

A Factor Analysis of Trade Integration: The Case of Asian and Oceanic Economies*

Yin-Wong Cheung
University of California, Santa Cruz

Matthew S. Yiu
Hong Kong Monetary Authority

Kenneth K. Chow
Hong Kong Institute for Monetary Research

ABSTRACT

We study trade integration among 15 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 15 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: F15, F36, F42

Key words: Factor Model, Principal Component, Growth, Trade Barriers, ASEAN

* 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.

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 have devoted considerable effort to promote regional trade. Indeed, soon after the crisis, the intra-Asia trade activity has 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 world was quite phenomenal. At the same time, the intra-regional trade has increased at a rapid pace. According to Asian Development Bank (2006), intra-regional trade in developing Asia was about 40% of total exports in 2004, up from just 22% 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, say 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.

At least there are two approaches 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 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 15 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

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

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 – F_t is a common component of $X_{ij,t}$'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 could 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 could assess its economic content by examining its association with the possible economic determinants (see Section 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. Sub-section 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, there is an intense interest in assessing the integration of Asian economies. 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.¹ 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.²

3.1 Data

The sample period is January 1999 to December 2007. We consider data from 15 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 major trading economies in the region. Australia and New Zealand are included because they trade quite intensively with these Asian economies during the sample period. For instance, the other 13 economies in the sample accounted for 45.26% of Australia's and New Zealand's exports and imports in 1999 and 54.98% in 2007.³ The data used in the following subsections are from the *International Financial Statistics*, *Directions of Trade*, *World Development Indicator*, and the CEIC Database. For these economies, the within group trade was 53.20% of their total exports in 2007, up from just 47.11% in 1999.

¹ 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 (2007).

² See, for example, Asian Development Bank (2006), Hedi and Fouquin (2006), and Rajan and Sen (2005).

³ On exports, Australia and New Zealand sent 49.72% of their total exports in 1999 and 58.65% in 2007 to these 13 economies.

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.⁴ 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

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

where $Ex_{m,t}$ 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 2001.⁵ 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% of the total variation while the five largest ones explain 67%. 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 15 economies is driving by one common factor. Further, the results of

⁴ An alternative version is given by the ratio of imports to GDP; see, for example, Lane (1997) and Romer (1973).

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

applying the Bai and Ng (2002) method corroborate the inference of the presence of one common factor.⁶ Thus, in subsequent analyses, the first principal component is taken as the estimate of the common trade integration factor.

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

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

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% while Macao has the lowest average proportion of 17.81%. 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% 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% 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% (Japan-Thailand), have a mean of 49.25%, and a standard error of 33.84%. Thus, it is important to allow the coefficient γ_{ij} to be economy-specific.

3.3 *The Statistical Properties*

Figure 2 graphs the estimated common trade integration factor \hat{F}_t . It is apparently that \hat{F}_t exhibits a seasonality pattern. Further, there may be a structural break during the year of

⁶ All the 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.

2001. These features are comparable to those observed from the individual bilateral trade integration series in Figure 1. To shed some insights on the statistical properties of the common trade integration factor, we study the estimated common factor using the model

$$\hat{F}_t = D_t + u_t, \quad (4)$$

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 occurred in July 2001. The stochastic component is assumed to follow a standard autoregressive-moving-average (ARMA) specification.⁷

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 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% of its variability.

3.4 Economic Determinants

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

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

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

⁷ The null hypothesis of u_t follows an I(1) process was rejected at the 5% level by the augmented Dickey-fuller test.

output effect, we considered the industrial production indexes of the 15 economies in the sample, the European Union (EU), and the US. Straightly speaking, 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 degree of freedom, the largest principal component of the monthly industrial production indexes of the 15 economies, IP_{15} , is used as the proxy for their common output factor. Indeed, the largest principal component accounts for 70% of the variations in these 15 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 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).

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 15 economies, IP_{15} , exerts a larger impact than the US variable. Thus, besides the deterministic components, trade between these 15 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 15 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 14 economies. Specifically, the largest principal component of the 14 monthly ratios of import duties to total imports is used to gauge the general degree of trade barriers of these economies.⁸

The effects of trade barriers on the estimated common factor that drives the trade integration between the 15 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.

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 15 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, the US output, and the common output factor of the 15 economies. It was found that the correlation coefficient between the common import duties factor and the US output is -0.61 and the one between the common import duties factor and the common output factor of the 15 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.

⁸ The largest principal component accounts for more than one half (54.5%) 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.

Another possible catalyst for the flourishing intra-regional trade is the foreign direct investment (FDI). To investigate the FDI effect, we consider 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.

3.5 *Local Driving Force*

As stated in Section (2), the 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

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

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 ASEAN trade agreement on the degree of trade integration.⁹

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 $Q_{ij,t}$ ’s. Thus, the estimates of $Q_{ij,t}$ ’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.

⁹ For instance, the ASEAN Free Trade Area agreement was signed on 28 January 1992 – see, for example, <http://www.aseansec.org/12375.htm>.

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.

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.

5. Concluding Remarks

Instead of examining trade integration in a bilateral setting, a factor framework is employed to investigate trade integration between 15 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.

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 mean 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 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 comovement.

It is asserted that trade and FDI have played an important role in the development of Asia and they interact in such a way as to be mutually promoting. However, the preliminary results in this study show no statistical evidence between them. The negative result may be attributed to data deficiencies – we used aggregate FDI data in our analysis because of the paucity of bilateral FDI data. The FDI effect may be different if bilateral FDI and sector-specific FDI data were available.

Admittedly, the factor framework adopted in our exercise is quite standard. As mentioned in the text, the basic framework could be extended in various directions. Besides bringing in advanced factor model and dynamic factor model techniques, one could enrich the model by incorporating different types of integration in 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.

References

- Ando, Mitsuyo (2006), "Fragmentation and Vertical Intra-industry Trade in East Asia," *North American Journal of Economics and Finance*, 17:257-81.
- Asian Development Bank (2005), *Asian Economic Cooperation and Integration: Progress, Prospects, and Challenges*, Manila: Asian Development Bank.
- Asian Development Bank (2006), *Asian Development Outlook 2006*, Manila: Asian Development Bank.
- Asian Development Bank (2007), *Asian Development Outlook 2007*, Manila: Asian Development Bank.
- Bai, Jushan and Serena Ng (2002), "Determining the Number of Factors in Approximate Factor Models," *Econometrica*, 70: 191-221.
- Bchir, Hedi and Michel Fouquin (2006), "Economic Integration in Asia: Bilateral Free Trade Agreements Versus Asian Single Market," CEPII Research Center Working Papers 2006-15.
- Breitung, Jörg and Sandra Eickmeier (2005), "Dynamic Factor Models," Deutsche Bundesbank Discussion Paper Series 1: Economic Studies, No.38/2005.
- Chamberlain, Gary and Michael Rothschild (1983), "Arbitrage Factor Structure, and Mean-Variance Analysis of Large Asset Markets," *Econometrica*, 51: 1305-24.
- Cheung, Yin-Wong, Menzie Chinn and Eiji Fujii (2007), *The Economic Integration of Greater China: Real and Financial Linkages and the Prospects for Currency Union*, Hong Kong University Press.
- Cheung, Yin-Wong and Jude Yuen (2005), "The Suitability of a Greater China Currency Union," *Pacific Economic Review*, 10: 83-103.
- Cowen, David, Ranil Salgado, Hemant Shah, Leslie Teo and Alessandro Zanello (2006), "Financial Integration in Asia: Recent Developments and Next Steps," IMF Working Paper No. 06/196.
- Eichengreen, Barry, Yeongseop Rhee and Hui Tong (2004), "The Impact of China on the Exports of Other Asian Countries," NBER Working Paper No.10768, Cambridge MA: National Bureau of Economic Research.

- Eickmeier, Sandra and Christina Ziegler (2006), “How Good are Dynamic Factor Models at Forecasting Output and Inflation? A Meta-Analytic Approach,” Deutsche Bundesbank Discussion Paper Series 1: Economic Studies, No.42/2006.
- Forni, Mario and Lucrezia Reichlin (1998), “Lets Get Real: a Dynamic Factor Analytical Approach to Disaggregated Business Cycle,” *The Review of Economic Studies*, 65: 453–74.
- Forni, Mario, Marc Hallin, Marco Lippi and Lucrezia Reichlin (2000), “The Generalized Dynamic-Factor Model: Identification and Estimation,” *The Review of Economics and Statistics*, 82: 540-54.
- Gaulier, Guillaume, Françoise Lemoine and Deniz Ünal-Kesenci (2005), “China’s Integration in East Asia: Production Sharing, FDI & High-Tech Trade,” CEPII Working Paper No.2005-09.
- Giannone, Domenico, Lucrezia Reichlin and David Small (2005), “Nowcasting GDP and Inflation: the Real Time Information Content of Macroeconomic Data Release,” Finance and Economic Discussion Series, 2005-42, Board of Governors of the Federal Reserve System (U.S.).
- International Monetary Fund (1998), “Trade Liberalization in Fund-Supported Programs,” World Economic and Financial Surveys, Washington, DC: International Monetary Fund.
- International Monetary Fund (2002), *World Economic Outlook: Trade and Finance*, Washington, DC: International Monetary Fund.
- Kawai, Masahiro (2005), “East Asian Economic Regionalism: Progress and Challenges,” *Journal of Asian Economics*, 16:29-55.
- Kim, Soyung and Jong-Wha Lee (2008), “Real and Financial Integration in East Asia,” The ADB Working Paper Series on Regional Economic Integration No.17.
- Kimura, Fukunari (2007), “The Mechanics of Production Networks in Southeast Asia: the Fragmentation Theory Approach,” CEI Working Paper Series, No. 2007-8, Institute of Economic Research, Hitotsubashi University.

- Kimura, Fukunari and Mitsuyo Ando (2005), "The Economic Analysis of International Production/Distribution Networks in East Asia and Latin America: the Implication of Regional Trade Arrangements," *Business and Politics*, 7(1):1-36.
- Lane, Philip R. (1997), "Inflation in Open Economies," *Journal of International Economics*, 42(3-4): 327-47.
- Rajan, Ramkishan S. and Rahul Sen (2005), "The New Wave of Free Trade Agreements in Asia: With Particular Reference to ASEAN, China and India," in the Asian Development Bank volume on *Asian Economic Cooperation and Integration: Progress, Prospects and Challenges*, Manila: Asian Development Bank: 123-60.
- Romer, David (1993), "Openness and Inflation: Theory and Evidence," *The Quarterly Journal of Economics*, 108(4): 869-903.
- Sakakibara, Eisuke and Sharon Yamakawa (2003a), "Regional Integration in East Asia: Challenges and Opportunities, Part I: History and Institutions," World Bank Policy Research Working Paper Series No.3078.
- Sakakibara, Eisuke and Sharon Yamakawa (2003b), "Regional Integration in East Asia: Challenges and Opportunities, Part II: Trade Finance and Integration," World Bank Policy Research Working Paper Series No.3079.
- Stock, James and Mark Watson (1989), "New Indexes of Coincident and Leading Economic Indicators," NBER Macroeconomic Annual: 351-93.
- Stock, James and Mark Watson (2002a), "Forecasting Using Principal Components from a Large Number of Predictors," *Journal of the American Statistical Association*, 97: 1167-79.
- Stock, James and Mark Watson (2002b), "Macroeconomic Forecasting Using Diffusion Indexes," *Journal of Business & Economic Statistics*, 20: 147-62.
- Yu, Ip-Wing, Laurence Fung and Chi-Sang Tam (2007), "Assessing Bond Market Integration in Asia," HKMA Working Papers, No.10/2007, Hong Kong Monetary Authority.

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 |

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

Table 2. The Proportions of Bilateral Trade Integration Explained by the Estimated Common Factor, 1999M1 to 2007M12

| | 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 |

Notes: 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.

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 Jan | 0.12 (0.80) | 0.12 (0.81) |
| Dummy for Feb | -1.34 (0.01) | -1.33 (0.01) |
| Dummy for Mar | 4.75 (0.00) | 4.76 (0.00) |
| Dummy for Apr | 2.09 (0.00) | 2.11 (0.00) |
| Dummy for May | 2.60 (0.00) | 2.63 (0.00) |
| Dummy for Jun | 2.68 (0.00) | 2.72 (0.00) |
| Dummy for Jul | 2.47 (0.00) | 2.47 (0.00) |
| Dummy for Aug | 2.42 (0.00) | 2.42 (0.00) |
| Dummy for Sept | 3.37 (0.00) | 3.37 (0.00) |
| Dummy for Oct | 0.52 (0.27) | 0.53 (0.23) |
| Dummy for Nov | -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 |

Notes: 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.

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 |

Notes: 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.

Table 5. Effects of Trade Barriers and Output Growth

| | Model 1 | Model 2 | Model 3 | Model 4 |
|-------------------------|--------------|--------------|---------------|--------------|
| <i>MD</i> | -1.34 (0.00) | -1.11 (0.00) | -1.34 (0.00) | -1.18 (0.00) |
| <i>IP</i> ₁₅ | | 1.41 (0.00) | | 1.41 (0.00) |
| <i>IP</i> _{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 |

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

Table 6. The Five ASEAN Economies

| | Singapore vs Malaysia | Singapore vs Thailand | Singapore vs Indonesia | Singapore vs Philippines | Malaysia vs Thailand | Malaysia vs Indonesia | Malaysia vs Philippines | Thailand vs Indonesia | Thailand vs Philippines | Indonesia vs Philippines |
|---------------------------|-----------------------------|-----------------------------|------------------------------|--------------------------------|----------------------------|-----------------------------|-------------------------------|-----------------------------|----------------------------|--------------------------------|
| Panel A: | | | | | | | | | | |
| Constant | 20.22 (0.00) | 5.37 (0.00) | 5.44 (0.00) | 3.43 (0.00) | 3.42 (0.00) | 1.45 (0.00) | 1.76 (0.00) | 1.02 (0.00) | 1.18 (0.00) | 0.38 (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) | 0.03 (0.00) | 0.002 (0.70) | 0.03 (0.00) | 0.01 (0.04) | -0.002 (0.29) |
| <i>Adj.R</i> ² | -0.003 | 0.23 | 0.81 | 0.01 | 0.78 | 0.64 | -0.01 | 0.64 | 0.10 | 0.02 |
| Panel B: | | | | | | | | | | |
| Constant | 20.22 (0.00) | 5.37 (0.00) | 5.44 (0.00) | 3.43 (0.00) | 3.42 (0.00) | 1.45 (0.00) | 1.76 (0.00) | 1.02 (0.00) | 1.18 (0.00) | 0.38 (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) | 0.03 (0.00) | 0.002 (0.62) | 0.03 (0.00) | 0.01 (0.02) | -0.002 (0.14) |
| $Q_{ij,t}$ | 1.25 (0.00) | 0.33 (0.00) | 0.28 (0.01) | 0.10 (0.22) | 0.22 (0.00) | 0.07 (0.00) | 0.11 (0.00) | 0.08 (0.00) | 0.08 (0.00) | 0.05 (0.00) |
| <i>Adj.R</i> ² | 0.40 | 0.62 | 0.83 | 0.05 | 0.87 | 0.72 | 0.15 | 0.73 | 0.25 | 0.34 |

Notes: 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.

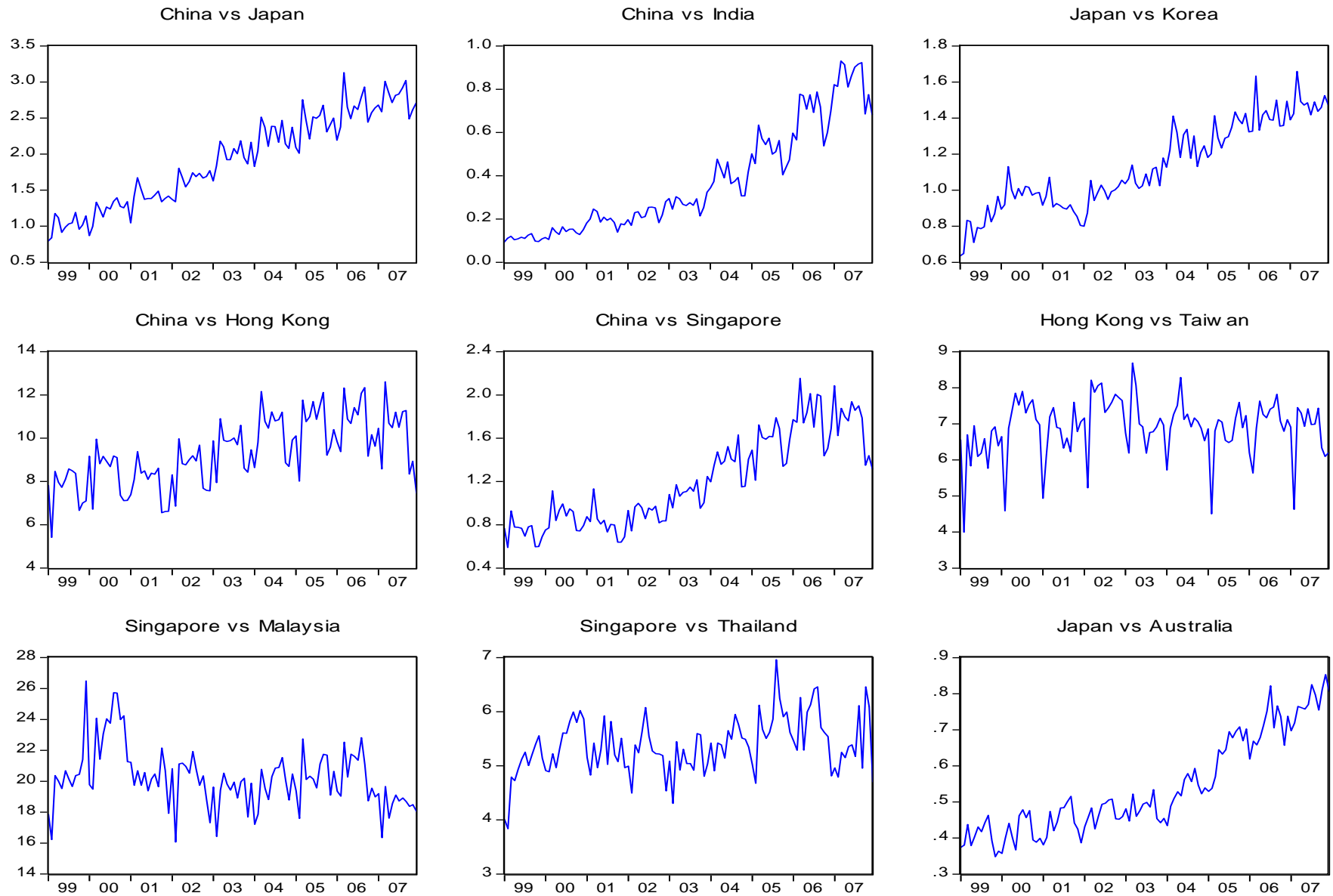


Figure 1. Selected Trade Integration Series

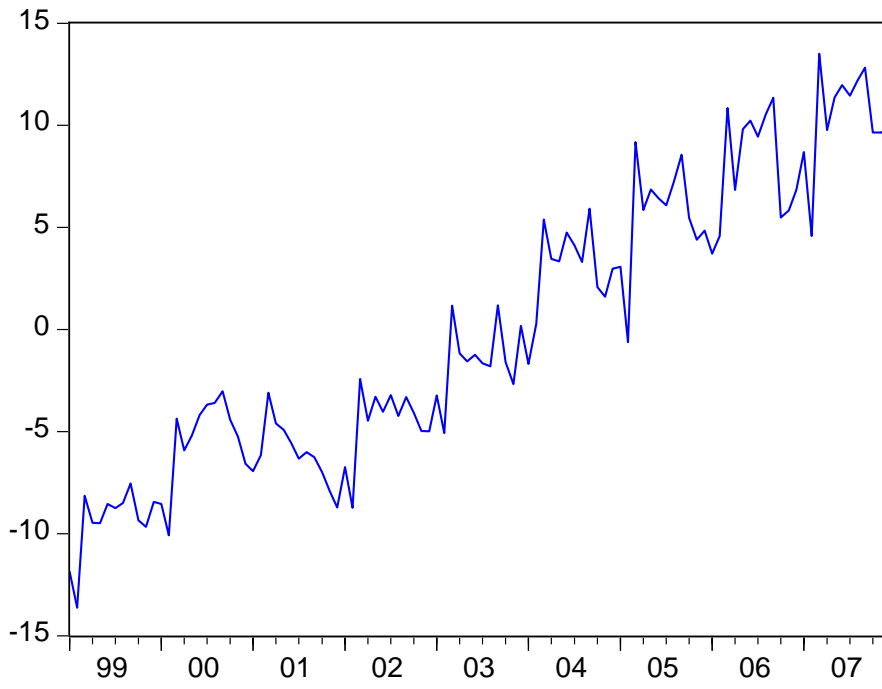


Figure 2. The Estimated Common Trade Integration Factor, \hat{F}_t