Convergence Test of Money Market Rates in East Asia

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ABSTRACT:

Increasing economic integration in East Asia over the last two decades has been evidenced by consistent growth in intra-regional trade and investment. The purpose of this paper is to examine whether financial integration in addition to economic integration has occurring in East Asia and if so, what the extent of financial integration is. Greater economic integration in the region, accompanied by financial deregulation and liberalization, has contributed to greater financial integration. This study confirms increasing degree of financial market integration in East Asia by comparing movements of monthly money market rates before and after the Asian financial crisis of 1997-98.

Convergence of interest rates across the countries in East Asia is examined by analyzing deviations, correlation coefficients and multivariate co-integration tests of interest rates for the sample period of 1990-2004. Multivariate co-integration test for the pre-crisis period indicates the existence of at least two stochastic trends, implying lower degree of financial integration. On the other hand, multivariate co-integration test for the post-crisis period indicates the existence of one common stochastic trend. This result indicates convergence of interest rates among the countries with non-stationary interest rate series and implies a higher degree of money market integration in the post-crisis period than in the pre-crisis period.

INTRODUCTION

East Asia has emerged as the most dynamic and successful region in the world, and its economic growth rates have seldom been surpassed by any other region in the world. The so-called "Asian economic miracle" has been largely attributed to export-led economic expansion in the region. The Asian economic miracle, which was started by Japan and then followed by the Newly Industrialized Economies (NIEs), namely, South Korea, Taiwan, Hong Kong, and Singapore, which have led the decades of spectacular economic growth, is now pursued by the ASEAN (Association of Southeast Asian Nations) countries, particularly Indonesia, Malaysia, Thailand, and the Philippines. This pattern of East Asian development has been thus commonly referred to as a "flying geese pattern." East Asia includes both Northeast Asia and Southeast Asia. Geographically, Northeast Asia covers Japan, South Korea, North Korea, Mongolia, China, Taiwan, and Hong Kong. In this study of economic and financial integration in East Asia, four countries are included: China, Japan, South Korea, and Taiwan, with Hong Kong as a separate entity. Southeast Asia is generally represented by ten member nations of the ASEAN, but only five major countries of importance are included in this study. They are Indonesia, Malaysia, the Philippines, Singapore and Thailand.

The 1990s witnessed a resurgence of regionalism as evidenced by the formation or reinforcement of two major trade blocs, the European Union (EU) and the North American market. Regionalism can be traced back to the 1950s when the European Economic Community (EEC) was initially formed in 1957 by the treaties of Rome. Although the creation of the EEC prompted subsequent formation of regional economic

integration in other regions of the world, only the EEC has grown as the most successful model of economic integration. In 1992, the EEC was transformed into the EU, a single market in Europe, according to the Single European Act of 1987, and it has further deepened its integration with the formation of the Economic Monetary Union (EMU) in 1999 and circulation of a common currency, the euro, in 2002 according to the Maastricht Agreement of 1991.

The year 1993 also witnessed the creation of another powerful regional trade bloc by the ratification of NAFTA which is an expanded version of the Canada-U.S. Free Trade Agreement to include Mexico. If these two major trade blocs move toward closed regionalism, the rest of world, particularly East Asian countries, with no arrangement of economic integration whatsoever and with heavy dependency of their trade on the U.S. and the EU, would be affected the most. The provision of NAFTA that is most susceptible to abuse is the domestic content rules known as rules of origin (usually over 50% in manufacturing and eventually 62.5% in the case of automobiles).

Both blocs insist that their arrangements complement the objectives of a multilateral trading system based on the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO) by promoting trade liberalization and strengthening the scope of international trade rules. In this regard, Schott (1993) described NAFTA as a "GATT-plus" accord that presages new and expanding multilateral trade negotiation. However, when such regional integration creates trade diversion and investment diversion, welfare of both member countries and non-member countries would be adversely affected. The U.S. Super 301 Clause, the most powerful

antidumping mechanism in the world, has been intact in the Uruguay Round negotiations and in more recent negotiations of the WTO.

Facing challenges from the creation of two major trading blocs and the presence of protectionist provisions in the WTO system, many scholars and government officials in East Asian economies have expressed their interest in closed regionalism and have realized the need to study the possibility of pursuing regional integration. However, until now, no concrete steps have been taken to create a regional trade bloc in East Asia. Instead, East Asia exhibits a unique and dynamic pattern of economic integration that is quite different from the closed regionalism of North America and Western Europe. This takes a form of open and non-preferential regionalism, an economic integration process driven by market forces and spearheaded by businesses in the region.

Economic integration in a narrow sense is perceived as closed and preferential regionalism exemplified by the creation of trade blocs like NAFTA or the EU. However, economic integration in a broad sense can be viewed as increasing economic activities such as trade and foreign direct investment in a geographic region and reducing the importance of national boundary in the economic arena. The increasing degree of economic integration in the region can be seen from trade and investment patterns of the region. Increase in trade of East Asian economies is also accompanied by a change in trade direction. The importance of the U.S. and the EU as East Asia's export markets and import sources has declined, and intra-region trade in East Asia has increased rapidly.

In 1980, East Asia's intraregional exports and imports were 31.2 percent and 30.7 percent of its total exports and imports, respectively. These intraregional trade figures

have gradually increased over the past two decades and reached 48.4 percent of total exports and 56.4 percent of total imports in 2004. During the same time period, exports to the EU and the USA have levelled off at 15 percent and 23 percent respectively, and imports from the USA have declined from 18.1 percent at their peak in 1990 to 13.2 percent in 2004. The trend toward increasing intraregional trade can also be seen from data on individual countries, which is not shown in this paper. All the countries in East Asia except for China show a steady decrease in their share of total exports going to and imports coming from the USA and a steady increase in their share of total exports going to and imports coming from within the region.

The growth of intraregional trade in East Asia has been largely attributable to the increased intra-industry trade among East Asian economies arising from foreign direct investment (FDI) flows that have taken place in the region. Without any free trade area or common market arrangements covering all the countries in the region, the amount of FDI flows in East Asia has grown more than twelve times from $5.6 billion 1980 to $69.9 billion in 1995, and East Asia has more than doubled its share of the world total FDI flows from 10.25 percent in 1980 to 21.15 percent in 1995. However, the Asian financial crisis of 1997-98 has slowed downed the FDI flows into the region, and its share in 2004 was at 13.85 percent.

Noteworthy in FDI flows into the region is a change in the sources of FDI. The FDI flows into the region that had been dominated by US firms until 1980 were initially replaced by Japanese firms during the 1980s, and then followed by the NIEs, that is, Singapore, Hong Kong, South Korea, and Taiwan during the 1990s. More recently

China has emerged not only as the largest recipient of the FDI flows, but also as one of the major investors in the region too. The FDI flows from Japan and the NIEs into the ASEAN countries prior to the Asian financial crisis ranged from a minimum of 41 percent of total FDI flows into the Philippines up to 66 percent of total FDI flows into Thailand.

We have observed increasing economic integration in the area of trade and investment in East Asia. Financial deregulation and liberalization in the region have also allowed free movement of financial capital. Greater economic integration, accompanied by financial deregulation and liberalization, may lead to greater financial integration in the region. In this paper, we will analyze the scope and patterns of financial integration occurring in East Asia and evaluate the degree of financial integration by co-integration tests of interest rates. In the next section, literature relevant to financial integration will be reviewed. In section three, descriptive statistics on the money market rates in East Asia, which can be a measure of financial integration, will be presented. In section four, tests of financial integration in East Asia by a multivariate co-integration model will be analyzed. Finally, conclusions will follow.

REVIEW OF LITERATURE

There are three most commonly used measures of financial integration besides a simple observation of changes in capital flows across countries. They are interest rate parity conditions, inter-country saving-investment correlations, and inter-country consumption correlations. First, in the analysis of saving-investment correlations, Feldstein and Horioka (1980) were the first to propose a test for capital mobility based on

saving-investment correlations. If the capital is perfectly mobile among countries, then domestic investment is not necessarily related to domestic savings. Feldstein and Horioka (1980) regressed investment on savings with data from OECD countries for the period of 1960-1974 and concluded low capital mobility because of high correlation coefficients (about .9). This analysis has been applied by others for different countries and time periods. However, this analysis has been under criticism because of its strict assumptions of both exogeneity of real interest rates and real interest parity, which do not usually hold. Furthermore, Montiel (1993) demonstrated that savings and investment may be correlated even though capital is perfectly mobile. Obstfeld (1994) also showed that investment and savings are both sensitive to business cycle movements and shocks in productivity and world real interest rate. According to Obstfeld (1994), saving-investment correlation coefficients for OECD have declined from the 1970s to the 1980s. A similar result was obtained by Montiel (1993) for 17 Pacific Basin countries. More recently Rensselaer and Copeland (2000) applied a similar analysis to the 15 Latin American countries.

Second, in the analysis of consumption correlations, Obstfeld (1986, 1994) proposed a test for capital mobility based on consumption correlations. The hypothesis is that if capital markets are integrated, then countries can trade internationally in financial assets to eliminate domestic consumption shocks and make their consumption over time smooth. Using the data of Summers and Heston (1991) for the period of 1951-1988, Obstfeld (1994) found that consumption correlations were higher for developed than developing countries and that they were higher in the later period than

earlier period. Montiel (1993) applied a similar test to developing countries and found relatively high capital mobility in the majority of East Asian countries, including Korea, Singapore, Thailand, Malaysia and the Philippines. More recently, Allitt and Moosa (1998) found imperfect capital mobility from some APEC countries and concluded that consumption patterns do not make a good criterion for measuring capital mobility.

Third, financial integration can be measured by the equalization of the rates of return on similar financial assets because, the more open and integrated markets among individual economies become, the less different should the rates of return be. Elimination of barriers to capital flows and technological advances in financial transactions over the last few decades have dramatically increased integration of financial markets. This diversification of financial assets across economies tends to reduce the differences among interest rates of individual countries. There have been many studies examining capital market integration or convergence of interest rates using real interest rates (Camarero, et. al., 2002; Moosa and Bhatti, 1995; Phylaktis, 1999; and Yamada, 2002). There is extensive empirical literature on interest rate parity conditions for the OECD countries (Camarero, et. al., 2002; Goodwin and Grennes, 1994; Kleimeier and Sander, 2000; and Yamada, 2002). There are also some studies that focused on East Asia (Chinn and Frankel, 1994; Glick and Moreno, 1994; and Phylaktis, 1999). Studies both on the OECD countries and on East Asia found that the impact of foreign interest rates on domestic rates in the region has increased over time, thus confirming an increasing tendency toward convergence. However, most of the studies have tested the influence of foreign interest rates such as the U.S. rates or the Japanese rates on the

domestic rates in the region, rather than testing convergence of interest rates among the countries within the region.

While many previous studies on interest rate parity conditions were based on differentials in real interest rates, Marston (1995) and Lemmen (1998) questioned the validity of real interest rate differentials as a measurement of financial integration. Lemmen (1998) specifically stated that differentials in real interest rates across countries can not be comparable because they are denominated in their own national currency. Consequently they do not offer profit opportunities for individual investors or borrowers because no single agent compares real interest rates across countries. Furthermore, he showed that the real interest rate parity requires very restrictive conditions such as zero exchange rate risk premium, zero country premium as measured by the validity of the covered interest parity, and zero deviation from the ex ante relative purchasing power parity. There has been ample empirical evidence that reveals persistent deviations from the purchasing power parity. Therefore, using real interest rates in East Asia as an indicator of financial integration may lead to a rejection of financial market integration because of incomplete economic integration in the region.

This study is differentiated from previous studies on financial integration in East Asia in two respects. First, the previous studies on East Asia focused on the real interest parity conditions, which are too restrictive and potentially misleading. Instead, this study tests convergence of nominal interest rates in East Asia as an indicator of financial integration in the region. Second, this study focuses on co-movement of nominal interest rates within the region by using a multivariate co-integration test, while most of

the previous studies dealt with the influence of a dominant foreign interest rate (e.g. the U.S. rates) on the domestic interest rate using a bivariate co-integration test. The bivariate co-integration test treats the foreign interest rate as exogenous. On the other hand, all interest rates are endogenous in the multivariate co-integration test.

DESCRIPTIVE STATISTICS AND CORRELATION ANALYSIS

The variable chosen to analyze the degree of financial market integration in East Asia is the nominal monthly money market rate for ten East Asian countries for the period from January 1990 to December 2004. No earlier period was used because many East Asian countries still had considerable financial regulation during the 1980s. For example, Taiwan and South Korea liberalized their interest rates in 1989. However, it may not be appropriate to analyze the entire period as a whole because the sample period is not homogeneous. The Asian financial crisis occurred in 1997, starting from Thailand in July 1997, spreading to neighbouring countries, and eventually affecting South Korea in December 1997. Most of the East Asian economies suffered from the Asian financial crisis, and at the same time, it was a wakeup call to the region. Exodus of foreign capital, chaos in financial markets, and unusually high interest rates continued to affect the countries in the region at least until June 1998. In response to the crisis and also under pressure from the International Monetary Fund (IMF), many countries in the region underwent major financial reforms that resulted in a drastic change in their financial systems from the pre-crisis period to the post-crisis period. Therefore, we perform analyses for two separate periods, the pre-crisis period and the post-crisis period.

Table 1 presents descriptive statistics on the monthly money market rates for both

the pre-crisis period (from January 1990 to July 1997) and the post-crisis period (from January 1999 to December 2004). Monthly money market rates are from the International Financial Statistics published by the IMF except for Taiwan where the data is taken from the Monthly Statistics of the Republic of China. Whenever the money market rate is not available, alternative rates are used: bank rate for China, call money rate for Indonesia, and inter-bank rate for Singapore.

During the pre-crisis period, the average money market rates ranged from a minimum in Singapore of 3.665 percent to a maximum in the Philippines of 14.07 percent. During the post-crisis period, the average money market rates ranged from a low of .086 percent in Japan to a high of 20.95 percent in Indonesia. The high average rate in Indonesia is because Indonesia had not yet recovered from the crisis until the end of 1998, with a money market rate as high as 81 percent in August 1998. Comparing the pre- and post-crisis period money market rates exposes a difference in the trend and stability of interest rates. All the nations except for Indonesia experienced decreasing interest rates, and all the nations except for Indonesia and Hong Kong experienced less volatile movements of interest rates evidenced by much smaller standard deviations. The average money market rate was 8.46 percent in the pre-crisis period and 3.94 percent in the post-crisis period, while the average standard deviation of the money market rates was 2.26 in the pre-crisis period and 1.48 in the post-crisis period. This trend seems to be in line with the overall reduction in interest rates in the world which has occurred in the last few years. The average money market rate of 3.94 percent in the post-crisis period is obtained by excluding Indonesia, which had not recovered from the effects of

the Asian financial crisis until sometime in the post-crisis period. If Indonesia is included in the calculation, the average money market rate increases to 5.64 percent, which is still lower than the average rate in the pre-crisis period.

In order to see the trend of co-movement of money market rates among the ten East Asian countries, correlation analysis is performed. Table 2 shows the estimated Pearson correlation coefficients among the ten countries along with the level of significance of the coefficient, and the number of observations for the pre- and post-crisis periods. The results for the pre-crisis period indicate only 13 significant correlation coefficients out of 45 pair-wise comparisons at the significance level of 1 percent. However, three significant and negative correlation coefficients for China are actually against co-movement, leaving only 10 significant cases as meaningful. Three countries, Japan, Singapore and Thailand, exhibit co-movement of their money market rates with those of at least three other countries in the region. On the other hand, the estimated results for the post-crisis period indicate that the money market rates among the ten countries move together with 45 significant correlation coefficients out of 45 pair-wise comparisons. The correlation coefficients are all positive and they range from a low of .502 to a high of .919. So far, we have observed three indicators of increased financial market integration in the region from the pre-crisis period to the post-crisis period: a reduction in nominal interest rates, less volatility of these rates, and an increase in significant correlation coefficients. In the post-crisis period, money market rates among the ten East Asian countries tend to be closer together and move together. This trend is partly due to globalization and the overall lower level of interest rates in the

world. For whatever reasons there might be, the increasing financial market integration in East Asia is a fact that cannot be denied. Since the Asian financial crisis, we have also observed stabilized exchange rates with less volatility and strong positive correlations in nominal exchange rates among the East Asian currencies that adopted floating exchange rate regimes (data not reported in this paper). This is another indicator of increasing financial integration in East Asia.

CO-INTEGRATION MODEL AND EMPIRICAL RESULTS

We now extend our analysis by performing a co-integration test for money market rates to examine convergence of interest rates across countries. In other words, this study will test the financial market integration hypothesis by performing co-integration tests with the data on monthly money market rates from 10 East Asian countries for the period from January 1990 to December 2004, which is divided into two separate periods, the pre-crisis period and the post-crisis period. Money market rates in individual countries may fluctuate in response to domestic financial conditions and move far apart from one another. However, if financial markets are integrated, efficient arbitrage in international financial markets will prevent money market rates in individual countries from moving far apart. In other words, if money market rates are co-integrated, they cannot wander too far away. Therefore, a co-integration test is a suitable test for convergence of interest rates and financial markets integration. As a prerequisite for co-integration analysis, the unit root test is applied to check whether the money market rate series are stationary or non-stationary. The following regression is used for the unit root test.

$$\Delta r = a + b\, r_{t-1} + \Sigma\, c_i\, \Delta r_{t-1} + T + e_{t,}$$

where r is money market rate, T is a trend variable, and u is white noise. The augmented Dickey-Fuller (ADF) test statistic is the ratio of b to its standard error obtained from the regression. If the value of b is negative and significantly different from zero, then the null hypothesis of a unit root (b = d = 0) or random walks is rejected. The test results on the level series and on the first difference series for both the pre-crisis and post-crisis periods are presented in Table 3. For the pre-crisis period, the null hypothesis of a unit root is rejected in 2 cases out of the 10 level series: Taiwan and the Philippines. The null hypothesis of a unit root is rejected in all of the first difference series at the one percent significance level. For the post-crisis period, the null hypothesis of a unit root is rejected in 5 cases out of the 10 level series at the 5 percent significance level: China, Hong Kong, South Korea, Singapore, and Thailand. The null hypothesis of a unit root is rejected in 8 cases out of the 10 first difference series at the 1 percent significance level, with the exception of South Korea and Thailand. However, the null hypothesis of a unit root can be rejected for even South Korea and Thailand at the 5 percent significance level. Therefore, we conclude that the first difference series of individual countries for both the pre-crisis and post-crisis periods are indeed stationary and that the original interest rate series are integrated of order 1, that is, I(1).

Traditionally, bivariate co-integration tests such as the ADF test recommended by Engle and Granger (1987) are used to examine the convergence of interest rates. For example, if the interest rate series in two different markets are non-stationary, but exhibit a linear combination of them, which is a stationary process, then the two interest rate

series are said to be co-integrated with each other and there is a long-run relationship between the two series. However, the bivariate tests have been under attack recently because of several limitations. Commonly listed limitations include sensitivity of the critical values to sample size and the restrictive requirement that one of the two series is designated as exogenous. To overcome these limitations of the bivariate tests, Stock and Watson (1988) and Johansen (1991) developed a multivariate co-integration testing system for the existence of common trends in a set of non-stationary variables. Since we are interested in examining the presence of a common trend in the interest rates among the East Asian economies, this multivariate test would be more appropriate than the bivariate test to define dimensionality of the common stochastic trend process.

Let X_t be a vector of money market rates of selected countries, r_1 r_2 …. r_n. The following vector autoregressive model can be estimated.

$$\Delta X_t = c + G X_{t-1} + \Sigma H_i \Delta X_{t-i} + \varepsilon_{t,}$$

where c is a constant vector, G and H_i are n x n matrices of parameters, and ε_t is a white noise vector of n x 1. Johansen (1991) developed the trace test statistic of evaluating the null hypothesis that there are at most r co-integration vectors, implying that there are n-r common stochastic trends among the variables. This trace test statistic is given by

$$\tau_{trace} = - T \Sigma \ln (1-\lambda_i),$$

where T is the sample size, and λ_i is the n-r smallest squared canonical correlations of X_{t-1} with respect to ΔX_{t-i}. Each univariate interest rate series may contain a stochastic trend. However, this stochastic trend may be common to other interest rate series. If there are r co-integrating vectors for a set of n interest rates where r = n-1, the nth interest rate can

be expressed in terms of n-1 interest rates. Then the interest rate series contain the same stochastic trend, and the series are said to be co-integrated. Therefore, the number of co-integrating vectors existing in the multivariate co-integration test is a good indicator of the extent of financial integration.

Table 4 presents the results of the Johansen multivariate co-integration test for a group of countries that exhibit non-stationary money market rates. For the pre-crisis period, they are China, Hong Kong, Japan, South Korea, Indonesia, Malaysia, Singapore, and Thailand. For the post-crisis period, they are Japan, Taiwan, Indonesia, Malaysia, and the Philippines. We used the assumption of a linear deterministic trend in the data. For the pre-crisis period, we cannot reject the null hypothesis of $r \leq 6$. The multivariate co-integration test for the pre-crisis period indicates the existence of six co-integrating equations with eight interest rate series. So there are at least two stochastic trends among eight interest rate series instead of one common stochastic trend, implying a lower degree of financial integration. For the post-crisis period, we cannot reject the null hypothesis of $r \leq 4$. The multivariate co-integration test for the post-crisis period indicates the existence of four co-integrating equations with five interest rate series and thus implies that any single money market rate can be a representative of the group of five money market rates. This result indicates convergence of interest rates among countries with non-stationary interest rate series in the post-crisis period and implies a higher degree of financial market integration in the post-crisis period than in the pre-crisis period.

Because the test for co-integration is supposed to be applied only to non-stationary series to see whether a linear combination of them can be a random walk, we

could not apply this test to the countries with stationary interest rate series. While no test for co-integration is applicable for the countries with stationary interest rate series, a comparison of the two groups may be noteworthy. Compared to the countries with non-stationary interest rate series, the countries with stationary interest rate series, particularly in the post-crisis period, exhibit much smaller variations in their average interest rates and standard deviation, which implicitly indicates convergence of their interest rates. Comparing the two periods, there are more countries with stationary interest rate series in the post-crisis period than in the pre-crisis period. Exceptions are Taiwan and the Philippines, which changed from being stationary in the pre-crisis period to non-stationary in the post-crisis period. Because non-stationarity can be caused by many different factors, further examination of economic and financial conditions of these two countries may be necessary.

CONCLUSION

In the previous sections, we have shown that economic integration in East Asia with regards to activities in trade and investment has increased considerably in the last two decades and that financial integration in East Asia has also increased in the last few years to a level that allows for the creation of a formally integrated market. What is the reality? Even though the need for formal regional integration for the East Asian economies has been expressed by many academicians and government officials in the region, there has been no formation of major trade blocs in the region other than the ASEAN and a few bilateral free trade agreements. However, the ASEAN's memberships are geographically constrained to Southeast Asia, and its trade volume is

less than one third of the Japanese trade volume alone, with no significant effects on the world economy. In regard to bilateral free trade agreements, only recently a few countries in the region signed the agreements and are in the process of finalizing their arrangements. Japan – Singapore economic partnership agreement allowing free trade between them has been in effect since November 2002. Singapore has free trade agreements with New Zealand and EFTA (European Free Trade Agreement) nations. There are several bilateral trade agreements being negotiated between South Korea and Japan, between South Korea and Chile, and between Japan and Taiwan to name a few. China also proposed the creation of a free trade area among China, Japan, and South Korea in 2002.

In the wake of the Asian financial crisis, there has been a change in regional integration movement in East Asia. Even though the Asian Monetary Fund, which was proposed by the Japanese finance minister Miyazawa a few years ago, has not yet materialized, an ASEAN plus Three (China, Japan, and South Korea) currency swap agreement was adopted as the Chiang Mai initiative at the summit meeting of the ASEAN plus Three in May 2000. This arrangement could be the first step toward creation of the Asian Monetary Fund. The currency swap arrangement that was proposed as a tool in crisis management can also be used for the coordination of foreign exchange rates among countries, leading to increased regional integration.

There are many obstacles to overcome for the formation of a regional trading bloc or other formal arrangements in East Asia. There is no doubt that this mission is several times harder than the formation of the EU or the ratification of NAFTA. In addition to

cultural differences and historical animosities, there is the problem of no or weak political leadership in the region. An effective trading bloc requires major structural adjustment of the region as a whole, mandating reforms of domestic industrial policy and external trade policy. Many countries would suffer short-run losses from this structural adjustment. Furthermore, the formation of an East Asian trade bloc may have a trade-diverting effect instead of trade-creating because most of the countries in the region have had strong trade linkages with the U.S. historically. However, in the long run, dynamic gains due to economies of scale, increased productivity, and increased investment will more than offset these short-run losses.

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Table 1. Descriptive Statistics

Descriptive Statistics (Jan. 1990 - June 1997)

	N	Minimum	Maximum	Mean	Std. Deviation
CHI	88	7.20	10.44	8.8486	1.26924
HKC	46	3.38	11.50	5.3484	1.24583
JAP	90	.444	8.191	3.52906	2.683370
KOR	90	9.5	19.7	13.464	2.2037
TAI	90	5.09	13.23	7.1219	1.57784
IND	90	5.68	26.90	12.4378	3.23469
MAL	90	4.116	10.100	6.63009	1.180271
PHI	90	7.426	36.210	14.07151	4.494053
SIN	90	1.0	7.7	3.665	1.4969
THA	90	2.367	16.259	9.43558	3.225900

Descriptive Statistics (July 1998 – Dec. 2004)

	N	Minimum	Maximum	Mean	Std. Deviation
CHI	78	2.70	5.22	3.4633	.76542
HKC	78	1.38	17.75	4.7278	2.53049
JAP	78	.002	.427	.08674	.115780
KOR	78	3.99	12.67	5.2019	1.48925
TAI	78	1.52	6.95	4.1344	1.42230
IND	78	8.49	81.01	20.9539	17.70454
MAL	78	2.51	9.21	3.3604	1.55883
PHI	78	6.9	15.9	10.031	2.5262
SIN	78	.75	5.38	2.0980	.99787
THA	78	1.23	11.72	2.4069	1.91939

CHI = Mainland China, HKC = Hong Kong, China, JAP = Japan,
KOR = South Korea, TAI = Taiwan, IND = Indonesia, MAL = Malaysia,
PHI = the Philippines, SIN = Singapore, and THA= Thailand .

Table 2. Correlation Coefficients

Correlations (Jan. 1990 – June 1997**)**

		CHI	HKC	JAP	KOR	TAI	IND	MAL	PHI	SIN	THA
CHI	Pearson Correlation	1	-.216	-.670**	-.554**	-.252*	-.225*	-.677**	-.232*	-.220*	-.123
	Sig. (2-tailed)	.	.150	.000	.000	.018	.035	.000	.029	.039	.253
HKC	Pearson Correlation	-.216	1	.211	.238	-.040	.780**	.306*	.219	.112	.556**
	Sig. (2-tailed)	.150	.	.159	.111	.793	.000	.038	.144	.459	.000
JAP	Pearson Correlation	-.670**	.211	1	.612**	.570**	.252*	.143	.270*	.690**	.284**
	Sig. (2-tailed)	.000	.159	.	.000	.000	.017	.178	.010	.000	.007
KOR	Pearson Correlation	-.554**	.238	.612**	1	.150	.185	.248*	.227*	.403**	.212*
	Sig. (2-tailed)	.000	.111	.000	.	.159	.081	.019	.031	.000	.045
TAI	Pearson Correlation	-.252*	-.040	.570**	.150	1	.034	-.193	-.018	.603**	.215*
	Sig. (2-tailed)	.018	.793	.000	.159	.	.753	.069	.868	.000	.042
IND	Pearson Correlation	-.225*	.780**	.252*	.185	.034	1	.130	-.038	.213*	.525**
	Sig. (2-tailed)	.035	.000	.017	.081	.753	.	.222	.725	.044	.000
MAL	Pearson Correlation	-.677**	.306*	.143	.248*	-.193	.130	1	.168	-.214*	-.042
	Sig. (2-tailed)	.000	.038	.178	.019	.069	.222	.	.112	.043	.696
PHI	Pearson Correlation	-.232*	.219	.270*	.227*	-.018	-.038	.168	1	.009	-.092
	Sig. (2-tailed)	.029	.144	.010	.031	.868	.725	.112	.	.936	.388
SIN	Pearson Correlation	-.220*	.112	.690**	.403**	.603**	.213*	-.214*	.009	1	.492**
	Sig. (2-tailed)	.039	.459	.000	.000	.000	.044	.043	.936	.	.000
THA	Pearson Correlation	-.123	.556**	.284**	.212*	.215*	.525**	-.042	-.092	.492**	1
	Sig. (2-tailed)	.253	.000	.007	.045	.042	.000	.696	.388	.000	.

** Correlation is significant at the 0.01 level (2-tailed).

* Correlation is significant at the 0.05 level (2-tailed).

Table 2 Continued
Correlations (July 1999 – Dec. 2004)

		CHI	HKC	JAP	KOR	TAI	IND	MAL	PHI	SIN	THA
CHI	Pearson Correlation	1	.594**	.655**	.776**	.728**	.907**	.867**	.785**	.611**	.689**
	Sig. (2-tailed)	.	.000	.000	.000	.000	.000	.000	.000	.000	.000
HKC	Pearson Correlation	.594**	1	.652**	.630**	.824**	.527**	.577**	.694**	.779**	.541**
	Sig. (2-tailed)	.000	.	.000	.000	.000	.000	.000	.000	.000	.000
JAP	Pearson Correlation	.655**	.652**	1	.815**	.681**	.678**	.748**	.863**	.707**	.694**
	Sig. (2-tailed)	.000	.000	.	.000	.000	.000	.000	.000	.000	.000
KOR	Pearson Correlation	.776**	.630**	.815**	1	.712**	.834**	.905**	.710**	.821**	.919**
	Sig. (2-tailed)	.000	.000	.000	.	.000	.000	.000	.000	.000	.000
TAI	Pearson Correlation	.728**	.824**	.681**	.712**	1	.549**	.562**	.808**	.852**	.502**
	Sig. (2-tailed)	.000	.000	.000	.000	.	.000	.000	.000	.000	.000
IND	Pearson Correlation	.907**	.527**	.678**	.834**	.549**	1	.962**	.668**	.572**	.845**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.	.000	.000	.000	.000
MAL	Pearson Correlation	.867**	.577**	.748**	.905**	.562**	.962**	1	.687**	.634**	.905**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.	.000	.000	.000
PHI	Pearson Correlation	.785**	.694**	.863**	.710**	.808**	.668**	.687**	1	.709**	.550**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.	.000	.000
SIN	Pearson Correlation	.611**	.779**	.707**	.821**	.852**	.572**	.634**	.709**	1	.737**
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.	.000
THA	Pearson Correlation	.689**	.541**	.694**	.919**	.502**	.845**	.905**	.550**	.737**	1
	Sig. (2-tailed)	.000	.000	.000	.000	.000	.000	.000	.000	.000	.

** Correlation is significant at the 0.01 level (2-tailed).

Table 3. Unit Root Tests for Money Market Rates

Pre-crisis Period (Jan. 1990 – June 1997)

Country	Levels		First Differences	
	lag	ADF statistic	lag	ADF statistic
China	2	-2.032152	2	-4.358656**
Hong Kong	2	-1.756557	2	-4.469104**
Japan	2	-1.545663	1	-4.858091**
S. Korea	2	-3.390949	2	-6.034975**
Taiwan	1	-5.162297**	1	-9.529255**
Indonesia	2	-2.379215	2	-6.097177**
Malaysia	2	-1.436168	1	-8.746820**
Philippines	2	-4.680725**	2	-8.519602**
Singapore	2	-1.676088	2	-5.386017**
Thailand	2	-2.506739	2	-6.716186**

Post-crisis Period (July 1998 – Dec. 2004)

Country	Levels		First Differences	
	lag	ADF statistic	lag	ADF statistic
China	1	-3.787775*	1	-6.319919**
Hong Kong	2	-3.863159*	2	-6.404870**
Japan	1	-3.030101	1	-4.935971**
S. Korea	1	-10.762610**	1	-3.747458*
Taiwan	1	-2.165212	1	-4.782432**
Indonesia	1	-2.165212	1	-6.398614**
Malaysia	1	-1.716078	1	-4.610259**
Philippines	1	-2.506624	1	-5.240516**
Singapore	1	-3.800198*	1	-5.083557**
Thailand	1	-20.889741**	1	-3.532143*

** significant at the 1 percent level.

* significant at the 5 percent level.

Table 4. Multivariate Co-integration Test Results

Pre-crisis Period (Jan. 1990 – June 1997)

Series: China, Hong Kong, Japan, South Korea, Indonesia, Malaysia, Singapore, and Thailand
Lag interval: 1 to 2
Test assumption: linear deterministic trend in the data

Hypothesis	Likelihood Ratio	Eigenvalue	5% Critical Value	1% Critical Value
H: r=0	280.26	.877	156.00	168.36
H: r≤1	196.39	.730	124.24	133.57
H: r≤2	143.96	.711	94.15	103.18
H: r≤3	94.25	.602	68.52	76.07
H: r≤4	57.36	.491	47.21	54.46
H: r≤5	30.28	.394	29.68	35.65
H: r≤6	10.27	.216	15.41	20.04
H: r≤7	.53	.013	3.76	6.65

Likelihood ratio test indicates 6 co-integration equations at 5% significance level.

Post-crisis Period (July 1998 – Dec. 2004)

Series: Japan, Taiwan, Indonesia, Malaysia, and the Philippines
Lag interval: 1 to 2
Test assumption: linear deterministic trend in the data

Hypothesis	Likelihood Ratio	Eigenvalue	5% Critical Value	1% Critical Value
H: r=0	136.35	.616	68.53	76.07
H: r≤1	84.64	.601	47.21	54.46
H: r≤2	39.99	.367	29.68	35.65
H: r≤3	16.23	.247	15.41	20.04
H: r≤4	2.12	.092	3.76	6.65

Likelihood ratio test indicates 4 co-integration equations at 5% significance level.