Économie internationale 119 (2009), p. 5-23

ÉCONOMIE INTERNATIONALE
INTERNATIONAL ECONOMICS

A factor analysis of trade integration: The case of Asian and Oceanic economies

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Article received on June 19, 2009
Accepted on August 31, 2009

Abstract. We study trade integration among fifteen selected Asian and Oceanic economies using factor models. The principal component approach is employed to extract the common factor that drives trade integration from bilateral trade integration series. It is found that the estimated common trade integration factor has strong seasonal and deterministic components. In accordance with theory, the common trade integration factor is significantly associated with the economic growth and the trade barriers of the fifteen economies. However, we find no evidence that the common trade integration factor is affected by foreign direct investment. The basic model is extended to incorporate an ASEAN factor that affects trade integration among the ASEAN economies in our sample.

JEL Classification: F15; F36; F42.
Keywords: Factor Model; Principal Component; Growth; Trade Barriers; ASEAN.

Résumé. Cet article présente une étude de l'intégration commerciale entre quinze économies de la zone Asie et Océanie qui s'appuie sur des modèles factoriels. L'analyse en composantes principales est utilisée pour extraire, des séries d'échanges bilatéraux, le facteur commun qui sous-tend l'intégration commerciale. Le résultat montre que le facteur commun estimé de l'intégration commerciale a de fortes composantes saisonnières et déterministes. Conformément à la théorie, le facteur commun de l'intégration commerciale est lié de manière significative à la croissance économique et aux barrières aux échanges au sein des quinze économies. Cependant, les résultats ne montrent pas que ce facteur dépend de l'investissement direct étranger. Le modèle de base est élargi pour incorporer un facteur ASEAN qui affecte l'intégration commerciale au sein des pays de l'ASEAN figurant dans notre échantillon.

Classification *JEL* : F15 ; F36 ; F42.
Mots-clefs : Modèle factoriel ; composantes principales ; croissance ; barrières aux échanges ; ASEAN.

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1. Introduction

Arguably, international trade plays an important role in shaping the growth of the Asian region. Trade is also a main vehicle that links up the Asian economies and integrates them into the global economy. After the 1997 financial crisis, the Asian economies devoted considerable effort to promote regional trade. Indeed, soon after the crisis, the intra-Asia trade activity resumed its strength and intensified noticeably (Asian Development Bank, 2006 & 2007).

In the last two decades, the growth of trade between Asia and the rest of the world was quite phenomenal. At the same time, the intra-regional trade increased at a rapid pace. According to the Asian Development Bank (2006), intra-regional trade in developing Asia was about 40 percent of total exports in 2004, up from just 22 percent in 1980. The significant rise in intra-regional trade attests the increasing degree of integration among Asian economies.

There are a few factors contributing to the growth of the Asian intra-regional trade. They include the rise in regional income, the removal of trade barriers, and advances in production and transportation technologies. Compared with other regions, such as the European Union, intra-regional trade in Asia is characterized by a high proportion of trade in parts, components, and intermediate products (Ando, 2006; Kimura, 2007; Kimura and Ando, 2005). The People's Republic of China (hereinafter China) is conceived to hold a significant position in the intra-regional component trade. While its return to the world stage is often described in terms laden with hyperbole, it is difficult to overstate China's role in the regional production chain. Being the last leg of the production chain, China assembles final products and exports them to the rest of the world (Eichengreen, *et al.*, 2004; Gaulier, *et al.*, 2005). Thus, the intra-regional trade in Asia is trade creating instead of trade diverting. It is not expanded at the expense of its trade with the rest of the world, and both regional integration and its integration with the world are strengthened at the same time.

In the current exercise, we study trade integration among selected Asian and Oceanic economies after the 1997 Asian financial crisis. Australia and New Zealand are included in our sample because of their growing trade interactions with Asian economies (Cowen, *et al.*, 2006). Instead of the usual bilateral approach, the current exercise adopts a factor model and focuses on driving forces that affect the general degree of trade integration of these economies as a group. The analytical framework is based on the premise that trade integration is driven by common factors that affect all economies and that there are also economy-specific, idiosyncratic forces. The framework could be extended to include factors that affect only a sub-group of economies that share some common characteristics in the sample.

There are two approaches that can be used to construct the common factor required for the analysis. One approach is to assume that the common factor driving trade integration is represented by a set of observed economic variables or by common elements of these economic variables. The choice of these economic variables is usually guided by some theoretical considerations. The second approach is to assume that the common factor is unobservable. We can extract the latent common factor directly from, say, some measure of bilateral trade integration. The approach implicitly assumes that the observed measure of trade integration contains information on the common force that drives the integration process. Although the approach is atheoretical, it is quite intuitive and can be easily implemented. Indeed, the technical specification is drawn mainly from factor models, which have been used to analyse various economic issues. In the current exercise, we will follow the latent common factor approach.

In studying the trade integration of fifteen Asian and Oceanic economies, we identify the presence of a common factor driving the degree of trade integration of the selected economies. The estimated common trade integration factor displays deterministic seasonal patterns. It is also affected by the economic activity of, and the trade barriers between, the selected economies. In addition, we document the presence of an ASEAN group factor that affects the degree of trade integration of the five ASEAN economies in our sample.

2. The empirical framework

To simplify the presentation, we consider the case of one common factor. Then we discuss the variants of the basic setup. The basic specification is given by:

$$X_{ij,t} = \gamma_{ij} F_t + v_{ij,t}; \qquad i,j = 1, 2, \ldots, N \quad \text{and} \quad i < j\ ,\ t = 1, \ldots, T, \qquad (1)$$

where $X_{ij,t}$ is a measure of trade integration between economies i and j at time t, F_t is the common factor that affects the degree of trade integration among all the economies, $v_{ij,t}$ is the regression error term that captures the idiosyncratic components, N is the number of economies under consideration, and T gives the time dimension of the sample. The coefficient γ_{ij} captures the effect of the common factor on the degree of trade integration between economies i and j. It is allowed to vary across economies. We consider that cross-economy heterogeneity is commonplace in reality and, hence, a homogeneity-restriction on the common factor coefficients is undesirable.

In the literature, equation (1) is known as a factor model and F_t is a common component of the $X_{ij,t}$'s in the analysis. The specification has been adapted in finance to investigate asset pricing, in macroeconomics to study business cycles and generate economic forecasts; see, for example, Chamberlain and Rothschild (1983), Eickmeier and Ziegler (2006), Forni and Reichlin (1998), Giannone, Reichlin and Small (2005) and Stock and Watson (1989 & 2002a & b). In the current context, it is implicitly assumed that the effects of economic variables on the evolution of trade integration can be represented by a few latent common factors.

One advantage of the data-driven approach is that we can estimate the common factor F_t without subscribing to a specific theory on the determinants of trade integration and the specific (dynamic) channels through which these determinants affect trade integration. Once we have an estimate of F_t, we can assess its economic content by examining its association with the possible economic determinants (see subsection 3.4).

A few remarks are in order. First, the model can be easily modified to accommodate the case in which F_t is a vector containing more than one factor and/or lags. Further, it can be modified to accommodate a group factor that affects a specific subset of economies under consideration. Subsection 3.5 uses an example to illustrate the extension to include a group factor.

Second, the principal component approach can be used to estimate the latent factor F_t. Stock and Watson (2002a & b), for example, show that under some regularity conditions, the principal component of $X_{ij,t}$ is a consistent estimator of the common factor that drives $X_{ij,t}$.

Third, the latent factor F_t can be estimated via a dynamic factor model based on, say, Kalman filtering (Breitung and Eickmeier, 2005; Forni *et al.*, 2000). In our pilot study, it is found that estimates of F_t derived from the principal component approach and the dynamic factor specification are quite similar and have a correlation coefficient of 0.99. Thus, for simplicity, we present the results based on the common factors estimated using the principal component approach.

3. Empirical analysis

In the aftermath of the 1997 Asian financial crisis, an intense interest in assessing the integration of Asian economies developed. Besides enhancing economic efficiency, integration promotes policy coordination, which could deter future crises in the region. Further, integration is usually deemed to be one of the preconditions for forming an economic or currency union.[2] Indeed, in the post-crisis period, various initiatives including bilateral trade agreements have been taken to foster regional integration, and there has been a substantial rise in intra-regional trade.[3]

3.1. Data

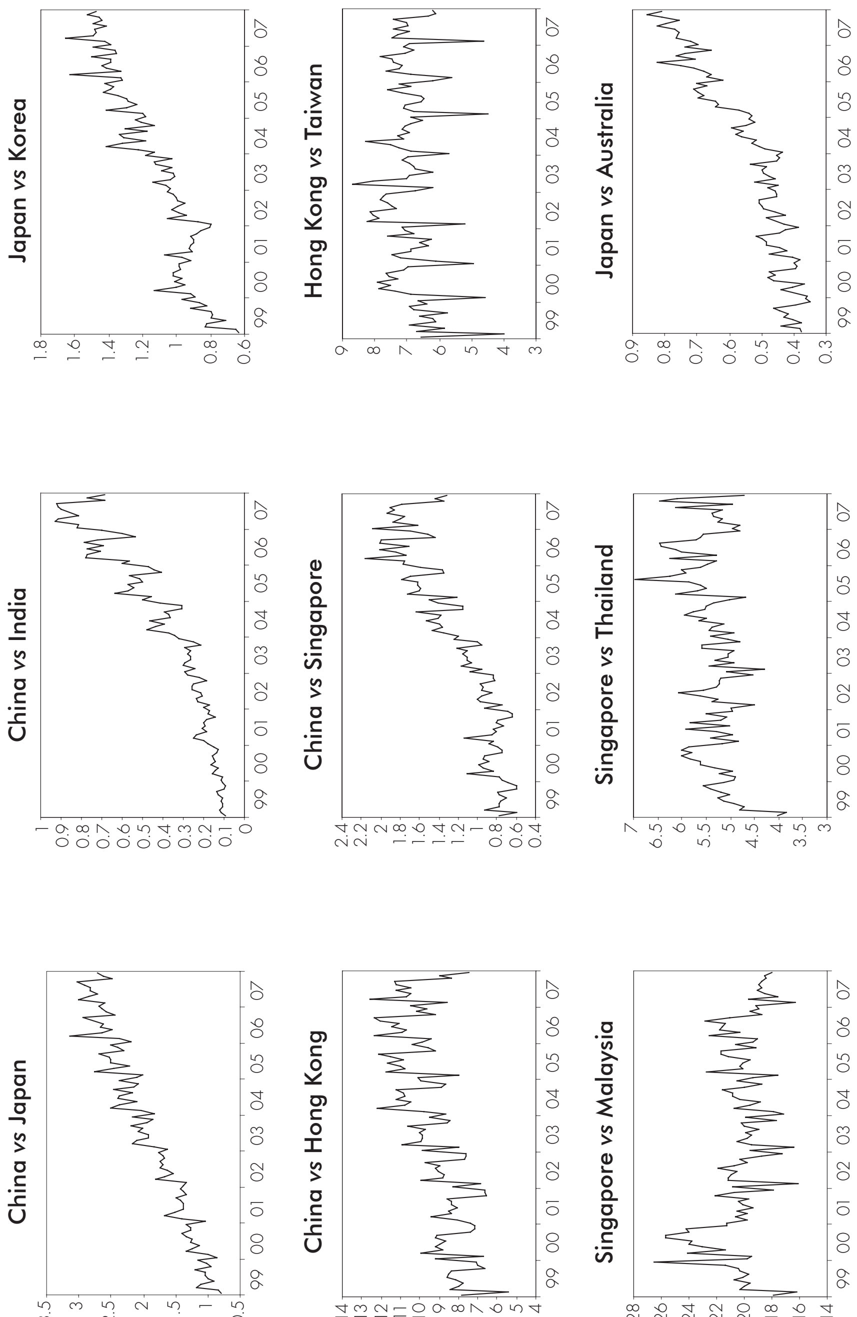
The sample period is January 1999 to December 2007. We consider data from fifteen economies; namely Australia, China, Hong Kong SAR (hereinafter Hong Kong), India, Indonesia, Japan, Korea, Malaysia, Macao SAR (hereinafter Macao), New Zealand, the Philippines, Singapore, Taiwan (China) (hereinafter Taiwan), Thailand, and Vietnam. These are the major trading economies in the region. Australia and New Zealand are included because they traded quite intensively with these Asian economies during the sample period. For instance, the other thirteen economies in the sample accounted for 45.26 percent of Australia's and New Zealand's exports and imports in 1999 and 54.98 percent in 2007.[4] The data used in the following subsections are from the *International Financial Statistics*,

2. See, for example, Asian Development Bank (2005); Cheung *et al.* (2007); Cheung and Yuen (2005); Cowen *et al.* (2006); Kawai (2005); Kim and Lee (2008); Sakakibara and Yamakawa (2003a & b); Yu, *et al.* (2007).

3. See, for example, Asian Development Bank (2006); Bchir and Fouquin (2006); Rajan and Sen (2005).

4. On exports, Australia and New Zealand sent 49.72 percent of their total exports in 1999 and 58.65 percent in 2007 to these thirteen economies.

Figure 1 - Selected trade integration series



Directions of Trade, *World Development Indicator*, and the CEIC Database. For these economies, the within group trade was 53.20 percent of their total exports in 2007, up from just 47.11 percent in 1999.

The trade openness variable given by the ratio of external trade to GDP is routinely used to describe an economy's degree of trade integration with the world economy.[5] Thus, we use the amount of trade between two economies to assess the degree of bilateral trade integration. Specifically, we consider the bilateral trade integration $X_{ij,t}$ given by

$$X_{ij,t} = (Ex_{ij,t} + Ex_{ji,t}) / (GDP_{i,t} + GDP_{j,t}), \qquad (2)$$

where $Ex_{mn,t}$ is the exports of economy m to economy n, and $GDP_{m,t}$ is the gross domestic product (GDP) of economy m at time t. These variables are in US dollars. The monthly GDP data used to construct the ratios were interpolated from the corresponding quarterly GDP data. Normalizing bilateral trade volume by the corresponding GDPs facilitates comparison across economy-pairs of different sizes. For brevity, we call $X_{ij,t}$ the (bilateral) trade integration index and scale it by 100 to make it a percentage of the sum of the two GDPs.

A few selected trade integration series are plotted in Figure 1. It is quite transparent that some economies trade more intensively with others over time while some economy-pairs do not display a discernable increase in their bilateral trade integration indexes. That is, if there is a common factor driving trade integration amongst these economies, the factor has differential effects on individual economy-pairs. Further, these bilateral trade integration indexes display some deterministic patterns – most series exhibit the monthly seasonality and some show a break that may be associated with the economic effects of the burst of the dot-com bubble in 2001.[6] The information will be incorporated in modelling the common trade integration factor.

3.2. The common trade integration factor

Table 1 reports the five largest principal components computed for the 105 bilateral trade integration indexes. The largest principal component explains 45 percent of the total variation while the five largest ones explain 67 percent. The explanatory power of these principal components drops very dramatically after the first component – indicating that a substantial amount of the bilateral trade activities of these fifteen economies is driving by one common factor. Further, the results of applying the Bai and Ng (2002) method corroborate the inference of the presence of one common factor.[7] Thus, in subsequent analyses, the first principal component is taken as the estimate of the common trade integration factor.

5. An alternative version is given by the ratio of imports to GDP; see, for example, Lane (1997) and Romer (1993).

6. The dot-com bubble reached its apex in 2000 when the NASDAQ index broke through the 5,000 mark.

7. All three criteria: $IC_{p1}(k)$, $IC_{p2}(k)$ and $IC_{p3}(k)$ proposed by Bai and Ng (2002) suggested the presence of one common factor. These results are available from the authors. See Bai and Ng (2002) for a detailed discussion of these procedures.

Table 1 - The five largest principal components of trade integration series, 1999M1 to 2007M12*

	First principal component	Second principal component	Third principal component	Fourth principal component	Fifth principal component
Eigenvalue	47.56	8.64	6.63	4.41	3.18
Cumulative value	47.56	56.20	62.83	67.25	70.43
Variance proportion	0.45	0.08	0.06	0.04	0.03
Cumulative proportion	0.45	0.53	0.60	0.64	0.67

* The table presents eigenvalues and proportions of variability explained by the five largest principal components.

To assess the ability of the common trade integration factor to explain individual bilateral trade integration indexes, we note that, from equation (1), the variation of $\{X_{ij,t}\}$ can be decomposed into:

$$V(X_{ij,t}) = \gamma_{ij}^{2} V(F_t) + V(v_{ij,t}). \qquad (3)$$

Using (3), Table 2 presents the proportions of trade integration variability explained by the estimated common factor $\hat{F}_t$ and $\hat{v}_{ij,t}$. The average proportions of an economy's bilateral trade integration indexes explained by the estimated common factor $\hat{F}_t$ are given in the last row. China garners the highest average explained proportion of 77.78 percent while Macao has the lowest average proportion of 17.81 percent. Indeed, the common factor plays a significant role in explaining the average proportions of China's and Japan's degrees of trade integration – in both cases, it explains an average 77 percent of the variability of their trade integration series. The result coincides with the anecdotal evidence that China and Japan are the two largest trading economies in the region. In addition to these two economies, the common factor explains more than 50 percent of the average bilateral trade integration of the other four economies.

In accordance with the diverse pattern depicted in Figure 1, the common trade integration factor displays vastly differential effects on individual economy-pairs. The proportions of trade integration variability explained by the common factor range from zero (Indonesia-Korea) to 94.10 percent (Japan-Thailand), have a mean of 49.25 percent, and a standard error of 33.84 percent. Thus, it is important to allow the coefficient γ_{ij} to be economy-specific.

Table 2 - The proportions of bilateral trade integration explained by the estimated common factor, 1999M1 to 2007M12, in percentage*

	China	India	Japan	Korea	Singapore	Malaysia	Thailand	Indonesia	Philippines	Taiwan	Hong Kong	Vietnam	Australia	New Zealand	Macao
China		11.26	6.44	10.63	10.05	16.60	10.27	20.33	35.75	13.04	35.27	23.46	7.51	36.31	74.11
India	88.74		33.08	11.00	15.43	51.64	26.00	9.57	99.46	34.86	60.78	11.19	21.46	74.86	99.96
Japan	93.56	66.92		6.85	32.64	49.61	5.90	14.04	41.77	25.05	10.11	15.65	14.67	23.61	41.13
Korea	89.37	89.00	93.15		67.67	99.97	53.89	99.99	65.64	41.40	96.51	45.56	99.18	98.81	77.66
Singapore	89.95	84.57	67.36	32.33		99.35	76.68	18.93	97.83	43.27	6.53	33.32	83.35	44.08	58.93
Malaysia	83.40	48.36	50.39	0.03	0.65		22.28	35.39	99.68	83.87	50.75	27.70	87.83	99.98	99.95
Thailand	89.73	74.00	94.10	46.11	23.32	77.72		35.97	89.10	41.97	14.42	14.31	28.49	52.68	98.50
Indonesia	79.67	90.43	85.96	0.00	81.07	64.61	64.03		96.66	57.88	89.94	99.97	99.54	77.81	97.22
Philippines	64.25	0.54	58.23	34.36	2.17	0.32	10.90	3.34		95.79	41.07	88.68	67.88	85.25	78.86
Taiwan	86.96	65.14	74.95	58.60	56.73	16.13	58.03	42.12	4.21		95.17	18.56	97.14	69.02	95.14
Hong Kong	64.73	39.22	89.89	3.49	93.47	49.25	85.58	10.06	58.93	4.83		15.82	70.17	96.78	39.10
Vietnam	76.54	88.81	84.35	54.44	66.68	72.30	85.69	0.03	11.32	81.44	84.18		58.44	96.11	97.41
Australia	92.49	78.54	85.33	0.82	16.65	12.17	71.51	0.46	32.12	2.86	29.83	41.56		93.23	93.79
New Zealand	63.69	25.14	76.39	1.19	55.92	0.02	47.32	22.19	14.75	30.98	3.22	3.89	6.77		98.88
Macao	25.89	0.04	58.87	22.34	41.07	0.05	1.50	2.78	21.14	4.86	60.90	2.59	6.21	1.12	
Mean	77.78	59.96	77.10	37.52	50.85	33.96	59.25	39.05	22.61	41.99	48.40	53.84	34.10	25.19	17.81

* The numbers listed below the diagonal are the percentages of trade integration variability explained by the estimated common trade integration factor. The numbers listed above the diagonal are the unexplained proportions in percentages.

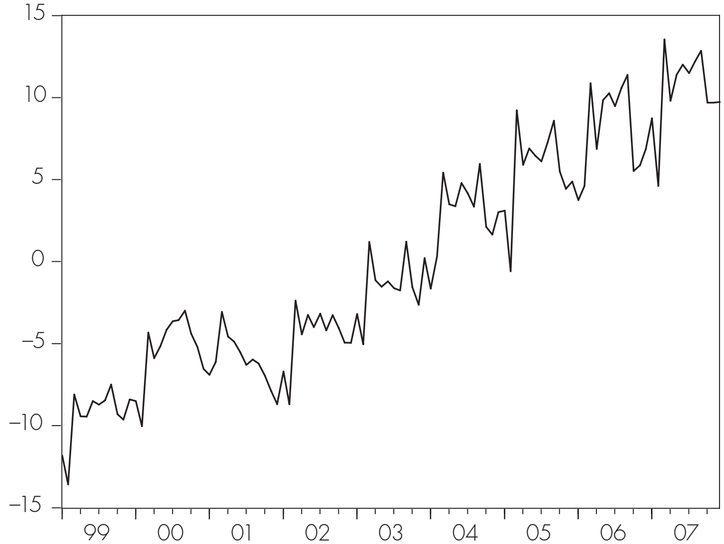
3.3. The statistical properties

Figure 2 graphs the estimated common trade integration factor $\hat{F}_t$. It is apparent that $\hat{F}_t$ exhibits a seasonality pattern. Further, there may be a structural break during the year of 2001. These features are comparable to those observed from the individual bilateral trade integration series in Figure 1. To give some insight into the statistical properties of the common trade integration factor, we study the estimated common factor using the model

$$\hat{F}_t = D_t + u_t, \tag{4}$$

where D_t is the deterministic component and u_t is the stochastic component. From the pilot analysis, the D_t variable is set to include a constant, a deterministic time trend variable, a set of monthly seasonal dummies, and a dummy variable that accounts for a structural break that occurred in July 2001. The stochastic component is assumed to follow a standard autoregressive- moving-average (ARMA) specification.[8]

Figure 2 - The estimated common trade integration factor, $\hat{F}_t$



The estimation results are presented in Table 3. The time trend, most of the seasonal dummy variables, and the structural break dummy, are highly significant. The results corroborate the visual evidence from Figure 2. The ARMA structure of u_t is determined based on both information criteria and the properties of the estimated residuals. An ARMA(1,1) is selected by the Schwarz information criterion and the ARMA(1,2) by the Akaike information criterion. The estimated residuals from the latter model specification pass the usual serial correlation

8. The stationary ARMA structure is consistent with findings from the pilot analysis. Specifically, the null hypothesis of u_t follows an I(1) process was rejected at the 5 percent level by the augmented Dickey-fuller test; indicating the common trade integration factor is stationary around the deterministic component. Note that if the common trade integration factor is non-stationary, a dynamic factor model based on Kalman filtering, for example, should be employed.

Q-test while those from the former one do not. Nonetheless, both specifications explain the estimated common trade integration factor quite well and account for 98 percent of its variability.

Table 3 - Statistical properties of the estimated common factor, $\hat{F}_t$*

	Model 1	Model 2
Constant	–15.20 (0.00)	–14.92 (0.00)
Time trend	0.24 (0.00)	0.23 (0.00)
Dummy for structural break in July 2001	2.57 (0.00)	2.12 (0.01)
Dummy for January	0.12 (0.80)	0.12 (0.81)
Dummy for February	–1.34 (0.01)	–1.33 (0.01)
Dummy for March	4.75 (0.00)	4.76 (0.00)
Dummy for April	2.09 (0.00)	2.11 (0.00)
Dummy for May	2.60 (0.00)	2.63 (0.00)
Dummy for June	2.68 (0.00)	2.72 (0.00)
Dummy for July	2.47 (0.00)	2.47 (0.00)
Dummy for August	2.42 (0.00)	2.42 (0.00)
Dummy for September	3.37 (0.00)	3.37 (0.00)
Dummy for October	0.52 (0.27)	0.53 (0.23)
Dummy for November	–0.29 (0.48)	–0.28 (0.51)
AR(1)	0.88 (0.00)	0.83 (0.00)
MA(1)	–0.56 (0.00)	–0.66 (0.00)
MA(2)		0.31 (0.01)
$\bar{R}^2$	0.98	0.98
Q-statistics (6, 12)	10.39*, 19.09*	4.79, 13.32

* *P*-values based on the Newey-West heteroskedasticity and autocorrelation consistent standard errors are given in brackets next to the coefficient estimates. The Q-statistics based on the squares of the first six and twelve serial correlation estimates are reported in the row labeled "Q-statistics (6, 12)" and "*" indicates significance at the 5% level.

3.4. Economic determinants

In this subsection, we augment equation (4) with some economic determinants of trade integration. Specifically, (4) is modified to:

$$\hat{F}_t = D_t + E_t + u_t, \qquad (5)$$

where E_t contains the effects of economic determinants. Economic activity is the first economic variable included in the analysis. It is widely perceived that a high degree of output tends to support a high degree of trade between economies, *ceteris paribus*. To capture the output effect, we considered the industrial production indexes of the fifteen economies in the sample, the European Union (EU), and the US. The bilateral trade integration measures should be driven by economic activities of the economies in the sample. Nevertheless, these economies trade quite heavily with both the EU and the US. The intra-regional trade, which is characterized by regional production sharing, could be affected by the trade between these economies and the EU and the US. Thus, these two economies' industrial production indexes are included to allow for possible interactions between intra-regional trade and inter-regional trade.

To conserve the degrees of freedom, the largest principal component of the monthly industrial production indexes of the fifteen economies, IP_{15}, is used as the proxy for their common output factor. Indeed, the largest principal component accounts for 70 percent of the variations in these fifteen indexes.

The estimated output effects are presented in Table 4. The coefficient estimates associated with the deterministic variable D_t are very similar to those in Table 3 and, thus, are not reported in order to conserve space. Individually, the three output variables are statistically significant and have the expected positive sign; that is, a high degree of economic activity is associated with a high degree of trade integration (Models 1 to 3).

Table 4 - Effects of output growth*

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
IP_{15}	1.90 (0.00)			1.76 (0.00)	1.81 (0.00)	1.83 (0.00)
IP_{US}		0.32 (0.01)		0.22 (0.02)	0.23 (0.01)	0.20 (0.03)
IP_{EU}			0.21 (0.07)	–0.05 (0.53)	–0.07 (0.41)	
AR(1)	0.83 (0.00)	0.76 (0.00)	0.86 (0.00)	0.50 (0.04)	0.31 (0.00)	0.34 (0.00)
MA(1)	–0.42 (0.01)	–0.70 (0.00)	–0.69 (0.00)	–0.22 (0.37)		
MA(2)		0.31 (0.01)	0.28 (0.02)	0.25 (0.05)	0.26 (0.01)	0.25 (0.01)
$\bar{R}^2$	0.98	0.98	0.98	0.98	0.98	0.98
Q-statistics (6, 12)	2.97, 8.73	4.56, 15.61	4.50, 13.92	4.17, 8.74	7.51, 11.73	8.28, 12.21

* *P*-values based on the Newey-West heteroskedasticity and autocorrelation consistent standard errors are given in brackets next to the coefficient estimates. See the text for the definition of IP_{15}, IP_{US}, and IP_{EU}. For brevity, estimates of the deterministic trend, the structural break variable and the seasonal dummy variables are not reported. The Q-statistics are all insignificant.

However, in the presence of other industrial production variables, the EU variable becomes insignificant and even has a negative sign. Model 5 excludes the insignificant MA(1) estimate and Model 6 includes only significant output and ARMA variables. The magnitudes of the estimates indicate that the common economic activity factor of the fifteen economies, IP_{15}, exerts a larger impact than the US variable. Thus, besides the deterministic components, trade between these fifteen economies is mainly associated with the economic activity in the region and, to a lesser extent, affected by the US. While the presence of these output variables does not increase the adjusted *R*-square estimate, it reduces the magnitudes of the ARMA coefficient estimates.

We also checked the data on trade between these fifteen economies and the EU and US. We did not find substantial evidence that these economies trade much more with the US than with the EU. Apparently, the differential output effects are not directly related to the levels of trade between these economies and the EU and the US.

Next, we consider the trade barriers. In the recent years, we have witnessed a significant reduction in trade barriers and the proliferation of, say, bilateral free trade agreements amongst these economies (Asian Development Bank, 2006; Rajan and Sen, 2005). To assess the implication of trade barriers, we introduce a measure of trade impediments – the ratio of import duties to total imports. Since the data on Macao's import duties are not available, we worked with the ratios from the remaining fourteen economies. Specifically, the largest principal component of the fourteen monthly ratios of import duties to total imports is used to gauge the general degree of trade barriers of these economies.[9]

The effects of trade barriers on the estimated common factor that drives the trade integration between the fifteen economies and on the estimated output effect are presented in Table 5. The EU output variable is insignificant in these specifications and, thus, is not reported for brevity. The results confirm the notion that the lower the trade barriers, the higher the degree of trade integration among these economies – the common factor of the ratios of import duties to total imports (*MD*) has a significantly negative coefficient estimate across all specifications.

Table 5 - Effects of trade barriers and output growth*

	Model 1	Model 2	Model 3	Model 4
MD	−1.34 (0.00)	−1.11 (0.00)	−1.34 (0.00)	−1.18 (0.00)
IP_{15}		1.41 (0.00)		1.41 (0.00)
IP_{US}			−0.003 (0.98)	−0.06 (0.48)
AR(1)	0.52 (0.01)	0.18 (0.08)	0.52 (0.01)	0.18 (0.09)
MA(1)	−0.46 (0.06)		−0.45 (0.06)	
MA(2)	0.31 (0.00)	0.24 (0.00)	0.31 (0.00)	0.23 (0.00)
$\bar{R}^2$	0.98	0.99	0.98	0.99
Q-statistics (6, 12)	5.20, 13.43	6.10, 10.66	5.19, 13.40	6.34, 11.16

* See the notes to Table 4. The Q-statistics are all insignificant. See the text for the definition of the trade barrier variables *MD*.

9. The largest principal component accounts for more than one half (54.5 percent) of the variations in these ratios. Note that the ratio of import duties to total imports is a measure of trade restrictiveness and, thus, some studies use it to assess the degree of non-integration. See, for example, International Monetary Fund (1998 & 2002) for a detailed discussion of various measures of integration.

The trade barrier variable has some interesting implications for the estimated output effects. Specifically, the US output effect is rendered insignificant while the common output factor of the fifteen economies has a slightly smaller but still positively significant effect on the degree of intra-regional trade integration. That is, the US output variable does not offer any incremental explanatory power in the presence of trade barriers.

To gain some insights into the trade barrier effect, we assessed the associations between the common import duties factor, US output, and the common output factor of the fifteen economies. It was found that the correlation coefficient between the common import duties factor and US output is –0.61 and the one between the common import duties factor and the common output factor of the fifteen economies is –0.20; the former correlation coefficient is significant while the latter is not. That is, the US output effect reported in TABLE 4 could be spurious and attributable to its close association with the trade barrier effect.

Another possible catalyst for the flourishing intra-regional trade is the foreign direct investment (FDI). Theoretically, it is the type of FDI that determines its implication for trade activity. Vertical FDI is perceived to complement trade and horizontal FDI is a trade substitute. In the case of Asian economies, a typical headline story is the component trade and production chain setup implied by vertical FDI. The contribution of vertical FDI related activity to trade between emerging market economies, however, is subject to interpretation. Anderson (2009), for example, shows that the increase in intra-emerging-market trade over the past decade is not greatly affected after stripping China out of the calculation. As China is the focal economy in the production chain story, the finding suggests that the evolution of intra-regional trade may not be too heavily driven by FDI related activity.

To investigate the FDI effect, we consider a measure defined by the ratio of inward and outward foreign direct investments to GDP. Again, the FDI activity is normalized to facilitate comparison across countries of different sizes. We also experimented with the inward FDI to GDP and outward FDI ratios. Nevertheless, none of these FDI measures yield a significant effect in our analyses. For brevity, we did not present these FDI results, which are available from the authors.

As discussed above, the FDI effect depends on its nature. Our findings, at the face value, suggest that the evolution of trade integration in the region is not dominant by vertical FDI related activity. We should, however, note that the insignificant result may be attributed to data deficiencies – we used aggregate FDI data in our analysis because the paucity of bilateral FDI data. The FDI effect may have been different if bilateral FDI and sector-specific FDI data were available. Thus, future research on the FDI effect; especially with bilateral data on horizontal and vertical FDI, is warranted.

3.5. Local driving force

As stated in Section 2, model (1) can be modified and extended to accommodate the presence of a "group" factor that affects the degree of trade integration among a subset of economies in the sample. To illustrate the point, let us consider the modified model

$$X_{ij,t} = \gamma_{ij} F_t + \delta_{ij} Q_{ij,t} + v_{ij,t}\,; \quad i,j = 1, 2, \ldots, N \text{ and } i < j\,,\ t = 1, \ldots, T, \qquad (6)$$

where $Q_{ij,t}$ is the group factor defined by some common characteristics of economies in the sample. To fix the idea, suppose $Q_{ij,t}$ represents a driving force specific to the five ASEAN economies (namely, Indonesia, Malaysia, the Philippines, Singapore and Thailand) in our sample. The group factor may represent the effect of the ASEAN trade agreement on the degree of trade integration.[10]

An estimate of $Q_{ij,t}$ could be obtained as follows. First, we estimate, say, the largest principal component of the ASEAN economies' trade integration series. Then, we regress the ASEAN principal component on the estimated common trade integration factor $\hat{F}_t$ and the resulting residuals are taken as estimates of the $Q_{ij,t}$'s. Thus, the estimates of the $Q_{ij,t}$'s capture the incremental effect of the ASEAN- specific driving force of trade integration, in the presence of the common trade integration factor F_t. For brevity, we label the group factor $Q_{ij,t}$ the ASEAN factor in the following discussion.

The results pertaining to the five ASEAN economies are presented in Table 6. Panel A of Table 6 recaps the explanatory power of $\hat{F}_t$ and Panel B gives the results of regressing individual bilateral trade integration series on the common trade integration and the ASEAN factors. The common trade integration factor has limited ability to explain the degree of trade integration of four economy-pairs: Singapore *vs* Malaysia, Singapore *vs* Philippines, Malaysia *vs* Philippines, and Indonesia *vs* Philippines. The ASEAN factor, on the other hand, is statistically significant in nine of the ten cases. In most cases, the ASEAN factor offers a substantial incremental explanatory power over the common trade integration factor. Apparently, the trade integration between Singapore and Malaysia is vastly driven by the ASEAN factor and not by the common trade integration factor – the inclusion of $Q_{ij,t}$ raises the adjusted R-squares estimate from –0.00 to 0.40. It is interesting to note that the trade integration between the two ASEAN economies Singapore and Philippines can hardly be explained by the common trade integration or the ASEAN factor.

10. The ASEAN Free Trade Area agreement was signed on 28 January 1992 – see, for example, http://www.aseansec.org/12375.htm.

Table 6 - The five ASEAN economies*

	Singapore *vs* Malaysia	Singapore *vs* Thailand	Singapore *vs* Indonesia	Singapore *vs* Philippines	Malaysia *vs* Thailand
Panel A:					
Constant	20.22 (0.00)	5.37 (0.00)	5.44 (0.00)	3.43 (0.00)	3.42 (0.00)
$\hat{F}_t$	–0.02 (0.59)	0.04 (0.00)	0.25 (0.00)	0.01 (0.27)	0.09 (0.00)
$Adj.R^2$	–0.003	0.23	0.81	0.01	0.78
Panel B:					
Constant	20.22 (0.00)	5.37 (0.00)	5.44 (0.00)	3.43 (0.00)	3.42 (0.00)
$\hat{F}_t$	–0.02 (0.40)	0.04 (0.00)	0.25 (0.00)	0.01 (0.30)	0.09 (0.00)
$Q_{ij,t}$	1.25 (0.00)	0.33 (0.00)	0.28 (0.01)	0.10 (0.22)	0.22 (0.00)
$Adj.R^2$	0.40	0.62	0.83	0.05	0.87

	Malaysia *vs* Indonesia	Malaysia *vs* Philippines	Thailand *vs* Indonesia	Thailand *vs* Philippines	Indonesia *vs* Philippines
Panel A:					
Constant	1.45 (0.00)	1.76 (0.00)	1.02 (0.00)	1.18 (0.00)	0.38 (0.00)
$\hat{F}_t$	0.03 (0.00)	0.002 (0.70)	0.03 (0.00)	0.01 (0.04)	–0.002 (0.29)
$Adj.R^2$	0.64	–0.01	0.64	0.10	0.02
Panel B:					
Constant	1.45 (0.00)	1.76 (0.00)	1.02 (0.00)	1.18 (0.00)	0.38 (0.00)
$\hat{F}_t$	0.03 (0.00)	0.002 (0.62)	0.03 (0.00)	0.01 (0.02)	–0.002 (0.14)
$Q_{ij,t}$	0.07 (0.00)	0.11 (0.00)	0.08 (0.00)	0.08 (0.00)	0.05 (0.00)
$Adj.R^2$	0.72	0.15	0.73	0.25	0.34

* Panel A presents the explanatory power of the estimated common trade integration factor. The results of including the ASEAN factor $Q_{ij,t}$ are presented in Panel B. See the text for the definition of $Q_{ij,t}$. *P*-values based on the Newey-West heteroskedasticity and autocorrelation consistent standard errors are given in brackets next to the coefficient estimates.

Echoing the evidence in Table 2, the ability of the common factor to explain the degree of trade integration varies quite widely across bilateral ASEAN economies. The incremental explanatory power of the ASEAN factor, though not as variable as the common trade integration factor, is quite diverse too. Thus, further study on forces driving trade integration is warranted.

4. Concluding remarks

Instead of examining trade integration in a bilateral setting, a factor framework is employed to investigate trade integration between fifteen selected Asian and Oceanic economies. The common trade integration factor extracted using the principal component approach explains a substantial proportion of variations in the degree of trade integration between these economies. It is found that the evolution of the common trade integration factor is affected by some seasonal patterns, economic activity, and trade barriers. Beside the common factor, it is found that there is an ASEAN group factor that affects the degree of trade integration of the five ASEAN economies in our sample.

In sum, our approach offers an intuitive framework to analyze the general degree of trade integration. If the policy objective is to enhance economic efficiency and coordination between these economies via strengthening the degree of trade integration, our empirical results lend support to policies of reducing trade barriers and promoting economic activity. Indeed, since the 1997 Asian financial crisis, the economies in the regional have initiated a series of free trade negotiations among themselves. Among the numerous bilateral and multi-lateral negotiations, the most notably one is the on establishing of a ASEAN-China free trade zone in 2012.

Besides cutting back tariffs and removing trade restrictions, there are other proposals for reducing hindrances to trade in the region. Amid the adverse dollar shortage effect on trade experienced in the recent global financial crisis, economies are exploring alternative ways to facilitate trade. China, for instance, in April 2009 launched a pilot scheme for cross-border trade settlement in renminbi, initially involving selected firms in five Chinese cities and Hong Kong. Reportedly, China is also talking to, say, Malaysia about the possibility of using local currencies in settling their bilateral trade.

In addition, China signed in 2009 bilateral renminbi currency swap agreements with a few central banks; including Bank Indonesia, Bank Negara Malaysia, and Hong Kong Monetary Authority. These agreements permit swaps between the renminbi and the local currency of the counterparty for a maturity of three years and could potentially promote trade when there is a dollar liquidity shortage. Thus, various efforts have been pursued to reduce direct and indirect trade barriers in the region.

The implication of trade integration for business cycle synchronization is not considered in our exercise. Theoretically speaking, an increase in the degree of trade integration between economies does not necessarily means their business cycles are synchronized. The effect depends on the nature of the shock and the nature of increased trade links. For instance, if trade integration induces production specialization across economies, which are hit by sector-specific shocks, then trade integration leads to the synchronization of business cycles. On the other hand, if the trade is of an intra-industry nature, then the argument does not apply. Thus, one way to extend the current exercise is to include the pattern of trade in our trade integration analysis and examine its implications for business cycle co-movement.

Admittedly, the factor framework adopted in our exercise is quite standard and could be extended in several directions indicated in Section 2. We adopted the principal component approach to abstract from some technical complexities that may not add too much to the notion of common trade integration. The simplification in the current exercise is deemed reasonable since, as pointed out in Section 2, the common factors estimated using the principal component method and the elaborate dynamic factor specification are very similar. Nonetheless, it is worth in future search exploring various possible extensions of the basic factor model and the implications of implied correlation between national data.

Besides bringing in advanced factor model and dynamic factor model techniques, one could enrich the model by incorporating different types of integration into the model. For instance, the current exercise focuses on trade integration, the same framework could be employed to analyze the general degree of financial integration using, say, the commonly available data on bilateral financial integration. Then, a composite factor model comprising both trade and financial integration could be constructed to examine common factors that drive these two types of integration. Such an exercise will be left for future research.

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11. We thank the participants of the First Workshop of the Asian Research Network for Financial Markets and Institutions organized by the BIS and the HKIMR (2008), Valérie Mignon (the Managing Editor), and two anonymous referees for their constructive comments and suggestions on previous versions of the paper. The views expressed in this paper are those of the authors, and do not necessarily reflect those of the Hong Kong Monetary Authority, the Hong Kong Institute for Monetary Research, its Council of Advisors, or the Board of Directors.

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