

International Business Cycles among the Asia Pacific Economies: Implications for APEC Cooperation

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EXECUTIVE SUMMARY

This paper examines the characteristics of international business cycles among the Asia-Pacific economies in the period of 2000:Q1-2013:Q4. A dynamic factor model is estimated for the output fluctuations and five macroeconomic drivers of business cycles. The estimation extracts the latent common factor shared by fourteen APEC economies and the region-specific factors of North America, Northeast Asia, Southeast Asia, and Oceania. We find that the relative contributions of the common and region-specific factors of business cycles are significant in accounting for national output fluctuations. Evidence for international business cycle comovements is strong between North America and the common business cycle particularly at low frequencies. North America and Northeast Asia also show significant business cycle synchronization. As for the driving forces of business cycles, international trade provides the largest contribution across four regions in the Asia Pacific and the monetary policy and productivity drivers are subsequent to it. The overall finding signifies the greater probability of economic cooperation and regionally coordinated monetary policies among the APEC economies.

Keywords: Business cycle comovement, Asia Pacific economies, APEC

JEL Classification: E30, E51, F44

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International Business Cycles among the Asia Pacific Economies: Implications for APEC Cooperation

Young-Joon Park^{*,**}

I. Introduction

The increasing scale of international transactions and expanding economic importance in the Asia-Pacific region developed international collective consensus across the economies. The international need for deepening economic integration across North America, East Asia, and Southwest Pacific economies has manifested through the establishment of the Asia-Pacific Economic Cooperation (APEC) in 1989.¹ APEC membership rose to twenty one economies in 1999.

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¹ Twelve founding members of APEC in 1989 are Australia, Brunei Darussalam, Canada, Indonesia, Japan, the Republic of Korea (Korea hereafter), Malaysia, New Zealand, the Philippines, Sin-

APEC finance ministers' meeting has formed a supranational economic bloc, and intra-regional economic policy coordination has contributed to the attainment of APEC objectives: international free trade and investment flows. The APEC summits have become regular occasions since 1993.

The APEC agenda has evolved, mainly focusing on trade liberalization through free trade, such as the Bogor Goals.² However, as Dutta (2000) points out, the annual meetings recognize that intra-APEC monetary and fiscal policies warrant coordination. In the absence of such cooperative effort the proposed free trade regime will be exposed to disruption. An APEC macroeconomic core with stabilized economic fluctuations provides a necessary and sufficient condition for the APEC goals of free trade. (Dutta 2000, p. 68) Indeed, business cycle comovement patterns have been important part of intra-regional economic cooperation, in particular in the APEC region by claiming to support "open regionalism."

Examining the dynamic properties and sources of international business cycles within an economic bloc, e.g. APEC, is important both for understanding regional economic fluctuations and making collective policy coordination. For example, if a significant fraction of a region's business cycle, e.g. Northeast Asia, is due to the common factor or is affected by another region's business cycle, e.g. North America, it sheds light on different approaches in making economic policy

gapore, Thailand, and the United States of America (U.S. hereafter). Since then, Chinese Taipei (Taiwan hereafter), Hong Kong, the People's Republic of China (China hereafter) has joined APEC in 1991, Mexico and Papua New Guinea in 1993, Russia, Chile, Peru, and Vietnam in 1998.

² As with the Bogor Goals, APEC Leaders committed in 1994 to achieve free trade and open investment by 2010 and by 2020. These are recognized as APEC's belief that free trade and open investment are essential for enhancing economic outcome for the APEC economies.

cooperation. Since the effective coordination of the APEC policies relies on the behavior of macroeconomic activities across the member economies, understanding the business cycle comovement patterns is important in assessing the international economic cooperation with the APEC policy initiatives. To that extent, it is of interest to examine international business cycle comovements among the APEC economies.

A growing body of research in international business cycle literature has focused on reporting the stylized characteristics of business cycles and analyzed primarily their aspects of international business cycles of several developed countries or a small number of developing countries in a region.³ Recently Kose *et al.* (2003) investigate the dynamic characteristics of world business cycles across countries by estimating a Bayesian dynamic factor model.

As for business cycle research for the Asia-Pacific economies, there are several studies. Fernandez and Kutan (2005) examine the business cycle synchronization and its convergence for six APEC members and the NAFTA countries. They perform a trend-cycle decomposition using wavelet analysis. Their results show that joining APEC increases the member's correlation of industrial production cycles and business cycle convergence of the Asia-Pacific economies is not complete. Weber (2006) addresses macroeconomic integration in the Asia-Pacific region by analyzing long-run convergence and business-cycle coherence. Their cointegration and vector error correction analyses show the results in favor of cyclical synchrony. Chan and Khong (2008) examine business cycle correlation and output linkages among the Asia Pacific economies. Their use of the asymmetric band-pass filtering method reveals that some APEC members, especially

³ Zarnowitz (1992) presents a survey of research on business cycle fluctuations across countries.

ASEAN and NIEs, show business cycle comovements since the 1990s.

This paper analyzes the characteristics of international business cycles and their comovement pattern among fourteen Asia-Pacific economies during the period of 2000:Q1–2013:Q4. We investigate the extent to which international business cycles in the Asia-Pacific are synchronized, and driven by both the commonly shared APEC component as well as four region-specific components of the macroeconomic drivers of business cycles. For these purposes, we apply a dynamic factor model to estimate the latent factors from the output fluctuations and macroeconomic business-cycle determinants of interest. A widely-used approach to measure economic variables' synchronization is to calculate bivariate constant correlations for the variables. This study employs a dynamic latent factor model to extract international business cycles and the macro-drivers in a multilateral perspective. Unlike previous research presenting constant correlations between individual country pairs, the degree of business cycle comovement is evaluated by calculating both the dynamic correlations in the frequency domain and the time-varying correlations.

Since APEC is aiming to promote international trade among the members and to foster investment in the Asia-Pacific region, the issue on international business cycles has been relatively neglected. The scope of this paper reaches the empirical examination of the characteristics of international business cycles among fourteen APEC member economies: the U.S., Canada, Indonesia, Thailand, the Philippines, Malaysia, Singapore, Korea, China, Japan, Taiwan, Hong Kong, Australia, and New Zealand.

This paper extends the literature by examining the following issues on international business cycles among the Asia-Pacific economies. First, we apply a dynamic latent factor model to estimate the common factor and four regional factors of

fourteen APEC member's business cycles. Second, the degree of business cycle comovement is quantitatively measured by dynamic correlations. Third, the macroeconomic drivers of business cycles are examined in explaining international business cycle comovements in the Asia Pacific.

The remainder of the paper is organized as follows. Section 2 briefly presents the empirical methodology and describes the data used for estimation. Section 3 provides the empirical results and properties of international business cycle comovements. Section 4 investigates the contribution of major macroeconomic drivers in accounting for business cycles. Section 5 concludes the paper.

II. Empirical Methodology and Data

1. Dynamic Latent Factor Model

A dynamic latent factor model estimates the unobserved latent factors based on the spectral density matrix of random variables, while a static factor model uses their variance-covariance matrix. Suppose X_t is a Q -dimensional vector of covariance-stationary time series at time t . In this study, it represents growth rates of output in Section 3 and growth rates of macro-driver variables in Section 4. Then X_t is represented by

$$X_t = a(L)\Theta_t + \psi_t$$

where $a(L)$ is a $Q \times K$ matrix of polynomials for the lag operator, Θ_t is a K -dimensional stochastic process of the factors, and the idiosyncratic error ψ_t is assumed to be normally distributed and cross-sectionally uncorrelated. (Kose *et al.* 2003)

The demeaned output growth rates of fourteen APEC economies are decomposed into a common factor, four regional factors, and the country-specific or idiosyncratic component. The common factor is common across all of the economies of interest, and the regional factor is specific to each sub-region within the Asia Pacific. To this end, a dynamic latent factor model, given by Eq. (1), is used to estimate these factors:

$$y_{i,t} = \beta_i F_t + \gamma_i f_{j,t} + v_{i,t} \quad (1)$$

where

$$F_t = \varphi_F(L)F_{t-1} + \varepsilon_t, \quad (2)$$

$$f_{j,t} = \varphi_f(L)f_{j,t-1} + \vartheta_t, \quad (3)$$

$$v_{i,t} = \varphi_v(L)v_{i,t-1} + v_{i,t}. \quad (4)$$

The data $y_{i,t}$ is stationary time series at time t for a national economy i . The factor F_t is a common factor which is shared by every APEC economies considered in this study, and thus it is referred to as a common factor. In addition, the factor $f_{j,t}$ stands for four region-specific factors, such as North America, Southeast Asia, Northeast Asia, and Oceania. $v_{i,t}$ is a country-specific factor, including its idiosyncratic component.

The β_i and γ_i are factor loadings that represent the quantitative impact of the common and region-specific factors. For example, if $\beta_i = \gamma_i = 0$ then output growth rates display no covariation with other countries' business cycles. These factors and the idiosyncratic component follow autoregressive processes to reflect the dynamic relationship of time series. The length of two is used for the order of autoregressive polynomials $\varphi_F(L)$, $\varphi_f(L)$, and $\varphi_v(L)$. The shocks in (2)–(4) are not cross-sectionally correlated at all leads and lags. Thus, the common, region-specific, and country-specific factors are orthogonal.

When $y_{i,t}$ is the demeaned growth rates of real gross domestic product for an APEC member economy i , the common factor is understood as the international business cycles across Asia-Pacific economies. In this study we evaluate the degree of business cycle comovements by calculating dynamic correlations be-

tween the common/regional factors and an individual economy's business cycle fluctuations. In the subsequent sections, the dynamic latent factor model, Eq. (1), is estimated for the output fluctuations and five macroeconomic drivers of business cycles.

Estimation of the latent factor model employs the procedure of Otrok and Whiteman (1998) and Kose *et al.* (2003). Bayesian estimation of the model characterizes the joint posterior of the latent factors and the parameters by using numerical methods to simulate from the posterior. The prior on factor loading coefficients is given by

$$(\beta_i, \gamma_i)' \sim N(0, I_2) \quad (i = 1, \dots, N).$$

For the innovation variances of the observable equations, the prior is given by $IG(6, 0.001)$. The prior on the parameters of autoregressive polynomials is $N[(0, \text{diag}(1, 0.5))]$.

To implement the procedure, the estimation utilizes a data augmentation algorithm to generate draws from the joint posterior, as in Tanner and Wong (1987). Markov-Chain Monte Carlo procedure is used to estimate the dynamic latent factor model, and the posterior distribution properties are drawn from 10,000 replications.⁴

2. Variance Decompositions

The variance decompositions allow us to calculate the relative contributions

⁴ For more details on the estimation procedure, see Otrok and Whiteman (1998) and Kose *et al.* (2003).

of the common, region-specific, and country-specific components. To quantify the share of the relative contributions, the variance of an observable variable is decomposed into the proportion that is attributable to the relevant factor. Following Kose *et al.* (2003) with the orthogonal factors, the variance of an observable variable of country i is written by:

$$\text{Var}(y_{i,t}) = (\hat{\beta}_i)^2 \text{Var}(F_t) + (\hat{\gamma}_i)^2 \text{Var}(f_{j,t}) + \text{Var}(v_{i,t}).$$

Then, for example, the fraction of the total variability of country i 's observable variable attributable to the common factor would be

$$\frac{(\hat{\beta}_i)^2 \text{Var}(F_t)}{\text{Var}(y_{i,t})}$$

which relies on both the quantity of factor loading and the relative share of the variations. The fractions of the variability due to the region-specific factor and the country-specific factor are calculated similarly.

3. Dynamic Correlations

To quantify the degree of business cycle comovement, two kinds of dynamic correlations are used: dynamic correlation in the frequency domain and time-varying dynamic conditional correlation.⁵

A measure of dynamic comovement in the frequency domain is presented by

⁵ Forbes and Rigobon (2002) show that simple correlation coefficient is troubled by bias in measuring time-varying relation between variables.

Croux *et al.* (2001). For two time series x and y , the dynamic correlation in the frequency domain is defined by

$$\rho_{xy}(\omega) = \frac{C_{xy}(\omega)}{\sqrt{S_x(\omega)S_y(\omega)}}$$

where $C_{xy}(\omega)$ is the co-spectrum, $S_x(\omega)$ and $S_y(\omega)$ are the spectral density functions of x and y at frequency ω .

The time-varying dynamic correlation is also calculated by estimating the DCC-GARCH model, presented by Engle (2002). The DCC-GARCH model is an extended version of the constant conditional correlation model, proposed by Bollerslev (1990), by using a time-dependent conditional correlation matrix. That is, the dynamic conditional correlation estimator allows time-varying R_t as follows:

$$r_t | \Omega_{t-1} \sim N(0, D_t R_t D_t)$$

where r_t is an $n \times 1$ vector with mean zero and time-varying covariance, R_t is a time-varying conditional correlation matrix, and D_t is a diagonal matrix of conditional standard deviations. The two-step estimation method fits a multivariate GARCH model to estimate \hat{D}_t , and then model R_t by estimating the parameters S , A , B by QMLE on the \hat{z}_t series:

$$\begin{aligned} \hat{z}_t &= \hat{D}_t^{-1} r_t \\ Q_t &= S \odot (u' - A - B) + A \odot \hat{z}_{t-1} \hat{z}_{t-1}' + B \odot Q_{t-1} \\ R_t &= \text{diag}[Q_t]^{-1} Q_t \text{diag}[Q_t]^{-1} \end{aligned}$$

where S is a sample covariance matrix of \hat{z}_t , ι as a vector of ones, and \odot stands for the Hadamard product of two matrices.

4. The Data

The quarterly data cover the period of 2000:Q1–2013:Q4. The fourteen Asia-Pacific economies include the U.S., Canada, Indonesia, Thailand, the Philippines, Malaysia, Singapore, China, Japan, Korea, Taiwan, Hong Kong, Australia, and New Zealand. Due to limited data availability, other APEC members are excluded in this study.

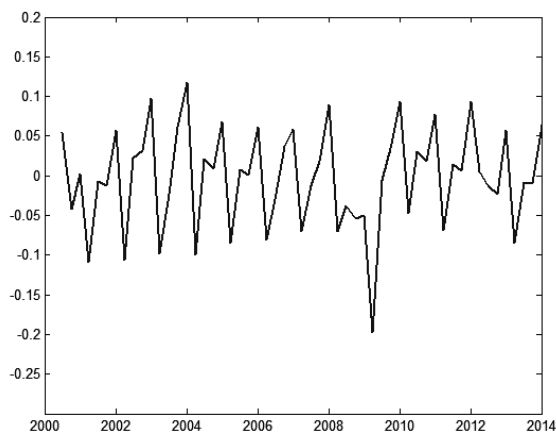
An economy's business cycle is measured based on real gross domestic product. As for the macroeconomic drivers of policy variables, both the monetary and fiscal variables use real money supply and real government expenditure. The other driving forces include productivity, total exports and imports, and the terms of trade. The data are taken from various sources: International Financial Statistics, Department of Statistics of Malaysia, National Bureau of Statistics of China, Bloomberg, and Oxford Economics. An economy's productivity variable is constructed by getting Solow-residual series with Cobb-Douglas production function, assuming the standard parameter values of labor and capital shares: 2/3 and 1/3, respectively. The list of data sources is presented in appendix.

III. International Business Cycle Comovements

1. Latent Factors of International Business Cycles

We first estimate the dynamic latent factor model of Eq. (1) for the demeaned growth rate of real GDP to extract the latent common factor, four region-specific factors, and the country-specific factors. Four sub-regions in the Asia Pacific are classified by geographical location: the U.S. · Canada in North America, Indonesia · Thailand · the Philippines · Malaysia · Singapore in Southeast Asia, Korea · China · Japan · Taiwan · Hong Kong in Northeast Asia, and Australia · New Zealand in Oceania. The common factor of business cycles across fourteen

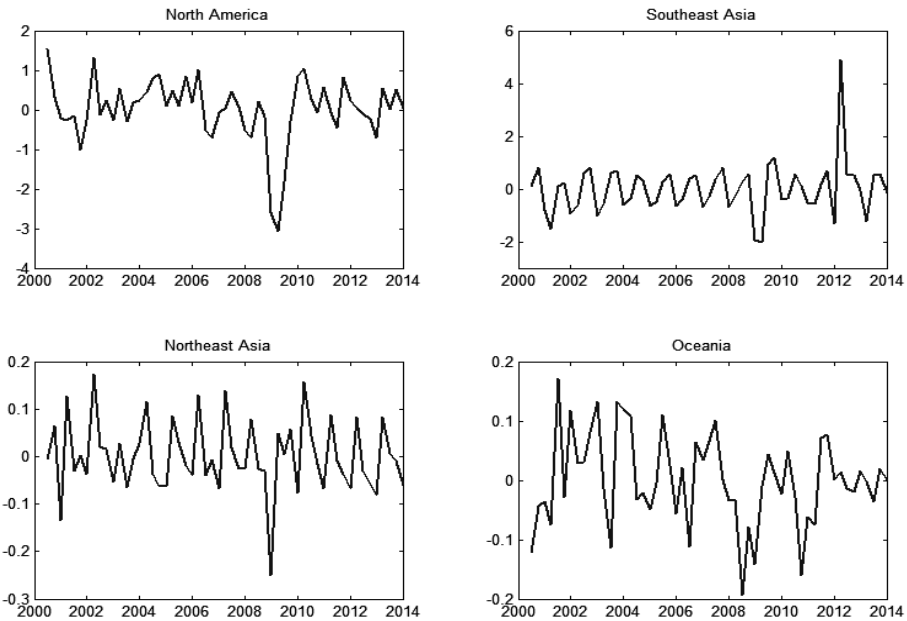
Figure 1. Common Factor of Business Cycles



economies is displayed in Figure 1. It captures a distinctive cyclical feature of the contraction and expansion phases with a deep recession during the global financial crisis.

Figure 2 shows the regional factors of business cycles for four sub-regions in the Asia Pacific. All of region-specific factors display the economic recession during the global financial crisis in 2008. However, the magnitude of the recession is heterogeneous in the sense that North America suffered from the deepest recession and in contrast both Northeast Asia and Oceania experienced relatively lesser depression. For the Southeast Asia’s regional factor, an extraordinary peak is

Figure 2. Regional Factors of Business Cycles



observed in 2012. It is because that Malaysia and Thailand recorded high economic growth rates of more than 5 percent in 2012. Moreover, Oceania experienced a recession due to the global financial crisis and another subsequent recession in the period of the European debt crisis.

It is useful to examine the relative contribution of the common, region-specific, and country-specific factors to the variation of each economy's business cycle as shown in Table 1. The common factor accounts for approximately half of national output fluctuations in China (57.46 percent) and Hong Kong (46.67 percent).

Table 1. Variance Decompositions of National Business Cycles

Unit: %

U.S.	Common	11.69	Korea	Common	12.75
	Region-specific	44.24		Region-specific	43.49
	Country-specific	44.07		Country-specific	43.76
Canada	Common	10.36	China	Common	57.46
	Region-specific	63.87		Region-specific	21.03
	Country-specific	25.77		Country-specific	21.51
Indonesia	Common	22.85	Japan	Common	8.90
	Region-specific	17.07		Region-specific	13.80
	Country-specific	60.08		Country-specific	77.31
Thailand	Common	3.33	Taiwan	Common	9.57
	Region-specific	31.04		Region-specific	16.39
	Country-specific	65.63		Country-specific	74.03
Philippines	Common	6.67	Hong Kong	Common	46.67
	Region-specific	10.94		Region-specific	18.80
	Country-specific	82.39		Country-specific	34.53
Malaysia	Common	17.77	Australia	Common	4.36
	Region-specific	64.69		Region-specific	42.28
	Country-specific	17.53		Country-specific	53.36
Singapore	Common	20.45	New Zealand	Common	6.18
	Region-specific	10.89		Region-specific	23.31
	Country-specific	68.66		Country-specific	70.51

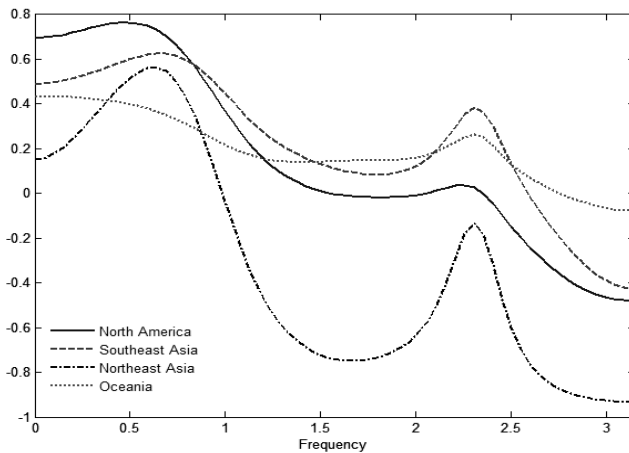
Note: The numbers are calculated based on the mean of posterior shares.

On the other hand, the region-specific factors are important for the U.S. (44.24 percent), Canada (63.87 percent), Malaysia (64.69 percent), Korea (43.49 percent), and Australia (42.28 percent).⁶

2. International Business Cycle Comovements

Business cycle comovements among the Asia-Pacific economies are examined by calculating the dynamic correlations, as described in section 2. The dynamic correlations in Figures 3 and 4 show the degree of business cycle comovement over the frequencies among the common factor and region-specific factors.

Figure 3. Dynamic Correlations between Common and Region-Specific Factors

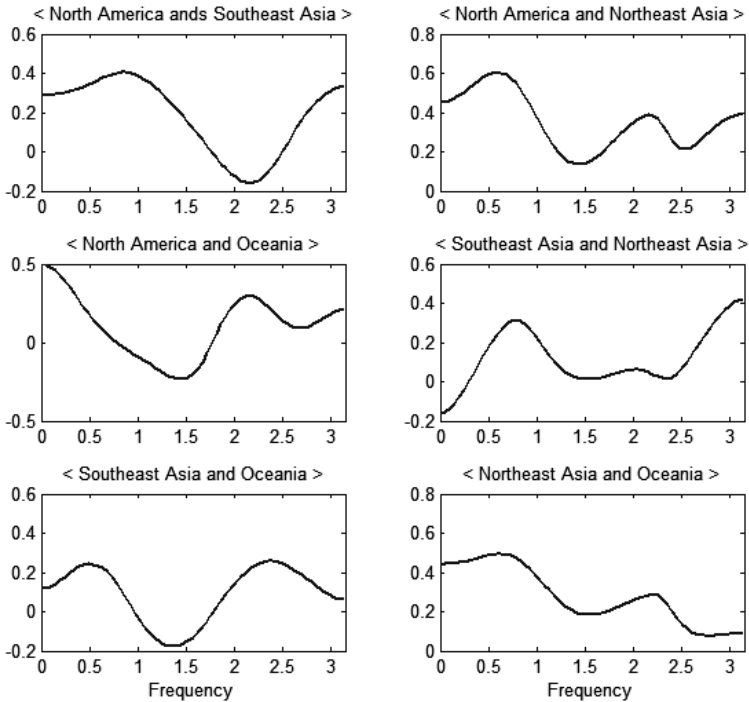


⁶ Kose *et al.* (2003) include 61 countries by grouping seven regions and estimate the world and region-specific factors. Comparing with their results, the region-specific factors of these five countries play more significant role in explaining their output fluctuations when we restrict ourselves to the Asia-Pacific economies.

Figure 3 illustrates international business cycle comovement between common factor and four region-specific factors. At low frequencies North America comoves strongly with the common international business cycles, while Northeast Asia shows a weak comovement at low frequencies. However, at business cycle frequencies (around 1.5 in the Figure) and high frequencies, both North America and Northeast Asia do not necessarily comove with the common factor of business cycles. Therefore, we conclude that North America's regional business cycles comove strongly with the Asia-Pacific common business cycle in the long run, but Northeast Asia shows a weak comovement with the Asia-Pacific business cycle in the long run. Furthermore, at business cycle frequencies the comovements of North America, Southeast Asia, and Oceania with the common factor show similar pattern, but Northeast Asia is different from other regions by showing decoupling behavior.

As for the region-specific factors, Figure 4 illustrates the degree of international business cycle comovements among four sub-regions in the Asia-Pacific economic bloc. At low frequencies, Northeast Asia and Oceania show relatively higher degree of comovement with North America than that of Southeast Asia. From a qualitative point of view, North America and other three regional factors comove at high frequencies, but their comovements become relatively weak at business cycle frequencies. Basically the issue of business cycle comovement in a region is relevant to the regional monetary and financial cooperation because the degree of business cycle comovement is regarded as one of the economic convergence criteria. Therefore, the above-mentioned comovement feature of regional business cycles implies the necessity of APEC effort to enhance regional business cycle convergence, especially targeting medium-term (e.g. over three to five years) policy horizon.

Figure 4. Dynamic Correlations between Region-Specific Factors

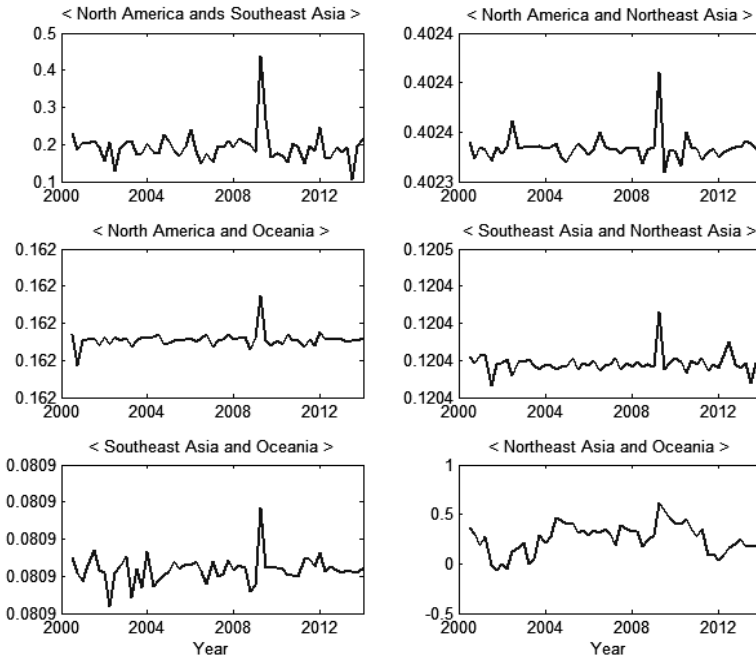


At low frequencies the degree of comovements is restored, except for the pair of Southeast Asia and Northeast Asia. It supports that East Asia should make stronger economic cooperation in the short and medium run, including both real and financial sectors in ASEAN+3 region. However, low degree of business cycle synchronization implies in part that the condition for East Asia's economic cooperation in the long horizon is premature in comparison with EU-like economic integration. In reality, economic cooperation in East Asia has progressed by growing intra-regional trade and financial flows in the short run. East Asia's collective financial cooperation has been also developed with several ASEAN+3

initiatives, which is regarded as the medium-term collective cooperation, since the Asian currency crisis. Thus, the economies in Southeast Asia and Northeast Asia should develop further economic cooperation in various aspects; such as regional financial arrangements, local currency bond markets under the Asian Bond Market Initiative, increasing cross-border capital flows and financial liberalization.

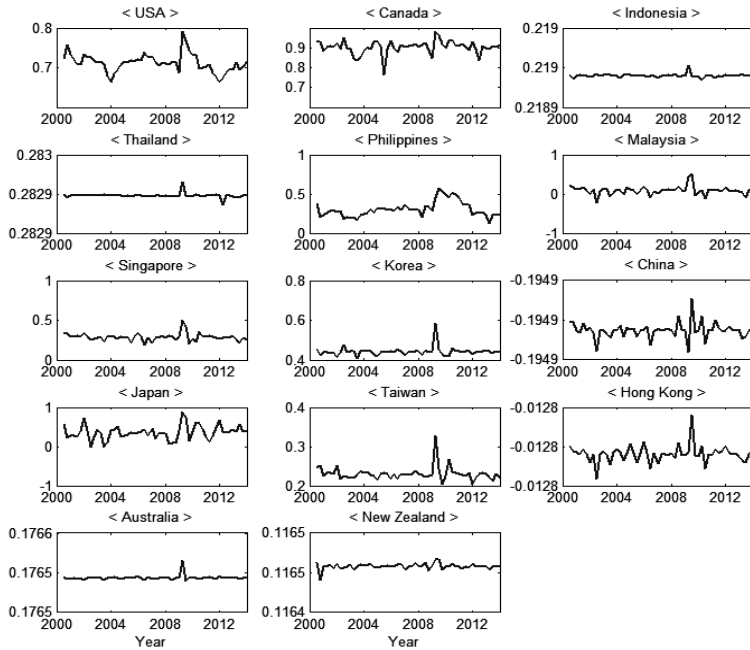
The time-varying dynamic correlations between regional business cycles are also shown in Figure 5. The time-varying correlations display a peak in 2008, meaning that the Asia-Pacific regional economies responded in a similar way to the global financial crisis. As for the magnitude during the global financial crisis,

Figure 5. Time-Varying Correlations between Region-Specific Factors



Southeast Asia and Northeast Asia were affected significantly by the shocks from North America, amounting to 0.44 and 0.40, respectively. Over the entire sample period the average value of time-varying correlations between North America and Northeast Asia has the highest value of 0.40. The relation between Southeast Asia and Oceania reveals the weakest link among them.⁷ In addition, the correlation

Figure 6. Time-Varying Correlations with North America's Regional Factor

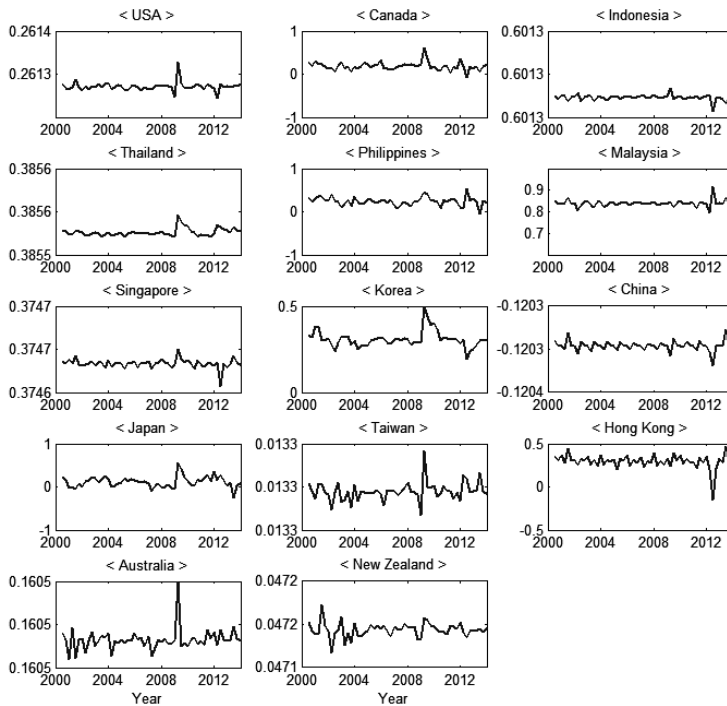


⁷ The average of time-varying correlations in Figure 5 are 0.19 for North America and Southeast Asia, 0.40 for North America and Northeast Asia, 0.16 for North America and Oceania, 0.12 for Southeast Asia and Northeast Asia, 0.08 for Southeast Asia and Oceania, and 0.25 for Northeast Asia and Oceania.

between Northeast Asia and Oceania in 2008 reaches 0.61, which implies the close relation between them during the crisis.

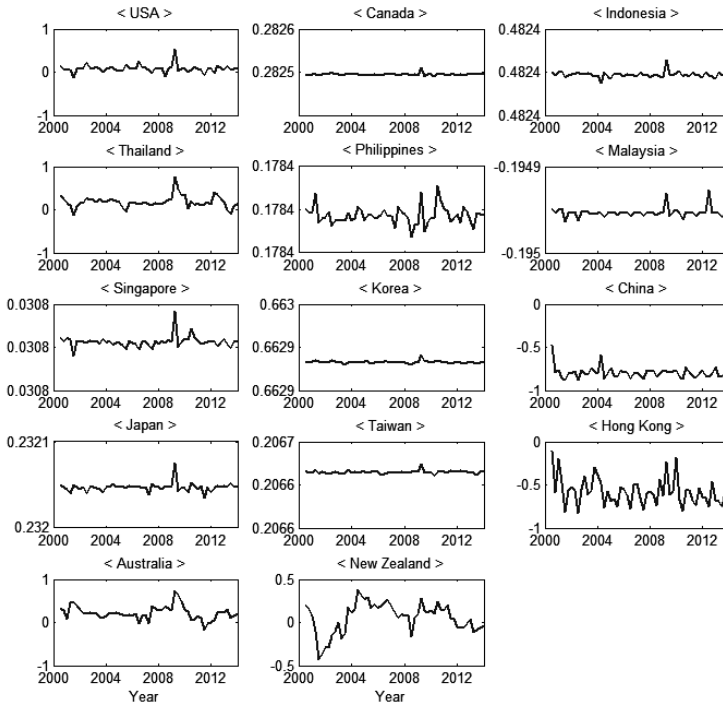
Figures 6 through 9 show the individual economy's business cycle synchronization pattern with four region-specific factors. For the North America's region-specific factor in Figure 6, Canada shows the highest average correlation of 0.90, the U.S. of 0.71, Korea of 0.44, Japan of 0.36. In Figure 7, Malaysia records the highest average correlation of 0.84 with the Southeast Asia's regional business

Figure 7. Time-Varying Correlations with Southeast Asia's Regional Factor



cycle, and Indonesia of 0.60 is the next. Australia and New Zealand have the correlations of 0.16 and 0.05, respectively. In Figure 8 with Northeast Asia, Korea has the highest correlation of 0.66 on average, and next Indonesia of 0.48, Canada of 0.28 and Japan of 0.23 are in sequence. For Oceania's regional factor in Figure 9, New Zealand shows the correlation of 0.92, Australia and Korea of 0.43, Japan of 0.33, Singapore of 0.27, Taiwan of 0.24, Thailand of 0.22, and Canada and the Philippines of 0.21. The results reveal that many of the economies

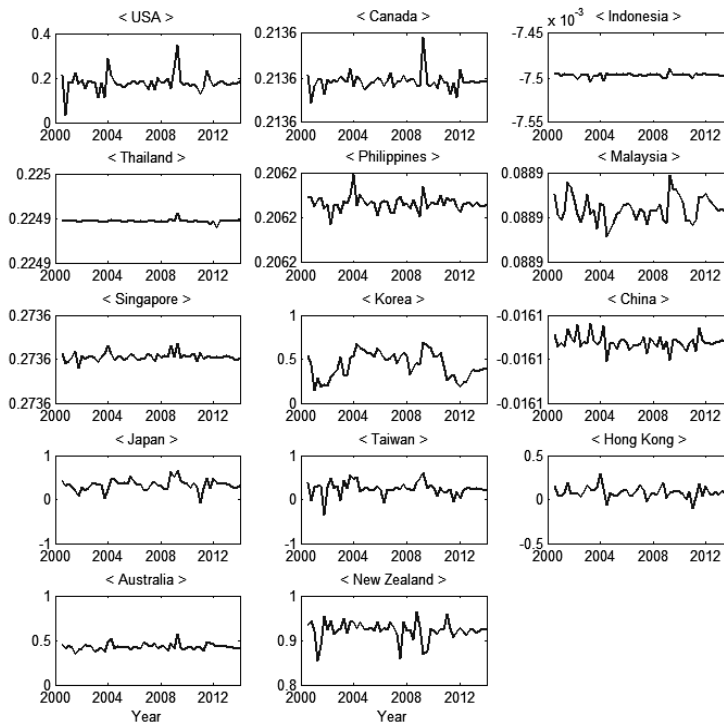
Figure 8. Time-Varying Correlations with Northeast Asia's Regional



show the synchronized patterns of international business cycles across the Asia-Pacific economies.

In terms of policy implications, international business cycle synchronization is regarded as a criterion of economic cooperation, but the Asia-Pacific economies have not utilized this merit because the degree of regional economic cooperations and policy coordination through APEC have not strongly manifested. It is because that APEC is essentially a non-binding forum, unlike the experience

Figure 9. Time-Varying Correlations with Oceania's Regional Factor



of the European Community. Accordingly, aforementioned business cycle synchronization across the Asia-Pacific economies satisfies one of economic convergence criteria, and thus we expect stronger economic policy coordination and the APEC member's effort toward the improved economic integration.

We also notice that China shows decoupling aspect from the regional factors, having negative time-varying correlations in Figures 6–9. It partly explains that China has relatively less affected by the wave of the global financial crisis and she has sought to remain a somewhat centralized and government-driven economy, rather than being subordinate to other economies.

IV. Driving Forces of Business Cycles

1. Regional Characteristics

This section examines how much of an economy's output growth variability is attributed to the region-specific and the country-specific components of variation in the macroeconomic driving forces. To attain this end, the region-specific factor of business cycles is regressed on the region-specific factors of the macro-driver variables:

$$f_{j,t}^y = \delta_m f_{j,t}^m + \delta_g f_{j,t}^g + \delta_r f_{j,t}^r + \delta_p f_{j,t}^p + \delta_e f_{j,t}^e + \varepsilon_{j,t} \quad (5)$$

where f_t^k is a region-specific factor shared by the economies in a geographical region for the variables $k = \{m, g, r, p, e\}$. $f_{j,t}^y$ denotes the regional factor of business cycles, indexing four regions by j . The superscripts $\{m, g, r, p, e\}$ stand for the stock of money as a proxy of monetary policy variable, government expenditure as a proxy of fiscal policy variable, total value of trade, total factor productivity, and the terms of trade, respectively. Taking the variance operator to both sides of Eq. (5), we perform variance decompositions of the estimated regional business cycles in terms of the regional component of each driving variable.

Table 2 reports the results of variance decompositions from Eq. (5), for the posterior mean of the drivers' region-specific factors. The region-specific factors of macroeconomic drivers account for significant share of the variations, i.e. 31.89

Table 2. Variance Decomposition for Region-Specific Factors

(Unit: %)

	Money supply	Government expenditure	Trade	Productivity	Terms of trade	Total
North America	26.48	0.41	9.66	13.07	1.07	50.69
Southeast Asia	0.02	5.73	9.93	5.02	0.44	21.13
Northeast Asia	8.61	3.90	26.25	3.33	1.22	43.31
Oceania	0.01	0.65	5.49	2.29	4.00	12.43
Average	8.78	2.67	12.83	5.93	1.68	31.89

percent on average. For North America, 50.69 percent of regional business cycle variation is accounted for by the regional macroeconomic driving forces. In particular, the monetary policy is the most important one, accounting for 26.5 percent, and also productivity and trade are the next to be important. We notice that the regional macro-drivers are crucial in explaining the regional business cycle in Northeast Asia, amounting to 43.31 percent. In Northeast Asia, the trade variable is the most important driving force of regional business cycles, accounting for 26.25 percent, and the monetary policy is next important. On the other hand, across four regions in the Asia Pacific, the trade variable presents the largest contribution, 12.83 percent on average, and the monetary policy and productivity variables are subsequent to it.

2. National Characteristics

We next perform the following variance decompositions of business cycles for the individual economies. Specifically, the following equations are estimated to decompose the variance of output fluctuations for each country:

$$y_{i,t} = \eta_m F_t^m + \eta_g F_t^g + \eta_r F_t^r + \eta_p F_t^p + \eta_e F_t^e + \zeta_{i,t} \quad (6)$$

$$y_{i,t} = \lambda_m f_{j,t}^m + \lambda_g f_{j,t}^g + \lambda_r f_{j,t}^r + \lambda_p f_{j,t}^p + \lambda_e f_{j,t}^e + \xi_{i,t} \quad (7)$$

where $y_{i,t}$ is the demeaned growth rates of real GDP of an economy i , F_t^k is the common factor, and $f_{j,t}^k$ stands for the region-specific factors for macro-drivers $k = \{m, g, r, p, e\}$.

Tables 3–7 tabulate the results of variance decompositions, estimating Eqs. (6) and (7), for the posterior mean of the common and region-specific factors of macro-drivers. In Table 3, the common factor of macro-drivers accounts for a significant share of the variations (39.42 percent). For most of the Asia-Pacific economies, except Australia and New Zealand, their business cycles are explained

Table 3. Variance Decomposition: Common Factor of Macro-Drivers

(Unit: %)

	Money supply	Government expenditure	Trade	Productivity	Terms of trade	Total
U.S.	10.91	1.37	31.70	1.05	0.48	45.51
Canada	9.43	0.05	24.36	3.38	3.01	40.24
Indonesia	17.33	11.35	2.88	16.13	0.19	47.88
Thailand	0.06	5.17	19.93	0.22	4.32	29.71
Philippines	5.55	0.13	13.61	3.93	5.73	28.93
Malaysia	13.46	0.86	12.46	1.58	9.43	37.80
Singapore	3.03	12.09	38.94	2.26	9.25	65.56
Korea	4.33	2.05	39.78	1.61	0.02	47.78
China	0.01	54.74	0.24	5.60	0.11	60.70
Japan	1.78	0.23	28.38	6.11	1.47	37.97
Taiwan	0.08	0.19	43.67	0.01	0.53	44.46
Hong Kong	6.62	35.18	4.86	2.08	2.59	51.33
Australia	0.08	0.01	4.36	2.40	3.01	9.86
New Zealand	0.16	0.33	2.87	0.78	0.04	4.17
Average	5.20	8.84	19.15	3.37	3.87	39.42

by the common macro-factors: for example, Singapore (65.56 percent), China (60.70 percent), Hong Kong (51.33 percent), Indonesia (47.88 percent), Korea (47.78 percent), the U.S. (45.51 percent), Taiwan (44.46 percent), Canada (40.24 percent). In addition, across the economies, the trade variable explains the largest share of the variation, 19.15 percent on average.

We next turn to the regional macro-drivers accounting for national output fluctuations by using Eq. (7). Tables 4–7 summarize the results of variance decompositions: the region-specific factor of North America in Table 4, Southeast Asia in Table 5, Northeast Asia in Table 6, and Oceania in Table 7. The region-specific factors of macro-drivers are also significant as a whole in accounting for the national output growth variations: i.e., Northeast Asia (29.33 percent), South

Table 4. Variance Decomposition: North America's Regional Factor of Macro-Drivers

(Unit: %)

	Money supply	Government expenditure	Trade	Productivity	Terms of trade	Total
U.S.	31.05	0.49	2.55	9.16	0.04	43.28
Canada	19.50	1.62	8.08	10.50	4.72	44.42
Indonesia	0.05	2.84	0.87	15.10	0.48	19.34
Thailand	10.36	0.25	0.77	0.08	9.59	21.05
Philippines	9.47	0.53	0.01	5.47	6.38	21.85
Malaysia	0.71	0.04	4.48	1.90	1.66	8.79
Singapore	5.06	0.52	0.19	1.60	11.21	18.58
Korea	22.63	1.95	0.05	0.53	0.17	25.34
China	0.01	0.28	0.39	6.09	2.04	8.81
Japan	15.55	0.79	5.71	3.29	9.17	34.51
Taiwan	21.40	1.59	3.47	0.12	5.77	32.34
Hong Kong	0.01	0.03	2.76	3.03	2.29	8.12
Australia	8.35	5.95	2.16	0.21	0.50	17.17
New Zealand	2.74	0.07	1.26	0.79	0.02	4.88
Average	10.49	1.21	2.34	4.13	3.86	22.03

east Asia (22.28 percent), North America (22.03 percent). In contrast, Oceania's regional factor explains a smaller share of 10.38 percent. Overall, as for the regional macro-driver factor, the monetary driver of North America (10.49 percent) and Southeast Asia (9.00 percent) and the productivity driver of Northeast Asia (11.70 percent) are the most important region-specific driving forces.

In Table 4, the North American monetary factor accounts for 31.05 percent of the U.S. output fluctuations, 22.63 percent for Korea, 19.50 percent for Canada, and 15.55 percent for Japan. The monetary driver of North America is the most important one across the economies as a whole: i.e., 10.49 percent on average.

In Table 5, the Southeast Asia's monetary driver is especially important for China (58.95 percent), Hong Kong (23.09 percent), and Indonesia (16.79 percent).

Table 5. Variance Decomposition: Southeast Asia's Regional Factor of Macro-Drivers

	Money supply	Government expenditure	Trade	Productivity	Terms of trade	Total
U.S.	2.93	0.15	0.50	4.28	0.34	8.21
Canada	0.01	0.31	1.53	0.04	11.45	13.34
Indonesia	16.79	19.27	4.94	34.96	0.12	76.07
Thailand	4.29	0.65	0.95	1.45	0.07	7.40
Philippines	0.17	0.41	0.03	1.34	16.84	18.79
Malaysia	8.43	0.85	9.69	0.23	0.54	19.73
Singapore	5.75	0.97	1.68	0.74	1.63	10.77
Korea	4.43	0.01	2.70	2.46	0.08	9.68
China	58.95	15.17	0.46	15.00	0.88	90.46
Japan	0.39	0.07	1.04	0.23	1.34	3.08
Taiwan	0.01	4.76	0.74	1.63	0.03	7.17
Hong Kong	23.09	0.83	2.04	7.67	4.47	38.11
Australia	0.78	1.76	1.73	0.04	1.56	5.87
New Zealand	0.02	0.89	0.02	2.07	0.24	3.24
Average	9.00	3.29	2.00	5.15	2.83	22.28

(Unit: %)

Moreover, 90.46 percent of China's output growth variations are explained by the Southeast Asia's regional factor, 76.07 percent for Indonesia, and 38.11 percent for Hong Kong as well.

Table 6 emphasizes the importance of the Northeast Asia's productivity driver in accounting for the national output fluctuations: i.e., 11.70 percent. The next important driving forces of business cycles are the monetary and trade drivers: 6.24 percent and 5.53 percent, respectively. The Northeast Asia's macro regional factors account for 67.81 percent of Hong Kong's business cycle, 55.12 percent for Japan, 44.41 for Canada, 37.84 percent for China, and 35.91 percent for Malaysia. Furthermore, 51.42 percent of Japan's business cycle is accounted for by the Northeast Asia's productivity driver, and 31.80 percent of Hong Kong's business

Table 6. Variance Decomposition: Northeast Asia's Regional Factor of Macro-Drivers

(Unit: %)

	Money supply	Government expenditure	Trade	Productivity	Terms of trade	Total
U.S.	2.16	1.76	0.09	7.32	6.69	18.01
Canada	3.70	2.27	0.37	25.24	12.83	44.41
Indonesia	0.46	8.09	0.58	0.94	1.73	11.80
Thailand	1.32	0.03	5.32	14.07	1.00	21.74
Philippines	5.01	5.61	0.66	11.27	6.03	28.59
Malaysia	21.52	0.64	7.11	4.57	2.07	35.91
Singapore	13.88	0.97	2.37	9.74	2.10	29.06
Korea	1.68	0.09	4.58	12.34	4.65	23.34
China	18.65	4.49	13.91	0.72	0.08	37.84
Japan	2.19	0.39	0.58	51.42	0.54	55.12
Taiwan	0.01	0.04	6.13	15.14	0.15	21.47
Hong Kong	16.60	18.02	31.80	1.23	0.16	67.81
Australia	0.12	0.02	3.46	0.93	0.61	5.14
New Zealand	0.02	0.12	0.41	8.85	1.04	10.44
Average	6.24	3.04	5.53	11.70	2.83	29.33

Table 7. Variance Decomposition: Oceania's Regional Factor of Macro-Drivers

(Unit: %)

	Money supply	Government expenditure	Trade	Productivity	Terms of trade	Total
U.S.	3.74	0.97	0.42	4.55	0.01	9.69
Canada	1.38	5.43	7.21	0.03	5.20	19.25
Indonesia	0.19	1.21	6.66	0.21	1.47	9.74
Thailand	0.83	0.91	6.78	0.23	0.31	9.06
Philippines	0.49	16.23	0.99	0.45	0.02	18.18
Malaysia	1.10	0.13	0.87	0.01	9.14	11.25
Singapore	0.80	0.15	0.28	1.62	0.19	3.05
Korea	4.36	1.57	0.09	0.14	0.02	6.18
China	0.32	2.25	4.91	2.29	6.71	16.48
Japan	0.02	1.00	0.58	0.01	2.56	4.17
Taiwan	0.06	2.23	0.73	4.97	0.78	8.77
Hong Kong	0.20	0.87	0.21	0.02	3.07	4.37
Australia	0.01	2.54	10.13	1.99	0.11	14.78
New Zealand	0.01	0.06	1.48	1.46	7.35	10.36
Average	0.96	2.54	2.95	1.29	2.64	10.38

cycle is explained by the Northeast Asia's trade driver, as well as 25.24 percent of Canada's output fluctuations are due to the Northeast Asia's productivity driver.

In Table 7, the explanatory power of Oceania's regional factor is relatively smaller than those of other region's factors, amounting to 10.38 percent on average. In particular, more than 10 percent of the output growth variations in Canada, the Philippines, China, Australia, New Zealand, and Malaysia are explained by the Oceania's regional factor.

V. Concluding Remarks

The purpose of this paper is to examine the characteristics of international business cycles among fourteen Asia-Pacific economies over the period of 2000:Q1–2013:Q4. We investigate to what extent business cycles in the Asia-Pacific region are accounted for by the common factor and the region-specific factor of important macroeconomic determinants across the economies. To attain this end, a dynamic latent factor model is used to estimate the latent common factor and the region-specific factors of both business cycle and the macro-drivers. The dynamic correlations are calculated to measure the degree of business cycle comovements, and also variance decompositions are examined to evaluate relative importance of macroeconomic driving forces in accounting for business cycle movements.

Major findings are summarized as follows. First, we find that the common and region-specific factors of Asia-Pacific business cycles account for significant portion of national output fluctuations. The common factor accounts for approximately half of national output fluctuations in China (57.46 percent) and Hong Kong (46.67 percent). On the other hand, the region-specific factors are important for the U.S. (44.24 percent), Canada (63.87 percent), Malaysia (64.69 percent), Korea (43.49 percent), and Australia (42.28 percent).

Second, the analysis reveals evidence for international business cycle comovements across Asia-Pacific economies. According to the dynamic correlations in the frequency domain, North America's regional business cycles comove

strongly with the Asia-Pacific common business cycle in the long run, but Northeast Asia shows a weak comovement with the Asia-Pacific business cycle at low frequencies. The time-varying correlation between North America and Northeast Asia has the highest value of 0.40. The relation between Southeast Asia and Oceania reveals the weakest link among them.

Third, the region-specific factors of macro-drivers are important in accounting for the region-specific factor of business cycles: amounting to 50.69 percent for North America and 43.31 percent of Northeast Asia. In particular, the monetary policy is the most important for North America, and also productivity and international trade are the next to be important. In explaining Northeast Asia's regional business cycle, the variable of trade is the most important driver and the monetary policy is next important. Overall, across four sub-regions in the Asia Pacific, international trade presents the largest contribution on average, and the monetary policy and productivity variables are subsequent to it.

Fourth, as for country characteristics, the region-specific monetary driver of North America is the most important across the Asia-Pacific economies as a whole. The Southeast Asia's monetary driver is especially important for China, Hong Kong, and Indonesia. In addition, the Northeast Asia's productivity driver is crucial in accounting for the national output fluctuations, and next the monetary and trade drivers are in sequence.

Regional business cycle comovement is relevant to the issues of regional monetary and financial cooperation since its degree is regarded as one of the economic convergence criteria. The aforementioned comovement feature among the regional business cycles implies the necessity of enhancing the APEC economic policy coordination, and thus we expect stronger economic policy coordination and the APEC member's effort toward the improved economic integra-

tion.

Recent research points out that the market-driven economic integration has deepened in the Asia-Pacific and the economies are interconnected through trade in the region. For example, the plurilateral regional trade agreements, for example the Regional Comprehensive Economic Partnership (RCEP) and the Trans-Pacific Partnership (TPP), together with regionalism have drawn growing interest in production networks. Chung *et al.* (2013), for instance, conclude that production network is an important determinant of regional economic integration and APEC is active in this regard. In the context of both regional business cycle comovements and deepening policy coordination with APEC, more specific commitment by setting priority on policy coordination should be made to achieve Bogor Goals and the APEC objectives. To this end, APEC should conceive specific action plans on the ongoing regional initiatives, such as Information Technology Agreement. In addition, we found convincing signs of business cycle comovements in the Asia Pacific and the macroeconomic driving forces highlight the importance of macro-policy cooperation. These findings uphold the potential and the greater likelihood of regional cooperation and coordinated macroeconomic policies against economic crisis and regional monetary and financial vulnerability.

Another policy implication for East Asia can be sought from the dynamic correlations at low frequencies. It suggests that the East Asian economies require stronger economic cooperation in the long run, including both real and financial sides of the ASEAN+3 economy. In reality, economic integration in East Asia has progressed by growing intra-regional trade and financial cooperation. Thus, the economies in Southeast Asia and Northeast Asia should develop further their economic cooperation in various aspects; such as regional financial arrangements,

local currency bond markets under the Asian Bond Market Initiative, increasing cross-border capital flows and financial liberalization.

The Asian currency crisis revealed what East Asian economies have been lagging behind in terms of the financial sector compared with real sector development. Underdevelopment of the financial sector was caused by several reasons; high risk vulnerability to external shocks, excessive dependence on bank-intermediated financing, insufficient long-term credits and local currency bond markets, the absence of a full-fledged regional surveillance mechanism, among others. The market-based need for regional financial cooperation is supported by the rationale of both better risk sharing through better allocation of financial resources and sustainable regional economic growth.

East Asia's regional financial cooperation has been developed with ASEAN+3 initiatives since the Asian currency crisis. The process of regional financial cooperation in East Asia has been induced by establishing regional financial arrangements, developing Asian bonds market, and gradual financial liberalization. The regional collective initiatives have been manifested in various aspects: the Chiang Mai Initiative Multilateralization (CMIM), the Asian Bond Market Initiative (ABMI), and ASEAN+3 Macroeconomic Research Office (AMRO) among others. Even though the CMIM funding size has been increased to US\$240 billion in 2012 and introduced its crisis prevention functions by operating the CMIM Stability Facility (CMIM-SF) and the CMIM Precautionary Line (CMIM-PL), there are still limitations for CMIM to be an effective regional financial safety net. As for the ABMI, ASEAN+3 should arrange a Regional Settlement Intermediary (RSI) and establish a regional credit-rating agency and ASEAN+3 Multi-currency Bond Issuance Framework (AMBIF) to fostering local currency bond markets. Lastly, the role of AMRO, a regional surveillance unit

established in 2011, is crucial for early identification of members' crisis prevention needs and the assessment of their economic situation in crisis. However, its staff resources are still not enough to conduct full-fledged surveillance activities. Accordingly, based on the finding of this study, East Asia should make stronger economic cooperation, particularly targeting the short-term policy horizon, to overcome these limitations.

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Appendix

Table A.1 Data Sources

	Real GDP	Real gross capital formation	Real government expenditure	CPI	Money supply	Export and import	Employment	Export & import price index
North America								
U.S.	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg
Canada	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg
Southeast Asia								
Indonesia	Bloomberg	Bloomberg	Bloomberg	IFS, IMF	Bloomberg	IFS, IMF	Oxford Econ.	Oxford Econ.
Thailand	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Oxford Econ.	Bloomberg
Philippines	Bloomberg	Bloomberg	Bloomberg	IFS, IMF	IFS, IMF	Bloomberg	Bloomberg	IFS, IMF
Malaysia	Dep't of Stat.	Dep't of Stat.	Bloomberg	IFS, IMF	Bloomberg	Bloomberg	Dep't of Stat.	Oxford Econ.
Singapore	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	IFS, IMF	Bloomberg	Bloomberg
Northeast Asia								
Korea	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg
China	Oxford Econ.	Oxford Econ.	Bloomberg	Bloomberg	Bloomberg	IFS, IMF	NBS	Oxford Econ.
Japan	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg
Taiwan	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg
Hong Kong	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg
Oceania								
Australia	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg
New Zealand	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg	Bloomberg

Note: IFS and NBS refer to the International Financial Statistics and the National Bureau of Statistics of China, respectively.

국문요약

이 연구는 2000년 1/4분기~2013년 4/4분기 동안 APEC 회원국을 대상으로 국제 경기 변동의 특징을 분석하였다. 총생산 변동과 경기변동의 거시경제적 주요 동인에 대해 동태적 요인모형을 이용하여 APEC 14개국의 공통요인과 북미·동북아시아·동남아시아·오세아니아의 지역 고유요인을 추정하였다. 분산분해 결과에 따르면 경기변동의 공통요인과 지역 고유요인이 각국 경기변동의 상당 부분을 설명하는 것으로 나타났다. 특히 장기에 걸친 국제 경기변동 동조화 현상은 북미지역과 아시아·태평양 경기변동의 공통요인 사이에 강하게 나타났고, 북미와 동북아시아 사이의 경기변동 동조화도 유의하게 나타났다. 아시아·태평양 역내에서 경기변동의 동인으로 국제무역의 기여도가 가장 높았고, 그 다음으로 통화정책과 생산성 요인이 중요하게 나타났다. 이러한 분석결과는 향후 APEC을 통한 경제협력 및 아시아·태평양 지역의 통화정책 협력 가능성을 긍정적으로 보여준다.

핵심용어: 경기변동 동행성, 아시아·태평양 지역경제, 아시아·태평양 경제협력체 (APEC)

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저서 및 논문

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