576)
ρ_1^1	2.8915** (2.2213)	3.0598* (1.9206)	−1.7254** (−2.4911)	−0.4443 (−1.1355)	0.7713** (2.0367)	−0.9902** (−1.9849)
ρ_2^1	0.0902 (0.1067)	0.3754 (0.4048)	−0.5786 (−1.1105)	0.2331 (0.5365)	0.5289 (1.3225)	−1.2525** (−2.4796)
ρ_3^1	−0.2081 (−0.2766)	1.2424*** (3.0028)	−1.6406** (−2.4042)	−0.8852** (−2.3471)	−0.3293 (−1.0015)	−1.1781** (−2.3274)

	$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
ρ_4^1	−0.5575 (−1.4015)	1.7802 (1.3661)	−1.7560*** (−2.9295)	−0.0165 (−0.0549)	−0.1102 (−0.4811)	−0.0372 (−0.1821)
ρ_1^2	−2.4341* (−1.7527)	−2.3104 (−1.2586)	0.7420 (0.8218)	−0.0398 (−0.1042)	−1.0825** (−2.4845)	1.2818** (2.4109)
ρ_2^2	0.3596 (0.3425)	0.5025 (0.7116)	−0.7688 (−0.8641)	−0.2497 (−0.4401)	−0.3272 (−0.7376)	1.7844*** (3.1431)
ρ_3^2	0.2008 (0.2089)	0.1031 (0.1212)	0.5461 (0.6078)	0.5817 (1.2828)	0.5414 (1.2317)	1.5734** (2.5819)
ρ_4^2	1.2999** (2.4010)	−1.1284* (−1.6823)	1.7497** (2.1587)	0.2998 (0.7888)	0.2688 (0.8019)	0.3614 (1.2153)
ρ_1^3	−0.5919 (−1.5539)	−0.8863 (−1.6342)	0.4022 (0.6497)	−0.0634 (−0.2937)	0.3133 (1.5993)	−0.2532 (−1.3232)
ρ_2^3	−0.6042 (−1.3157)	−0.8048* (−1.8062)	1.2975* (1.8490)	−0.1122 (−0.4227)	0.1698 (0.6807)	−0.6664*** (−2.9638)
ρ_3^3	−0.4967 (−1.3487)	−1.6135** (−2.3139)	1.0314 (1.3559)	−0.2706 (−1.1600)	−0.0070 (−0.0309)	−0.5686** (−2.2783)
ρ_4^3	−0.8177*** (−2.6955)	−1.1726 (−0.7409)	0.0415 (0.0816)	−0.4621** (−2.1228)	−0.0534 (−0.3012)	−0.5255*** (−2.7449)
ρ_1^4	0.6401 (1.6460)	−0.5867 (−1.4646)	−0.8360* (−1.9524)	0.3049 (1.2227)	0.9376*** (3.6353)	0.3789* (1.8684)
ρ_2^4	−0.3286 (−0.4845)	−0.6404 (−0.8390)	0.6164 (0.8426)	0.1326 (0.4849)	0.4872* (1.8616)	0.1975 (0.9540)
ρ_3^4	0.9907* (1.9524)	−1.6495 (−0.9313)	1.4915** (2.4493)	0.2285 (0.8344)	−0.4080* (−1.8095)	0.6576*** (3.0573)
ρ_4^4	−0.5834 (−0.9185)	−0.7282 (−1.4935)	−0.8715 (−1.5993)	0.8016** (2.4409)	−0.3834* (−1.9801)	0.3341 (1.4174)
ρ_1^5	−1.3696** (−2.1359)	−4.5104** (−2.0148)	−0.1720 (−0.1807)	−0.0247 (−0.0432)	−0.6258 (−1.4806)	0.5209 (1.2313)
ρ_2^5	1.7311** (2.3321)	0.8655 (0.8178)	−0.2155 (−0.2435)	0.7779 (1.6146)	−0.8481 (−1.5722)	−1.0405** (−2.5300)
ρ_3^5	−1.7458*** (−2.8532)	0.6888 (1.0331)	0.9043 (1.0703)	1.1186** (2.4586)	−0.2183 (−0.6258)	−0.0876 (−0.2106)
ρ_4^5	−0.0824 (−0.1099)	1.4105** (1.9873)	1.3992 (1.2854)	−0.2856 (−0.5800)	−0.2299 (−0.6974)	−0.7288* (−1.8476)
ρ_1^6	0.5834 (1.1695)	2.7439** (2.0732)	−1.3139 (−1.1951)	0.1321 (0.2607)	0.0119 (0.0324)	−0.4940 (−1.3158)
ρ_2^6	−0.6983 (−0.7253)	−0.4418 (−0.3874)	−0.1760 (−0.2026)	−1.2836** (−2.0817)	−0.4876** (−2.0584)	0.4150 (1.1986)
ρ_3^6	2.1432*** (3.9248)	−2.3028 (−1.2319)	−3.5983*** (−2.6811)	−1.0337** (−2.5202)	−0.1867 (−0.6675)	−0.3051 (−0.7606)
ρ_4^6	0.4379 (0.8344)	−2.3084** (−2.1234)	−0.1733 (−0.1841)	0.6462 (1.4703)	−0.2620 (−0.6925)	0.2512 (0.6992)
γ^i	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)
Adj.R^2	0.5056	0.5166	0.4368	0.1947	0.2247	0.0245
SER	0.1294	0.1056	0.1194	0.0730	0.0553	0.0716
LLV	134.8783	167.9089	147.9686	228.0636	273.2866	231.2555
	LSTAR	LSTAR	ESTAR	ESTAR	LSTAR	ESTAR

Note: Refer to Notes in Table A4.

Table A7: Cointegration Equation between Stock Index Variables in the Australian Bloc

Estimation of equation (4) where $\triangle y_t^4$: log of equity market index of Australia (AS51), $\triangle y_t^5$: log of equity market index of New Zealand(NZSE50 FG), $\triangle y_t^6$: log of equity market index of Singapore (FSSTI).

	$\triangle y_t^4$
β_0	3.1748*** (10.2614)
β_1	0.3043*** (5.3340)
β_2	0.3676*** (5.3328)
Adj. R^2	0.6793
SER	0.0979
LLV	142.6235

Note: Please refer to Notes in Table A3.

Table A8: Estimation of Nonlinear STAR in the Australian Bloc: Australia, New Zealand, Singapore

Full estimation results for Table 3 of equation (3) where $\triangle y_t^1$: growth rate of trade between Australia and New Zealand, $\triangle y_t^2$: growth rate of trade between Singapore and Australia, $\triangle y_t^3$: growth rate of trade between Singapore and New Zealand, $\triangle y_t^4$: equity market index return of Australia (AS51), $\triangle y_t^5$: equity market index return of New Zealand (NZSE50 FG), $\triangle y_t^6$: equity market index return of Singapore (FSSTI).

	$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
α^i	0.0660* (1.7037)	0.0164 (0.3053)	−0.0872 (−1.2458)	0.0046 (0.7069)	0.0039 (0.9564)	0.0065 (0.9133)
ϕ_0^i	0.3920 (1.2739)	−0.7828** (−2.1095)	0.7457 (1.3096)	−0.0228 (−0.1938)	−0.1112** (−2.573)	−0.0252 (−0.3371)
ϕ_1^i	−0.1163 (−0.5742)	0.2168 (1.1328)	0.5355* (1.7664)	0.0183 (0.4182)	−0.0033 (−0.1100)	0.0055 (0.1207)
ϕ_2^i	−0.4672*** (−3.2322)	−0.0178 (−0.0772)	0.0566 (0.2782)	−0.0416 (−0.6881)	−0.0349 (−1.007)	−0.0094 (−0.1666)

	$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
ϕ_3^i	0.0547 (0.3142)	0.1097 (0.4599)	−0.3046 (−1.1779)	0.0142 (0.2338)	−0.0106 (−0.3111)	−0.0535 (−0.9434)
ϕ_4^i	0.0474 (0.2518)	−0.0710 (−0.3798)	0.6247** (2.5162)	−0.0153 (−0.2868)	−0.0049 (−0.1280)	0.0205 (0.3576)
ϕ_1^2	−0.3218 (−1.027)	−0.3659 (−0.946)	−0.6698 (−1.2041)	−0.0463 (−0.9876)	0.0068 (0.2206)	−0.0208 (−0.4824)
ϕ_2^2	−0.1809 (−0.5191)	−0.2819 (−0.9913)	0.4692 (0.9386)	0.0186 (0.365)	0.0047 (0.1283)	0.0441 (0.7734)
ϕ_3^2	−0.3911 (−0.915)	0.0799 (0.3766)	−0.0435 (−0.0864)	0.0268 (0.4404)	0.0333 (0.9279)	0.0450 (0.8024)
ϕ_4^2	−0.0548 (−0.3685)	0.2555 (1.2479)	−1.1094*** (−4.5866)	0.0131 (0.3014)	0.0100 (0.3187)	0.0449 (0.9387)
ϕ_1^3	0.1038 (0.5198)	−0.2150 (−0.9418)	−0.4950 (−1.5155)	0.0142 (0.5871)	0.0214 (1.1511)	−0.0000 (−0.0007)
ϕ_2^3	0.2220 (0.9437)	−0.2743* (−1.6674)	−0.1232 (−0.3919)	−0.0282 (−1.0696)	0.0073 (0.4701)	−0.0172 (−0.5964)
ϕ_3^3	0.2073 (0.872)	−0.1438 (−1.1663)	0.0028 (0.0103)	−0.0242 (−0.7858)	−0.0120 (−0.6959)	−0.0390 (−1.4248)
ϕ_4^3	−0.1225 (−1.5178)	−0.239* (−1.8737)	0.2969** (2.3996)	0.0252 (0.8898)	−0.0049 (−0.3859)	−0.0219 (−0.9164)
ϕ_1^4	−0.3758 (−0.4677)	0.0811 (0.0793)	1.8173 (0.9568)	0.2903 (1.1374)	0.4511*** (3.0535)	0.1026 (0.4103)
ϕ_2^4	2.0636** (2.5306)	0.5432 (0.5053)	3.2585* (1.6642)	−0.1766 (−0.5366)	0.1621 (1.2516)	0.0247 (0.084)
ϕ_3^4	−0.0011 (−0.0014)	1.0443 (0.8987)	0.3180 (0.2375)	0.5569** (2.1741)	0.2411 (1.6003)	0.4307 (1.6143)
ϕ_4^4	0.0034 (0.0035)	−0.0593 (−0.0535)	−6.3227*** (−4.8256)	0.3239 (1.1252)	−0.1021 (−0.6724)	−0.0524 (−0.1951)
ϕ_1^5	−0.4115 (−0.5968)	0.3896 (0.3897)	1.6366 (1.1984)	−0.1817 (−0.7819)	−0.3323** (−2.1619)	−0.2295 (−0.9459)
ϕ_2^5	−0.3210 (−0.3864)	−0.9590 (−0.8807)	0.7577 (0.6979)	−0.0263 (−0.0839)	−0.3712*** (−2.9789)	−0.0166 (−0.057)
ϕ_3^5	0.3391 (0.4578)	−0.6194 (−0.5621)	3.8855** (2.6197)	−0.5087** (−2.0343)	0.0080 (0.0513)	−0.4395 (−1.5208)
ϕ_4^5	1.193 (1.5133)	−0.4768 (−0.5068)	3.0932** (2.294)	−0.3379 (−1.2872)	−0.0284 (−0.1863)	0.1411 (0.4751)
ϕ_1^6	0.0426 (0.1131)	−0.9191 (−1.3133)	0.0075 (0.0083)	0.0446 (0.2664)	0.0095 (0.1041)	0.2601 (1.337)
ϕ_2^6	−0.6571 (−1.4807)	0.9641 (1.544)	−2.1781** (−2.1462)	0.2017 (1.4413)	0.0544 (0.6439)	0.0408 (0.2348)
ϕ_3^6	−0.3246 (−0.7612)	−0.3874 (−0.743)	−1.7732* (−1.9003)	−0.0404 (−0.3432)	−0.0695 (−0.7971)	−0.0496 (−0.3546)
ϕ_4^6	0.1036 (0.2394)	0.2765 (0.4132)	4.7123*** (4.8243)	0.0758 (0.5602)	0.0416 (0.5173)	0.1158 (0.8783)
α^i	−0.0971* (−1.8371)	0.0140 (0.1903)	0.1191 (1.5572)	−0.0109 (−0.706)	0.1716 (0.8922)	−1.1616 (−1.5731)
ρ_0^i	−0.4508 (−1.1932)	0.4953 (1.2878)	−0.6513 (−1.0565)	0.0464 (0.2284)	−0.6192 (−0.4031)	9.4352 (1.5316)
ρ_1^1	−0.3473 (−1.258)	0.0471 (0.1515)	−0.3507 (−0.899)	−0.0622 (−0.6903)	−0.0182 (−0.0574)	0.6037 (0.4455)
ρ_2^1	−0.0304 (−0.1086)	0.2183 (0.6766)	0.1365 (0.4255)	0.0577 (0.5077)	−0.1700* (−1.6902)	0.1829 (0.531)
ρ_3^1	−0.2857 (−1.0301)	−0.0731 (−0.2338)	0.3512 (0.9796)	−0.0856 (−0.706)	−0.2942 (−0.8347)	−0.3345 (−0.8188)

	$\triangle y_t^1$	$\triangle y_t^2$	$\triangle y_t^3$	$\triangle y_t^4$	$\triangle y_t^5$	$\triangle y_t^6$
ρ_4^1	−0.3841 (−1.1814)	−0.0116 (−0.0496)	−0.9002*** (−2.6555)	0.0287 (0.2431)	−0.4216* (−1.8087)	0.4188 (0.8759)
ρ_1^2	0.3476 (0.8324)	0.0508 (0.1277)	0.6695 (1.0875)	0.0876 (0.9287)	−0.2572 (−0.9852)	−0.1155 (−0.581)
ρ_2^2	0.2327 (0.5137)	−0.1161 (−0.3268)	−0.7243 (−1.2574)	−0.1137 (−1.1885)	−0.4241 (−1.0983)	−0.5553*** (−2.9571)
ρ_3^2	0.4183 (0.7929)	−0.4646* (−1.7034)	−0.2702 (−0.4804)	−0.1261 (−0.9908)	−0.5591 (−1.5422)	−0.6417*** (−3.1228)
ρ_4^2	0.1432 (0.6503)	−0.601** (−2.5633)	0.6732** (2.3653)	−0.0600 (−0.681)	−0.7304 (−1.3698)	−0.4307 (−1.5762)
ρ_1^3	−0.1254 (−0.4956)	0.0356 (0.1494)	−0.1149 (−0.3222)	−0.0345 (−0.5833)	−0.3819 (−1.2684)	0.3847* (1.8768)
ρ_2^3	−0.4775* (−1.6824)	0.1930 (0.9411)	−0.3555 (−0.9934)	0.0822 (1.1775)	−0.1094 (−0.5902)	0.5949*** (4.0251)
ρ_3^3	−0.3007 (−1.0962)	0.2261 (1.3777)	−0.1836 (−0.5700)	−0.0050 (−0.0753)	0.0788 (0.3967)	0.6748*** (3.4025)
ρ_4^3	0.0059 (0.0395)	0.3185** (2.1220)	−0.2577 (−1.4488)	−0.1202 (−1.6362)	0.4081 (1.3320)	0.2716 (0.9778)
ρ_1^4	−0.1646 (−0.1327)	1.5259 (1.0651)	−0.4758 (−0.2194)	−0.5924 (−1.1359)	−0.6515 (−0.2942)	−9.3283 (−1.1295)
ρ_2^4	−3.1643** (−2.2923)	−0.6200 (−0.4502)	−2.4995 (−1.1639)	0.7546 (1.2698)	2.8587 (0.9502)	−7.0944*** (−2.7015)
ρ_3^4	−0.1228 (−0.0909)	−2.1672 (−1.3652)	0.7606 (0.4649)	−1.0789 (−1.6029)	−1.2043 (−0.5738)	−10.7301 (−1.5349)
ρ_4^4	−1.0286 (−0.6498)	−0.6045 (−0.4404)	4.9586*** (3.1258)	−1.1471* (−1.9442)	−6.2639** (−2.2828)	−8.7916 (−1.6553)
ρ_1^5	0.6547 (0.5923)	−1.6606 (−1.2749)	−2.8966* (−1.728)	0.3244 (0.5817)	5.5463* (1.6899)	8.9009 (1.266)
ρ_2^5	1.0619 (0.7168)	1.8160 (1.2848)	−2.4778* (−1.7374)	−0.2745 (−0.4315)	−2.5043 (−1.4567)	6.7373 (1.4385)
ρ_3^5	−0.9355 (−0.6981)	1.3769 (0.9628)	−3.3749* (−1.8140)	1.5780* (1.9715)	−1.7137 (−1.3031)	11.4372 (1.4701)
ρ_4^5	−1.8608 (−1.5388)	−0.7939 (−0.647)	−4.0684** (−2.3771)	1.1030 (1.6603)	−1.7147 (−1.5873)	5.2356 (1.1571)
ρ_1^6	0.2287 (0.308)	0.8514 (0.9880)	−0.4397 (−0.4018)	0.0928 (0.2315)	−4.404*** (−2.6909)	0.2874 (0.207)
ρ_2^6	1.1392 (1.6216)	−1.3931* (−1.7227)	3.4360*** (2.8599)	−0.3130 (−0.8813)	1.4749 (0.7696)	2.1802 (1.459)
ρ_3^6	1.2396* (1.7618)	1.2524* (1.6779)	1.3758 (1.2871)	−0.2000 (−0.6476)	2.0473*** (3.6519)	1.1161 (0.8171)
ρ_4^6	1.0845 (1.1966)	0.6563 (0.7403)	−3.3875*** (−3.0498)	0.0258 (0.0755)	2.0922 (1.6228)	1.7468 (1.231)
γ^i	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)
Adj.R^2	0.2638	0.4881	0.4585	0.0421	0.2340	0.1442
SER	0.1042	0.1122	0.2006	0.0375	0.0312	0.0536
LLV	160.6998	149.4527	61.7468	314.8641	342.7170	261.0708
	ESTAR	LSTAR	LSTAR	ESTAR	LSTAR	LSTAR

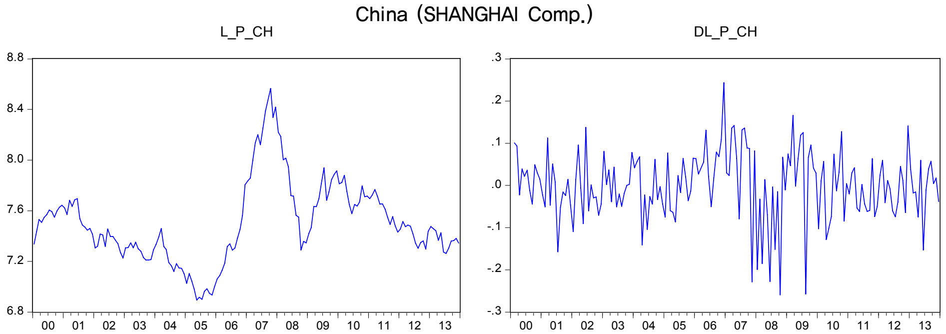
Note: Refer to Notes in Table A4.

Figure A1-1: Graphs of Real Stock Index and Monthly Return (Far Eastern Bloc)

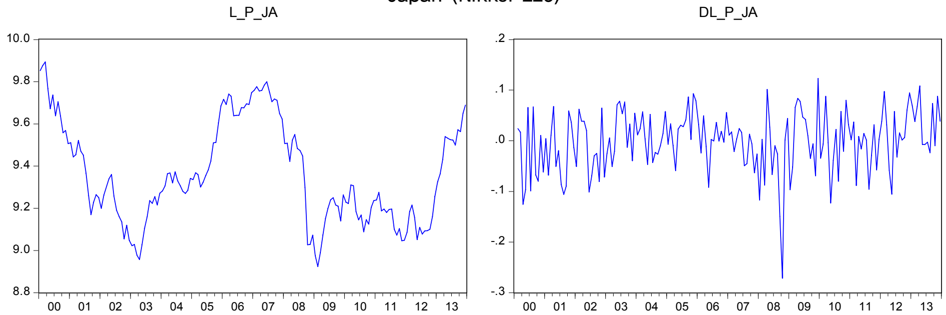
Left panel presents monthly real stock index in logarithm of each country in the Far Easter bloc and right panel presents its monthly changes.

Log of real stock index | Log difference of real stock index

China (SHANGHAI Comp.)



Japan (Nikkei 225)



Korea (KOSPI)

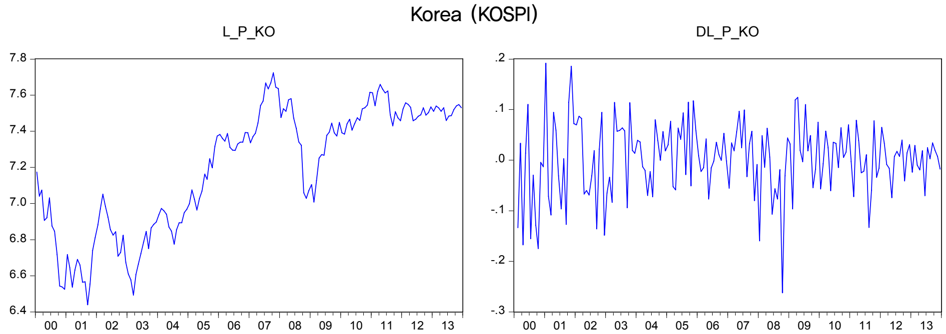


Figure A1-2: Graphs of Real Stock Index and Monthly Return (Chinese Bloc)

Left panel presents monthly real stock index in logarithm of each country in the Chinese bloc and right panel presents its monthly changes.

Log of real stock index | Log difference of real stock index

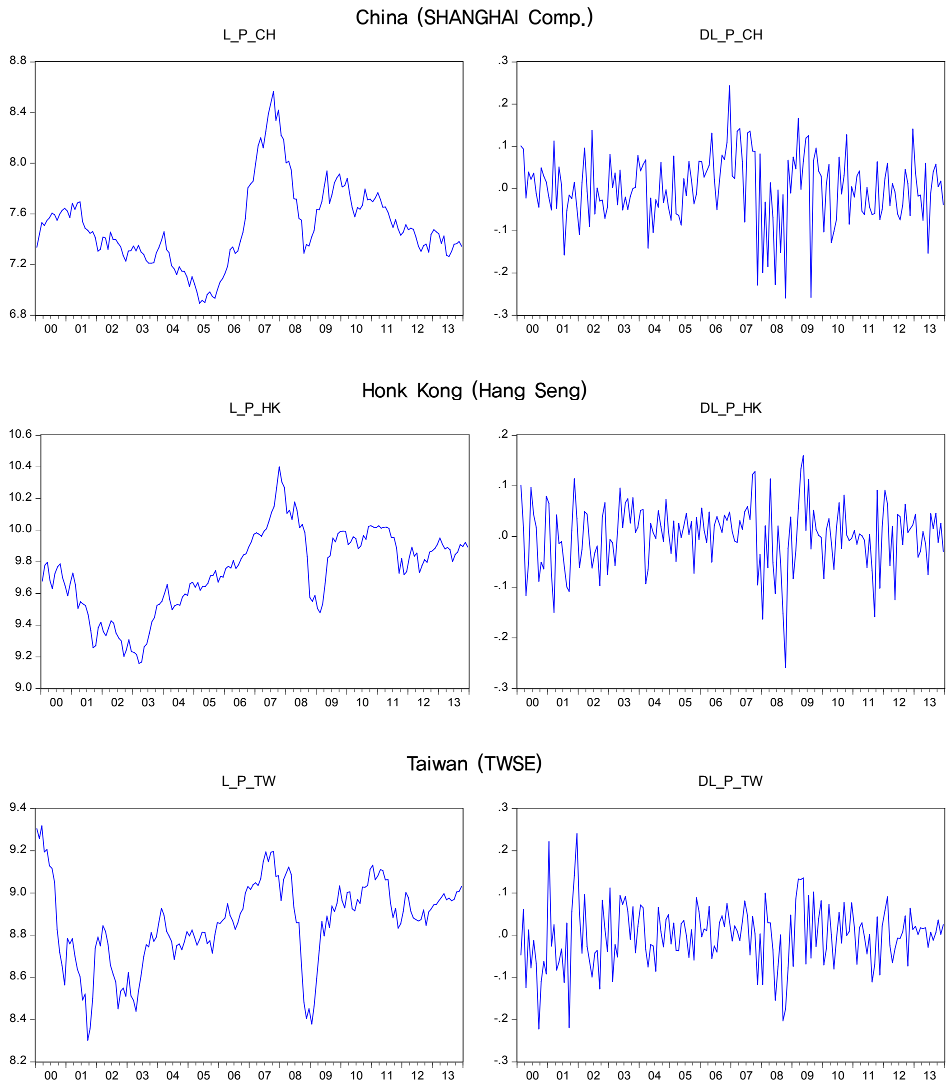


Figure A1-3: Graphs of Real Stock Index and Monthly Return (Australian Bloc)

Left panel presents monthly real stock index in logarithm of each country in the Australian bloc and right panel shows its monthly changes.

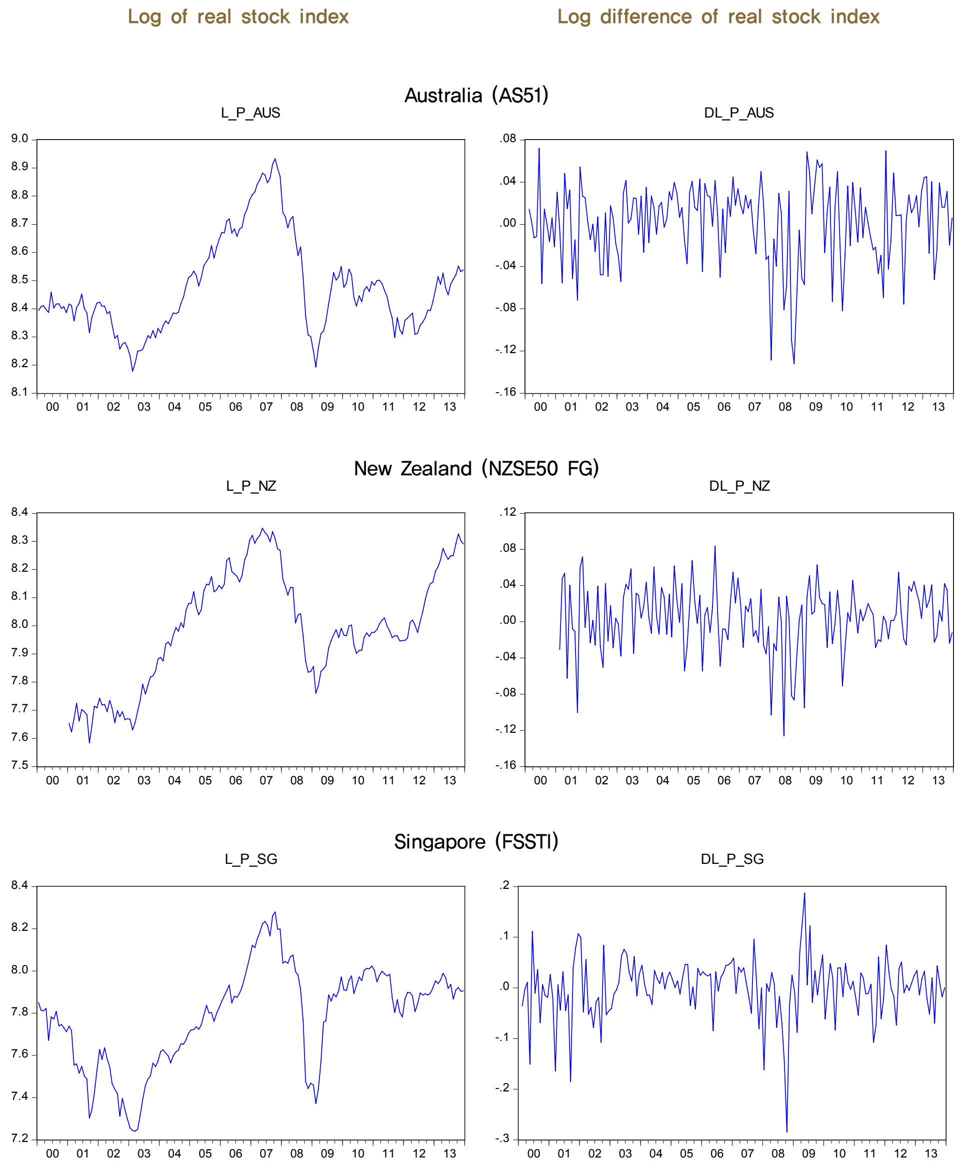


Figure A2-1: Graphs of Real Trade Value and Monthly Growth (Far Eastern Bloc)

Left panel shows monthly real trade value in logarithm of each country pair in the Far Easter bloc and right panel shows its monthly changes.

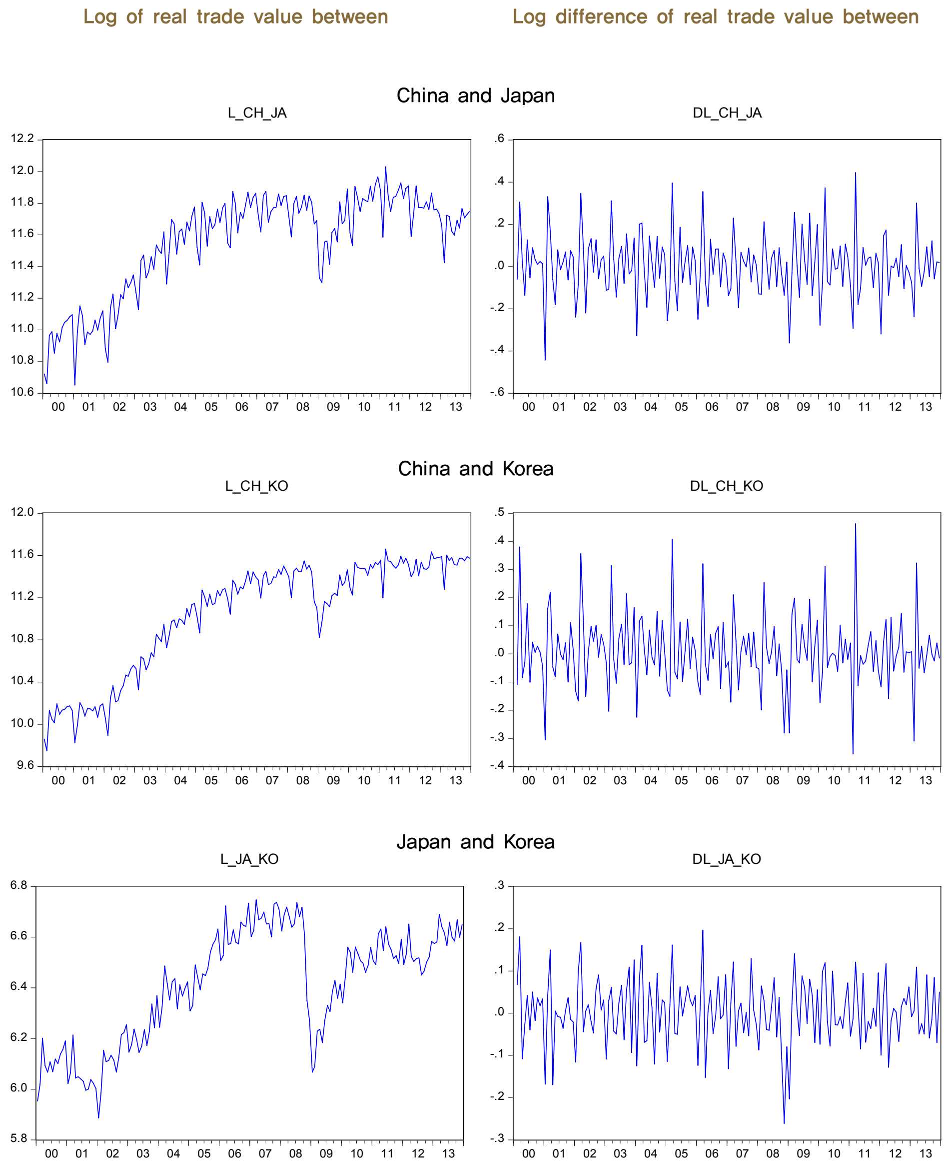
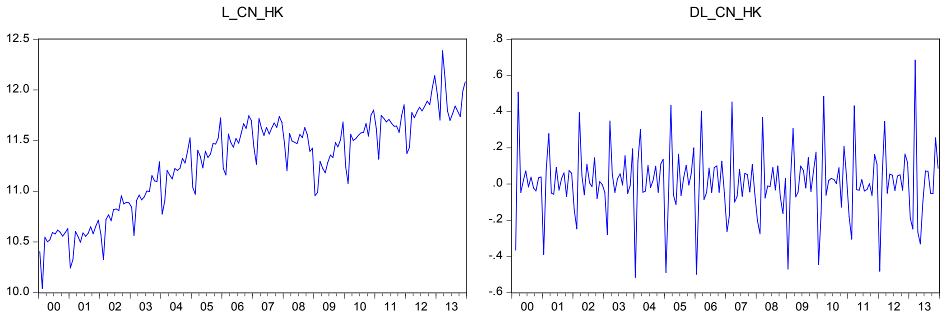


Figure A2-2: Graphs of Real Trade Value and Monthly Growth (Chinese Bloc)

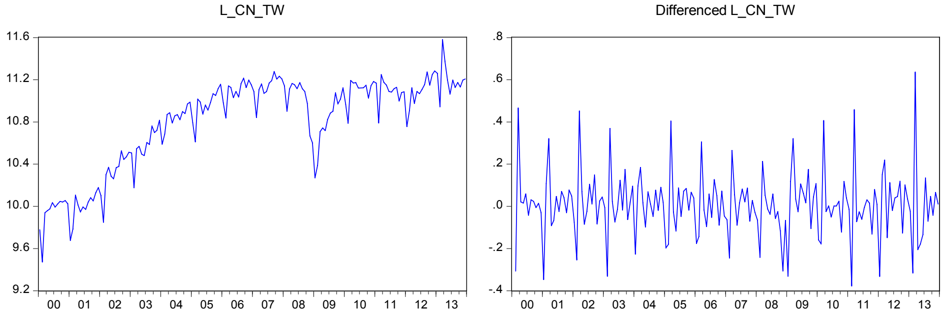
Left panel shows monthly real trade value in logarithm of each country pair in the Chinese bloc and right panel shows its monthly changes.

Log of real trade value between | Log difference of real trade value between

China and Hong Kong



China and Taiwan



Hong Kong and Taiwan

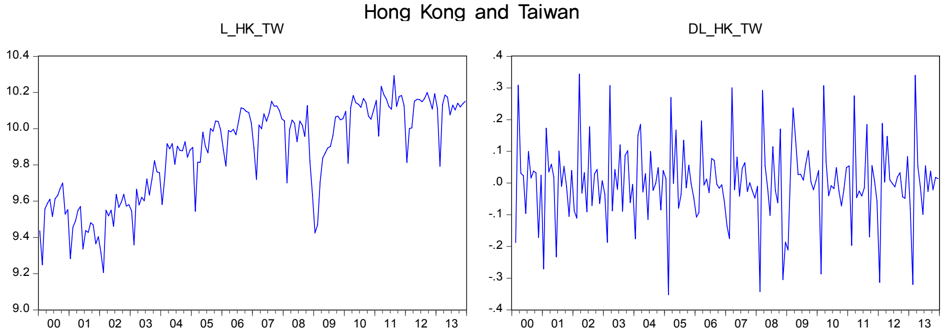
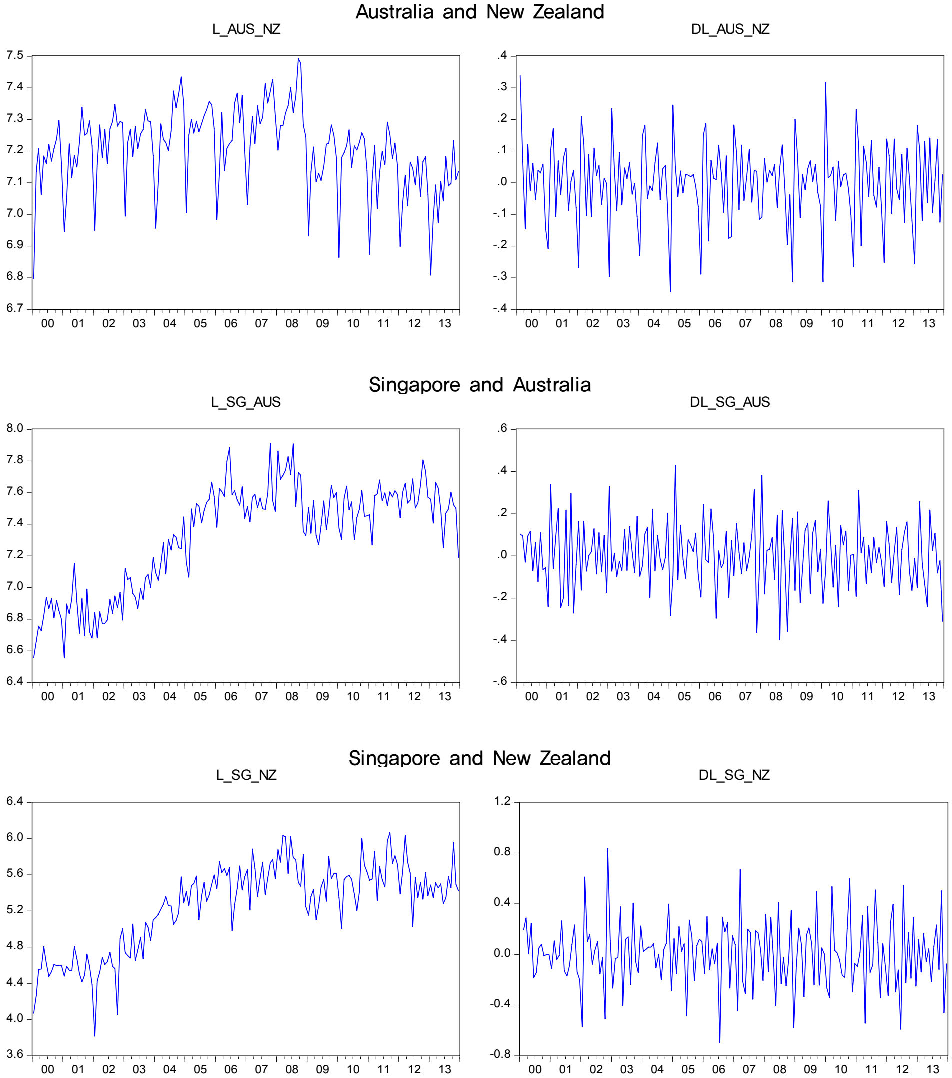


Figure A2-3: Graphs of Real Trade Value and Monthly Growth (Australian Bloc)

Left panel shows monthly real trade value in logarithm of each country pair in the Australian bloc and right panel shows its monthly changes.

Log of real trade value between | Log difference of real trade value between



Linearity test and choice of the STAR model between LSTAR and ESTAR

We perform the linearity test to examine whether the linear VECM model is appropriate against a nonlinear STAR alternative. Following Teräsvirta and Anderson (1992), we estimate the following auxiliary regression:

$$\Upsilon_t = \phi_0 + \sum_{i=1}^{k} \phi_{1,i} \cdot \Upsilon_{t-i} + \sum_{i=1}^{k} \phi_{2,i} \cdot \Upsilon_{t-i} \Upsilon_{t-d} + \sum_{i=1}^{k} \phi_{3,i} \cdot \Upsilon_{t-i} \Upsilon_{t-d}^2 + \sum_{i=1}^{k} \phi_{4,i} \cdot \Upsilon_{t-i} \Upsilon_{t-d}^3 + \varepsilon_t, \quad \text{(A1)}$$

where the linearity test becomes $H_{01}: \phi_{2i} = \phi_{3i} = \phi_{4i} = 0$, for all i. Reported in Table A9 is the maximum F-statistics for each delay lag, in which the delay parameter varies over the range $1 \leq d \leq 3$. The estimate of the delay parameter d is selected by the highest F-statistics.

Table A9: Linearity Tests of Variables

Log difference of real stock index								
delay	China $(p=2)$	Japan $(p=2)$	Korea $(p=3)$	Hong Kong $(p=2)$	Taiwan $(p=2)$	Australia $(p=3)$	New Zealand $(p=2)$	Singapore $(p=2)$
1	3.3640	7.6684	8.2114	9.1021*	12.8458*	6.2823	6.5775	3.5445
2	7.2197*	8.9155*	13.1715*	5.2993	9.3095	8.9035*	8.6317*	5.6577*
3	1.1421	7.2303	9.1932	6.8574	7.5775	6.5397	2.0928	2.1128

Log difference of real trade value between									
delay	China–Japan $(p=3)$	China–Korea $(p=2)$	Japan–Korea $(p=3)$	China–Hong Kong $(p=2)$	China–Taiwan $(p=2)$	Hong Kong–Taiwan $(p=2)$	Australia–New Zealand $(p=3)$	Australia–Singapore $(p=2)$	New Zealand–Singapore $(p=2)$
1	1.5640	3.6894	5.1364	9.1451*	5.4482*	4.1188	3.5403	4.5535	3.9904
2	6.1269	4.9245	12.1647*	5.7731	4.1095	7.1384*	10.6501*	9.3061*	10.1063*
3	7.2256*	6.2393*	8.4485	6.8457	3.7677	6.8446	3.8700	3.08492	5.0093

Notes: The asterisks indicate the maximum F-statistic for each delay (d) lag over the interval $1 \leq d \leq 3$. The maximum lag, p, of the linear AR model is selected by using the AIC statistic.

Given that linearity is rejected for all the sample countries, we next specify an appropriate STAR model to capture nonlinear dynamics of stock returns and trade growth. As suggested by Teräsvirta and Anderson (1992), the linearity test can be used to provide a sequence of nested hypothesis tests H_{04}, H_{03}, H_{02} for the choice between LSTAR and ESTAR alternatives. The sequence of nested tests for the coefficients in equation (A.1) above implies:

$$\begin{aligned} &H_{04} : \phi_{4i} = 0, && i = 1, \cdots, k \\ &H_{03} : \phi_{3i} = 0 \,/\, \phi_{4i} = 0, && i = 1, \cdots, k \\ &H_{02} : \phi_{2i} = 0 \,/\, \phi_{3i} = \phi_{4i} = 0, && i = 1, \cdots, k \end{aligned} \tag{A.2}$$

Rejection of H_{04} implies selecting the LSTAR model. If H_{04} is not rejected and H_{03} is rejected, the ESTAR model is chosen. Not rejecting H_{04} and H_{03} and rejecting H_{02} leads to an LSTAR model. It should be noted that if none of the null hypothesis is rejected, then the linearity cannot be rejected, such that the linear model should be selected.

<Abstract in Korean>

역내 무역이 주식시장에 미치는 영향: 아시아-태평양 지역을 중심으로

김 세 완*, 최 문 정**

본 연구는 아시아-태평양 지역 국가를 중심으로 역내무역과 주식시장의 관계를 살펴보기 위해 양국간(bilateral) 무역관계가 각국의 주식수익률에 미치는 영향과 국가간 주식시장이 상호간에 미치는 영향을 분석하였다. 분석 방법으로는 각국의 주식수익률과 국가간 무역데이터에서 나타나는 국면전환(regime shifting) 및 국가간 주식수익률의 공적분(cointegration) 특성을 감안하여 다변수 평활전이자기회귀 벡터오차수정모형(STAR-VECM)을 적용하였다. 대상 국가를 극동블록(한국, 중국, 일본), 중국블록(중국, 홍콩, 대만), 호주블록(호주, 뉴질랜드, 싱가포르)으로 나누어 분석한 결과, 각 블록 내에서 양국간 무역은 주식수익률에 유의하게 그랜저 인과관계를 가지며 영향의 크기와 방향은 국면전환에 따라 변하는 것으로 분석되었다. 특히, 무역증가율과 주식수익률 간의 보완관계는 극동블록에서 가장 두드러지는 것으로 분석되었으며 각 블록내의 주식시장간 동조화는 모든 블록에서 유의하게 나타났다.

핵심 주제어: 주식시장 동조화, 역내 무역, 국면전환, 평활전이자기회귀 모형

JEL Classification: F15, G14, C40, C51

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한국은행 경제연구원에서는 Working Paper인 『BOK 경제연구』를 수시로 발간하고 있습니다. 『BOK 경제연구』는 주요 경제 현상 및 정책 효과에 대한 직관적 설명 뿐 아니라 깊이 있는 이론 또는 실증 분석을 제공함으로써 엄밀한 논증에 초점을 두는 학술논문 형태의 연구이며 한국은행 직원 및 한국은행 연구용역사업의 연구 결과물이 수록되고 있습니다.
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