The Philippine Statistician, 2006
Vol. 55, Nos. 1-2, pp. 105-119

Measuring the Common Component of Stock Market Fluctuations in the Asia-Pacific Region[1]

Dennis S. Mapa and Kristine Joy S. Briones[2]

Received: July, 2006; Revised: August, 2006

ABSTRACT

This paper fits generalized auto-regressive conditional heteroskedasticity (GARCH) models to daily closing stock market indices of Australia, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, and Taiwan to compute for time-varying weights associated with the volatilities of individual indices. These weights and the returns of the various indices are then used to determine the common component of stock market returns. The results suggest that a common component of the Asia-Pacific stock market returns exists, which significantly explains the individual country's stock market returns. It is also established that stock markets of Korea and Hong Kong are the two most sensitive to changes in the common component stock returns, while China's stock market is the least sensitive.

Key Phrases: Common Component, Volatility, GARCH models

I. INTRODUCTION

Financial integration is brought about by increased capital mobility and relatively open accounts (Intal, et al [2001]). Tambi [2005] characterizes such integration as a condition wherein there are no quantitative and qualitative barriers such as tariffs, taxes, and restrictions on trading in foreign assets or information costs across borders. In the last 20 years, financial integration has advanced with increased cross-border capital flows, tighter links among financial markets, and greater commercial presence of foreign countries around the world (Claessens et al [2004]). Numerous methods have been employed to measure such financial integration and Cavoli et al [2004] classify them into three categories. The first category refers to price conditions involving mainly debt flows and is largely embodied in the interest parity conditions. The second category involves quantity based measures such as savings-investment correlations, consumption correlations, current account dynamics, and gross capital flows. The third category is classified as regulatory or institutional factors as well as non-debt flows such as the co-movement of stock market returns and shall be the focus of this paper.

An important element of the integration trend under the third category (regulatory or institutional factors) has been increased stock exchange activities taking place abroad most notably for emerging markets but also for developed countries. As a result, national stock

[1] Paper presented at the 30th Annual Conference of the ASEAN Economic Association held in Manila, Philippines last November 24 to 25, 2006.

[2] First author is an assistant professor and the Director for Research at the School of Statistics, University of the Philippines Diliman and currently a Ph.D. Candidate in Economics at the School of Economics, UP Diliman; csmapa@up.edu.ph. Second author is an M.A. Economics Graduate at the School of Economics, University of the Philippines Diliman; kristine_joy.briones@up.edu.ph

market returns are increasingly influenced by global rather than domestic factors. According to Park and Woo [2002], this is because in a financially integrated market, similar assets display the same risk-adjusted returns.

Garay discusses some explanations why co-movements in the stock market occur. First, he states that co-movements in the stock markets of two countries may take place when financial markets of two countries are highly integrated so that shocks to the larger country are transmitted to the smaller one via asset-trading. The second explanation is the trade partners and bilateral or multilateral trade arrangements that enhance the possibilities of international shocks. The third reason is the role of technological factors on economic growth. Due to these factors, economic growth of a country is affected by the economic growth of its neighbors and vice versa. The fourth explanation is that spillovers or contagious crisis may occur for institutional reasons. Fifth, investors' sentiments can generate self-fulfilling crises if foreign investors do not discriminate among different macroeconomic fundamentals across countries and, finally, contagion may occur because of the way market participants interpret possible co-movement in macroeconomic policies and fundamentals in the economies subject to attack.

In the Asia-Pacific region, increased financial integration was observed beginning in the 1980s (Intal, Pontines, and Mojica [2001]). A number of studies address the issue of stock market integration in Asia-Pacific countries and produce mixed results. The variation in the results could be attributed to the difference in methodology, data, time period, and framework used (Fan [2003]). A group of studies focus on the relationship existing among the Asian stock markets and find that they are integrated (Divecha, Drach, and Stefec [1992] and Corhay, Rad, and Urbain [1995]) while other studies such as DeFusco, Geppert, and Tsetsekos [1996] show that the stock market indices are not cointegrated.

Early studies of Asia-Pacific stock market integration depend on the correlation method. However this method, as identified by Forbes and Rigobon [1998], are subject to limitations. Specifically, heteroscedasticity of the stock market returns produces an upward bias in the correlation of indices (Leong and Felmingham [2001]). As a consequence, correlation analysis can only represent a useful preliminary methodology and is still used in recent studies by Hashmi and Liu [2001], Chai and Rhee [2005].

The cointegration revolution of the early 1990s has provided stronger evidence of the presence of integration among Asia-Pacific stock markets (Kasa [1992], Chung and Liu [1994], Moon [2001]). This was followed by the variance decomposition tests (Hashmi and Liu [2001], Moon [2001], Chai and Rhee [2005]) and other tests based on asset pricing models (Phylaktis and Ravazzolo [2002]). These tests, although already advanced compared to the correlation procedure, still pose limitations. Specifically, cointegration, a method to simultaneously model long-run persistence and comovement, investigates forms of comovement that are only nonstationary (Parker and Parker).[3]

Lumsdaine and Prasad [2003] take into account the limitations of such procedures in introducing a new method of measuring the common component of fluctuations. In trying to measure this common component they argue that, first, a weighing scheme should be able to

[3] Co-movements can also be of the stationary nature which would mean that the common shocks are less persistent than unit roots (Parker and Parker).

distinguish between country-specific and common fluctuations and, second, shocks should be allowed to propagate across countries.

This paper uses the methodology introduced by Lumsdaine and Prasad in investigating the common component of stock market fluctuations among ten Asia-Pacific countries. From this study, the authors establish the following results: First, there exist common Asia-Pacific stock market returns that significantly explain the individual stock market of the Asia-Pacific countries. Second, it is also established that stock markets of Korea and Hong Kong are the most sensitive to changes in the common Asia-Pacific stock returns while China's stock market is the least sensitive.

The paper is structured as follows: the next section reviews and briefly presents the economy of the ten Asia-Pacific countries after the Asian crisis. Sections III and IV explains the process behind the Lumsdaine and Prasad procedure and the analysis of the results from a regression analysis, respectively. Section V concludes by reviewing implications of financial integration in the Asia-Pacific economies and presents the challenges and options for the Philippines to benefit in the integration markets in the Asia-Pacific region.

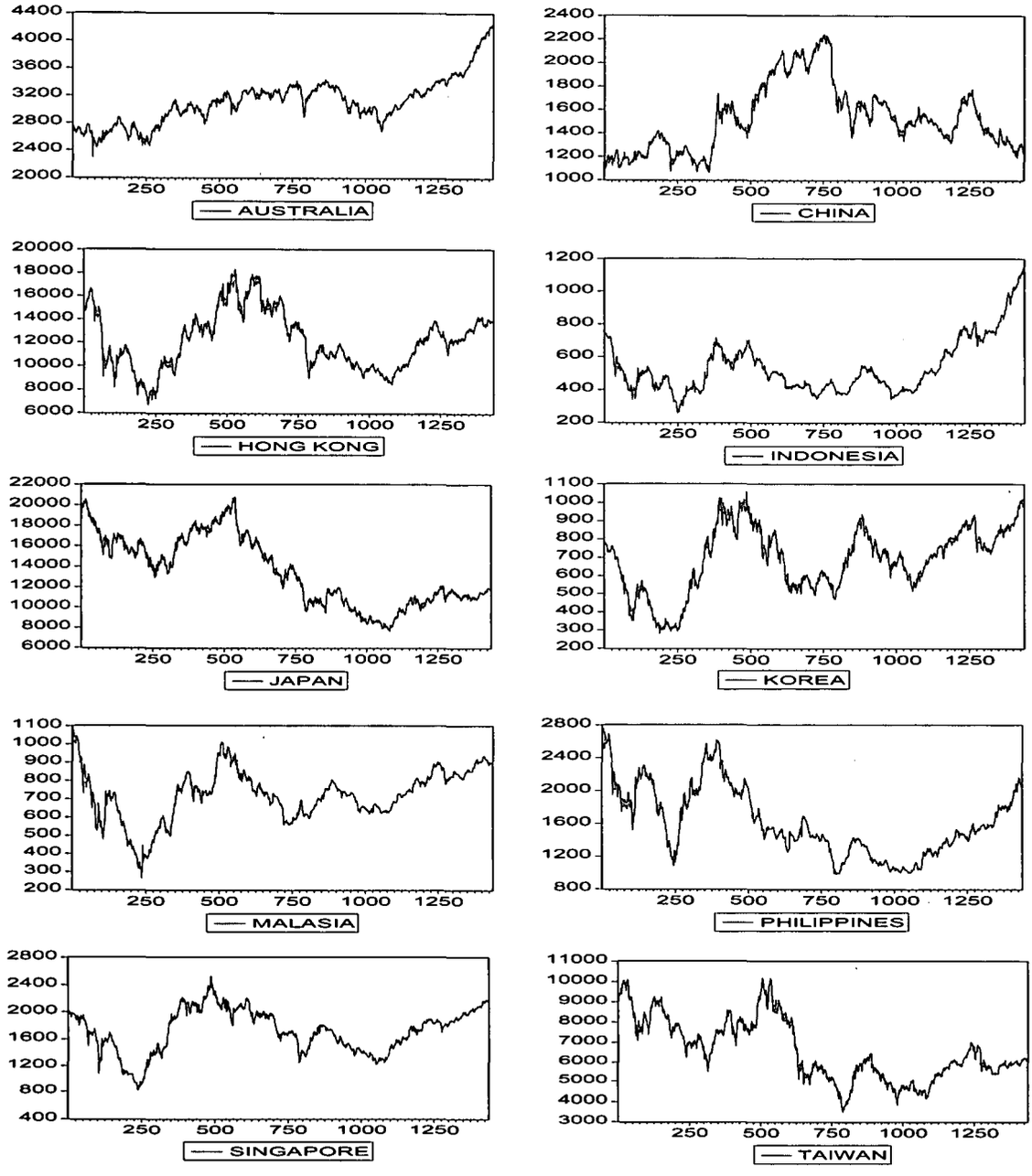
II. THE ASIA-PACIFIC ECONOMY AFTER THE ASIAN FINANCIAL CRISIS

The Asian crisis marked the end of a decade of average growth rates of 7.4 percent for the countries of Korea, Thailand, Malaysia, Taiwan, Singapore, Hong Kong, Indonesia, and the Philippines among others. Between 1985 and 1995, these East Asian countries were commonly referred to as the "miracle economies". These countries first made shoes and garments, but quickly converted to heavy industry and electronics that led to unprecedented growth levels. Beginning in 1996, growth rates weakened, export trade fell, and currencies depreciated as many people lost confidence. Thereby, the beginning of the Asian crisis occurred which resulted in loan intervention by the IMF to help bring an end to the chaos.

In the year 2000, the potential for a second Asian crisis was far from over. The Indonesian rupiah, the Thai baht, and the Philippine peso were all down since the beginning of the year. Jittery investors, low consumer spending, high levels of non-performing loans, and high levels of foreign debt all contributed to this situation. In addition, equity investors were hesitant to invest in these stock markets due to the fear of currency depreciation eroding their stock values.

The daily closing stock market indices of the ten countries are presented in Figure 1. From the graphs, it can be inferred that the countries, excluding Australia and China, experienced a period of downward trending stock market during and after the 1997 Asian financial crisis. This downward trend ended by September 1998 (around the 238th observation in the graph). Most of the countries experienced peaks during the periods of July 1999 (around the 390th observation) and April 2002 (around the 885th observation) and experienced troughs during the periods of September 1998, September 2001 (around the 790th observation), and March 2003 (around the 1,055th observation). China, on the other hand, experienced different periods of peaks and troughs from the rest of the countries. Also, from March 2003 to the present the stock markets of the countries excluding China are on the upward trend.

Figure 1. Daily Closing Stock Market Indices of Each Country
(July 3, 1997 to March 18, 2005)



III. EMPIRICAL APPROACH

Data employed in this study are daily closing stock market indices for Australia, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, Philippines, Singapore, and Taiwan. The study focuses on the possible integration of the Asian-Pacific countries after the 1997 Asian Crisis and sample data covers the period from July 3, 1997 to March 18, 2005 (1435 observations).

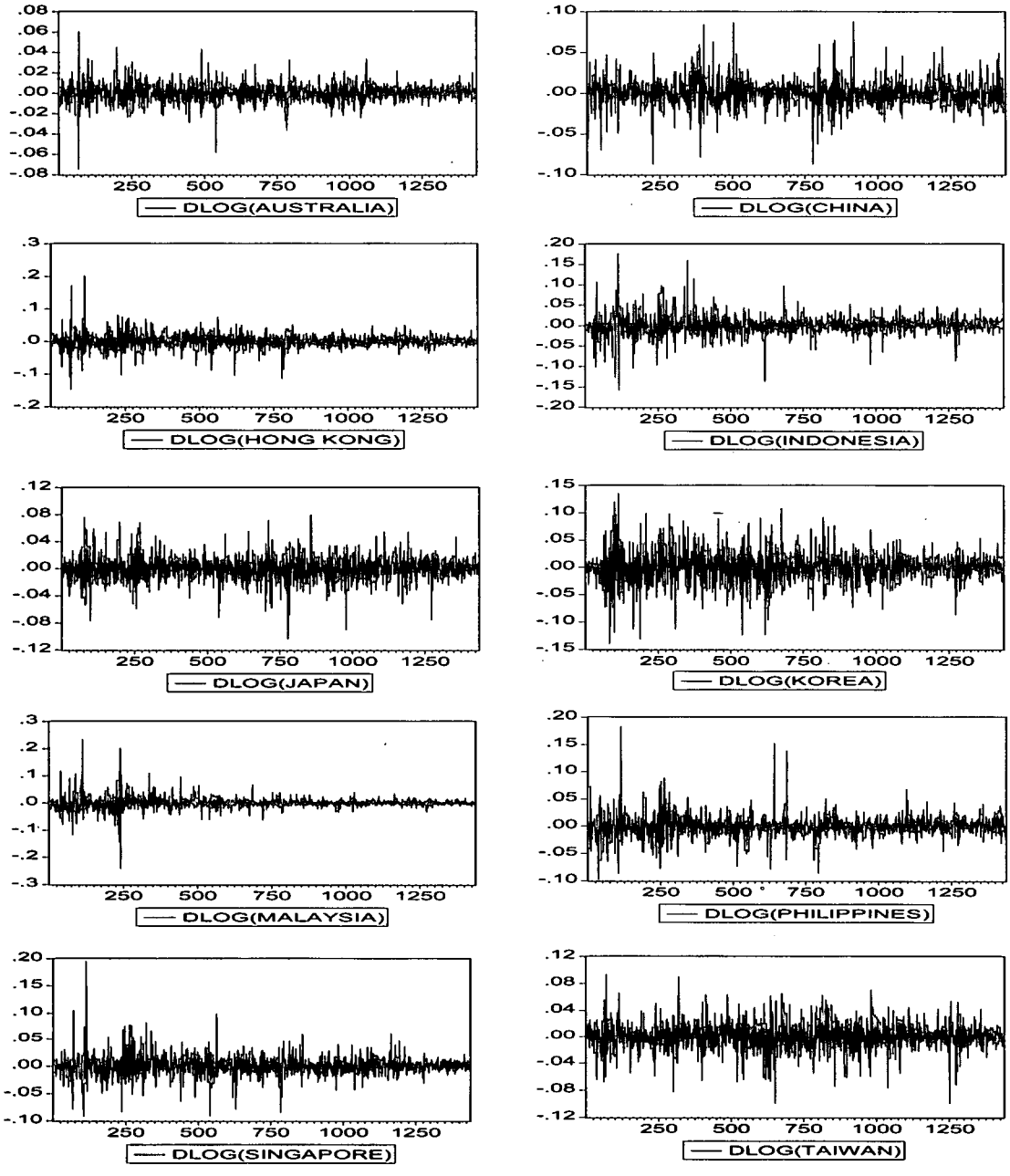
For the results to be consistent in the long-run, variables to be run in the regressions should be stationary, therefore, stationarity of the daily closing stock indices of each country is first checked with the use of the Augmented Dickey-Fuller unit root test. Since the stock market indices of the ten countries are nonstationary at 5% level of significance (reported in Table 1), first-difference of the logarithmic transformation (or popularly known as the dlog transformation) is considered necessary to make the series stationary. First differencing takes into account the nonstationarity of time series with unit roots while the log transformation allows for possible nonlinearity and stabilizes possible seasonal patterns with non-constant variance. The transformed series which can now be defined as the daily changes or daily stock market returns for each country is presented in Figure 2.

Table 1. Augmented Dickey-Fuller Unit Root Test on Each Country

Country	ADF test statistic	P-value
Australia	-0.016751	0.9559
China	-1.700477	0.4308
Hong Kong	-2.07834	0.2537
Indonesia	0.588788	0.9895
Japan	-2.023271	0.2769
Korea	-1.612728	0.4758
Malaysia	-2.593159	0.0946
Philippines	-2.679929	0.0777
Singapore	-1.731314	0.4152
Taiwan	-2.000468	0.2868

Note: The null hypothesis under the ADF test is presence of unit root.

Figure 2. Daily Stock Returns of Each Country
(July 4, 1997 to March 18, 2005)



The graphs show that for each country the stock market exhibits the phenomenon of volatility clustering.[4] These first differences of the stock market indices exhibit volatility suggesting that the variance of the series varies over time. One way of modeling series that exhibit volatility clustering is to estimate generalized autoregressive conditional heteroskedasticity (GARCH) models developed by Bollerslev [1986][5]. It has been shown that GARCH models capture the volatility dynamics and that the pseudo-maximum likelihood estimators of these models are consistent and asymptotically normal (Greene [1993]). Due to its feature, this study shall estimate GARCH models in verifying the integration of the stock market indices of Asia-Pacific countries.

One of the objectives of the study is to identify the common component of daily closing stock market indices of ten Asia-Pacific countries. To do this, the Lumsdaine and Prasad method for the construction of the time-varying weight common component of international fluctuations is applied (Lumsdaine and Prasad [2003]). Unlike most procedures wherein all units of the disaggregated data are equally weighted in all periods, Lumsdaine and Prasad took into account some considerations that other methods did not consider. First, there should be a weighing scheme that would be able to distinguish between country-specific and common fluctuations. And second, shocks should be allowed to propagate across countries.

Since all the series exhibit volatility clustering, univariate GARCH(1,1) models are estimated. The GARCH(1,1) model expresses the conditional variance of the error term at time t as a function of not only the squared error term in the previous time period but also of its conditional variance in the previous period. The specification for each country i is as follows:

$$y_{it} = c_i + \varepsilon_{it}, \qquad \varepsilon_{it} \mid I_{t-1} \sim \mathrm{N}(0, h_{it}). \tag{i.i}$$

$$h_{it} = w_i + \alpha_i \varepsilon_{it-1}^2 + \beta_i h_{it-1}, \tag{i.ii}$$

where y_{it} represents the stock market returns in country i at time t, c_i is a country specific mean, ε_{it} is the error term, I_t denotes the information available at time t and h_{it} is the conditional variance of the error term at time t and is a function of both ε_{it-1}^2 (the squared error term in the previous period) and h_{it-1} (conditional variance in the previous period). In addition, the standard parameter restrictions in the estimation of GARCH models are assumed to hold.[6]

After estimating the GARCH(1,1) model for each series, the predicted values of the conditional variance from the model are then used to construct time-varying weights for the aggregate series. To construct the time-varying weights, the conditional variance, $\hat{h}_{it}$, is first computed for each series, $i = 1, 2, \ldots, 10$, $t = 1, 2, \ldots, T$, from the estimated model (1). The

[4] Volatility clustering means that relative changes in the stock market show periods of wide swings for some time and periods of moderate swings in other times.

[5] The GARCH model is an extension of the autoregressive conditional heteroskedasticity (ARCH) model developed by Engle(1982).

[6] This is similar to the model used by Lumsdaine and Prasad wherein y_t is represented as output growth of a country. Parameter restrictions in the estimation of GARCH models are discussed in Lumsdaine and Prasad [2003].

resulting conditional standard deviation, $h_t^{-1/2}$, is interpreted as a time-varying measure of the contribution of the fluctuations in a particular country to fluctuations in the international common component. The time-varying weights are then computed as,

$$W_{it} = \frac{1}{\sqrt{h_{it+1}}} \Big/ \sum_{i=1}^{10} \frac{1}{h_{it+1}} \qquad \text{(ii)}$$

so that they are related to the inverse of the estimated conditional standard deviations and are expressed as a fraction of the total weight. From these time-varying weights the aggregate series representing the common component of international fluctuations are computed next. This common component is given by the equation,

$$Z_t^G = \sum_{i=1}^{10} W_{it} y_{it} \,. \qquad \text{(iii)}$$

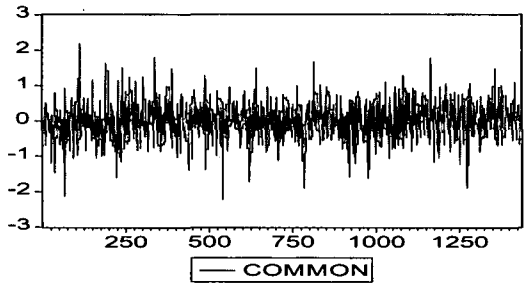
In the construction of the common component, a country-specific increase in conditional volatility is interpreted as country-specific fluctuations. If a shock hit only one country, it will increase the volatility of that country alone and will result in the decline of the weight assigned to that country in the construction of the common component. However, if the shock is passed on to the other countries, then the conditional volatility of the other countries will also increase. The method is capable of accounting for the propagation of shocks (Lumsdaine and Prasad [2003]).

It is important to note that this common component would not be biased towards economies with bigger stock market shares since y_{it} is not the actual stock market value but its volatility or returns while W_{it} is the contribution of the fluctuations in a particular country to fluctuations in the international common component.

IV. ANALYSIS OF RESULTS

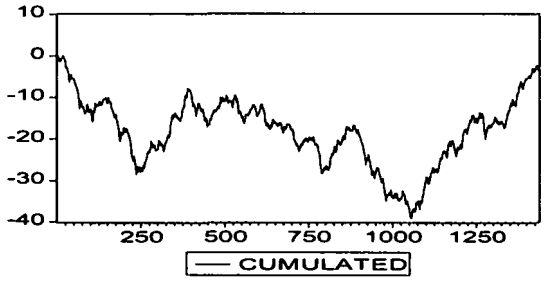
The aggregate series representing the common component of international fluctuations, Z_t^G, (represented with the variable name COMMON) is plotted in Figure 3. While the cumulated measure of the common component is presented in Figure 4. The graph of the cumulated common component provides a clear indication of how this component reflects events that affected the Asia-Pacific stock market during and after the 1997 Asian financial crisis.

Figure 3. The Estimated Time-Varying Weight Common Component



Besides from the evident impact of the financial crisis to the Asia-Pacific stock market, the graph shows that the common component of Asia-Pacific stock market suffered a decline in the stock market even after July 1999 (around the 400th observation). The continuous decline was mainly due to the "dot-com" crisis in 2000. On the other hand, the September 11, 2001 (the 783rd observation) attack in the US had a positive effect in the common component of Asian-Pacific stock market returns. But this increase was cut short because of the stock market downturn of 2002.[7] In 2002, stock prices in stock exchanges across the United States, Asia, and Europe experienced a sharp drop. By the start of 2003, the common component of the Asian-Pacific stock market returns is on the upward trend.

Figure 4. Cumulated Common Component



To better understand the co-movement between individual country stock returns and the common Asia-Pacific stock returns, the cumulated measures of the stock market returns of each country are checked if they follow the path of the cumulated measure of the common component (CUMULATED). This is done by graphing the cumulated stock market returns and the series CUMULATED in the same diagram for each country. The diagrams are presented in Figure 5.

From the presented graph, it can be inferred that Indonesia, the Philippines, and Japan follow the cumulated Asia-Pacific stock market. Australia follows the cumulated common stock returns only after 1998 (around the 100th observation) mainly because Australia was not affected by the Asian financial crisis. On the other hand, Hong Kong, Korea, Malaysia, Singapore, and Taiwan followed the common component only until 2003 (around the 1210th observation). After 2003, although also on the upward trend like the common component, these countries' stock market returns exhibited a flatter slope. While the other nine countries, more or less, follow the path of the common Asia-Pacific stock market returns, China obviously does not. Interestingly, there are periods where China's stock market return is inversely related to the common Asia-Pacific stock market returns.

[7] This downturn can be viewed as part of a larger correction, after a decade-long experience of unusually high stock valuations. http://www.wikipedia.com

Figure 5. Cumulated Common Component and Cumulated Stock Returns of Each Country

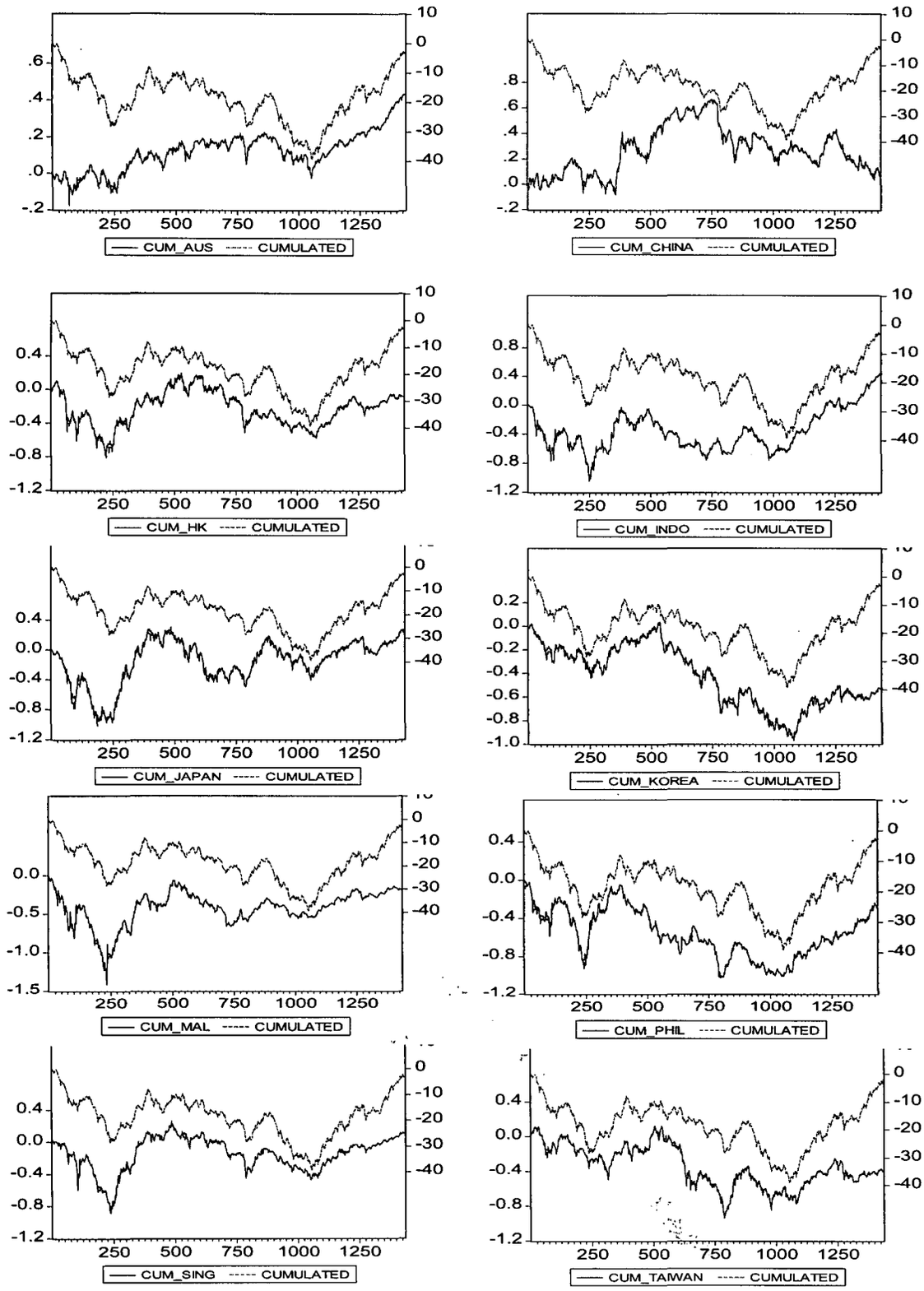


Table 2. Regressions of Each Country's Stock Market Returns on The Time-Varying Weight Common Component

	Constant	COMMON	R^2	Adjusted R^2
Australia	0.000331	1.3087	0.523501	0.523168
	(0.0445)	(0.0000)		
China	0.0000722	0.7716	0.057133	0.056474
	(0.8612)	(0.0000)		
Hong Kong	0.00001	2.9871	0.468611	0.468239
	(0.9809)	(0.0000)		
Indonesia	0.000355	2.238	0.225821	0.22528
	(0.5158)	(0.0000)		
Japan	-0.000319	2.3274	0.424561	0.424159
	(0.3711)	(0.0000)		
Korea	0.00024	3.2804	0.339082	0.33862
	(0.6905)	(0.0000)		
Malaysia	-0.0000804	2.0434	0.206575	0.20602
	(0.8789)	(0.0000)		
Philippines	-0.000139	2.0194	0.264456	0.263942
	(0.7542)	(0.0000)		
Singapore	0.000125	2.4989	0.443355	0.442966
	(0.7340)	(0.0000)		
Taiwan	-0.00023	2.178	0.289072	0.288575
	(0.6088)	(0.0000)		

Notes: The coefficients reported under the second and third columns are from regressions of each country's stock market returns on the time-varying weight common component and a constant. P-values are reported in parentheses.

To formally verify the co-movement between individual country stock market returns and the common Asia-Pacific returns, each country's stock market returns is regressed with the time-varying common component obtained from equation (2). Results of the individual regressions are presented in Table 2. Columns 2 and 3 report the constant term and coefficients of the time-varying common component (COMMON) together with their corresponding p-values. The R^2 and adjusted R^2 are reported in columns 4 and 5, respectively. The slope coefficient from the regressions in Table 2 can be interpreted as a country's BETA (similar to the concept in finance) in that it measures the sensitivity of a country's stock market returns to movements in the common component. Note that (in column (3)) all countries, except China, have betas that exceeded one. This shows that the time-varying aggregated common component is less volatile than the stock market returns in the individual countries, with notable exception of China.

The regression results show that stock markets of Korea and Hong Kong (with coefficients 3.28 and 2.99, respectively) are most sensitive to movements in the common component, while China is the least sensitive with a regression coefficient of 0.77. Australia (0.52), Hong Kong (0.47), Singapore (0.44), and Japan (0.42) have the highest reported R^2. On the other hand, China (0.06) has the lowest reported R^2 among the ten countries. This means that the common component explains the stock market returns of Australia, Hong Kong, Singapore,

and Japan more than it explains the stock market returns of the other countries. That is, stock market returns of the four countries follow the common component Asia-Pacific stock market returns more compared with the other East Asian countries.

On the other hand, the stock market returns for China is barely explained by the Asia-Pacific common stock returns. The result on China stock market being less sensitive to the common component is not unexpected. Jung, Song and Jeon (2004), have shown empirically that while the money and bond markets integration have strengthened for Northeast Asian countries (Japan, China and Korea), the stock market does not show clear sign of integration in the post-1997 period. The opening of China's financial sector has been step by step and this process has been protracted.

V. CONCLUSIONS AND DIRECTION FOR FUTURE RESEARCH

The study examines common component existing in the Asia-Pacific stock market returns after the 1997 Asian financial crisis. To do this, the daily closing stock market indices of Australia, China, Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore, and Taiwan are utilized. The Lumsdaine and Prasad method is used to test the existence of stock market returns common across the ten countries.

The paper finds that Australia follows the Asia-Pacific common stock market returns only after 1998 while the Hong Kong, Korea, Malaysia, Singapore, and Taiwan stock market returns started to deviate from the Asia-Pacific common stock market returns by the end of 2003. After regressing each country's stock market returns with the time-varying common component obtained through the Lumsdaine-Prasad method, results suggest that there exist common Asia-Pacific stock market returns that significantly explain the individual Asia-Pacific stock market. Specifically, Korea and Hong Kong stock markets are the most sensitive to changes in the common component stock returns while China's stock market is the least sensitive.

With the existence of the common stock market fluctuation and thereby implying a possible integration of the Asia-Pacific stock market, it is important to know how the Asia-Pacific countries are affected with this phenomenon. There are advantages as well as risks the Asia-Pacific countries get from the integration of their stock markets. It also presents improvements developing countries such as the Philippines should focus on in order to make certain that they benefit from the integration. Although integration of financial markets helps developing nations achieve high economic growth, improve efficiency, and improve living standards by opening international pool of resource, it has some downside as well. In the case of developing nations like the Philippines, financial integration, not only makes the domestic economy vulnerable to international shocks, but also increases the volatility of markets.

In the case of the Philippines several economists have emphasize the role of savings mobilization and investment facilitation in meeting the challenges of financial integration in the country. The Philippines is vulnerable to changes in foreign investors' sentiments towards the country because the country's investment rate is low since the Philippines' domestic saving rate is one of the lowest in the Asia-Pacific region. Increasing domestic savings shall provide for greater domestic investments and facilitate foreign direct investment through joint ventures increasing the growth rate of the country. It is therefore important that the country

creates and sustains the environment that encourages high domestic saving rate. It is also important to highlight the need for strong prudential regulations, supervision, and monitoring. This includes greater transparency and disclosure requirements on banks and other financial institutions.

Another possible way of constructing the common component is through the use of Principal Component Analysis (PCA) which is popular in Statistics. A comparison of the methodologies for constructing the common component suggested in this paper and the PCA method is a potential area for future research.

ACKNOWLEDGEMENTS

The authors are grateful to Dr. Ma. Socorro Gochoco-Bautista for introducing the topic on common component and to Dr. Joseph Capuno for invaluable comments and suggestions on the earlier draft of the paper. The authors would like to thank the anonymous referee as well as the participants of the 30th Annual Conference of the ASEAN Economic Association held in Manila, Philippines last November 24 to 25, 2006 for their comments and suggestions. The usual disclaimer applies.

References

ALBA, P., A. BHATTACHARYA, S. CLAESSENS, S. GHOSH, and L. HERNANDEZ [1998] "Volatility and contagion in a financially integrated world", World Bank Policy Research Working Paper 2008.

AKHTAR, S. [2004] "Economic integration in East Asia: trends, challenges and opportunities". Asian Development Bank. *Paper presented at the symposium "The challenges and opportunities of economic integration in East Asia," 27 October 2004.*

CAPORALE, G. M., P. HOWELLS, and A. SOLIMAN [2004] "Stock market development and economic growth: the causal linkage", Journal of Economic Development. Volume 29, Number 1.

CAVOLI, T., R. RAJAN and R. SIREGAR [2004] "A survey of financial integration in East Asia: How far? How much farther to go?" Centre for International Economic Studies Discussion Paper No. 0401, University of Adelaide, Australia.

CHAI, H-Y. and Y.RHEE [2005] "Financial integration and financial efficiency in East Asia". *Paper presented at the International Conference in Europe, June 2005.*

CLAESSENS, S., D. KLINGEBIEL, and S. SCHMUKLER [2003] "The future of stock exchanges in emerging economies: evolution and prospects", Wharton Financial Institutions Discussion Paper No 02-03, University of Pennsylvania.

CLAESSENS, S., D. KLINGEBIEL, and S. SCHMUKLER [2004] "Stock market development and internationalization: Do economic fundamentals spur both similarly?" wbln0018.worldbank.org/.../$FILE/Stock%20Market%20Development%20and%20Internationalization.pdf. Accessed 13 July 2005.