Pakistan Journal of Applied Economics, Vol. 17 Nos.1 & 2, (1 - 18), 2001

STOCK PRICE CO-MOVEMENTS IN EMERGING MARKETS

Eatzaz AHMAD and Ayaz AHMED*

This study finds that the emerging stock markets of Asia and Latin America are closely inter-linked. The stock market inter-linkages in the short run are stronger but less sustainable than the ones in the long run. Furthermore, the inter-linkages are relatively stronger and unstable for the more developed countries. Finally, only few markets have increased their level of integration with other markets over time. The study concludes that an investment strategy from the long run perspective is potentially more beneficial than the one based on short-term movements in market returns. The benefits from diversification are likely to be partially offset by the higher level of volatility in the markets that have weak correlation.

I. Introduction

With the present state of communication and information technology it is expected that stock markets around the world would be closely inter-linked and that no stock exchange is immune to external influences. According to the Perfect Arbitrage Proposition, with conditions of free capital mobility, financial capital will continue to move from low-return markets towards high-return markets until the rates of return are equalised across markets. The Capital Assets Pricing Models throw light on the reasons for the failure of perfect arbitrage outcomes on the basis of differential risks in various markets. It is further recognized that market specific risk and uncertainty relating to economic, political and institutional conditions, surrounding various markets, can also hinder the arbitrage process.

Nevertheless, whether or not the stock markets have come closer to one another remains an empirical question and the evidence is not conclusive. In an earlier study for twenty-two developed countries, Haney and Lloyd (1978) found that 37 per cent of inter-country correlation coefficients were statistically significant. Kaplanis (1988) and Meric and Meric (1989) found that the correlation structure of

* The authors are respectively, Professor at the Department of Economics, Quaid-i-Azam University, Islamabad, and Research Economists at the Pakistan Institute of Development Economics, Islamabad.

international equity returns among developed market was stable during 1970s and 1980s, while Shaked (1985) found that the degree of stability increases as the investment horizon is lengthened. On the other hand, Dwyer Jr. and Hafer (1988) found that the stock price indices for US, Japan, Germany and UK were not related. Arshanapalli and Doukas (1993) found that the markets in France, Germany and UK got linked with the US market, after the October 1987 crash. DeFusco, et al. (1993) reached similar results for thirteen emerging markets. More recently Claessents (1995) and Harvey (1995) observed that, though many of the emerging markets are not well integrated into the global market, the level of integration has increased following large capital inflows from industrial economies. Mullin (1993) observed that structural reforms during late 1980s and early 1990s had stimulated capital flows into emerging markets and helped to integrate them into the global financial system.

The present study attempts to provide a systematic analysis of stock price co-movements in a sample of fifteen emerging markets during the 1990s, the period of financial liberalization. Nine of these markets are from Asia while the remaining six are from Latin America. In addition to the inter-linkages among the emerging stock markets, the study also analyzes their relationship with the World major regional indices and leading country indices.

The study addresses the following specific issues:

a) How significant are the co-movements in stock returns within and across samples of Asian and Latin American markets?
b) Is the degree of co-movements dependent on time horizon? – are the inter-linkages across stock markets stronger or weaker in the long run as compared to the short run?
c) Are the stock markets co-movements stable?
d) Does the level of stability in stock markets co-movements increase in the long run?
e) What is the relative position of each individual stock market with respect to the degree and stability of its relationship with other markets?
f) Which markets have integrated with other markets over time and which have been isolated?

The paper is structured in the following way. Section II explains data and framework of analysis. The results are presented in Section III, while Section IV consists of conclusions of the paper.

II. Framework of Analysis

Stock market inter-linkages can be studied by observing either inter-country movements of equity capital or co-movements in stock prices. Under perfect arbitrage assumption (e.g., absence of transaction costs and uncertainty) the inter-

country movements of equity capital perfectly reflect stock price co-movements, though the association is weakened in the absence of the perfect arbitrage conditions.[1] The data on inter-country capital movements is not as reliable and as readily available as on stock price indices. However, one can expect that stock prices will mostly reflect the effects of capital movements. Therefore, stock market interlinkages are studied on the basis of monthly relative changes in stock prices as calculated by the logarithmic first difference of the monthly stock price indices. Thus, the stock price co-movement represents the relationship in the rates of return over a holding period of one month.

We start our analysis with the basic question that is whether stock markets are inter-linked or not. The next step is to find out if the level of integration has been stable and whether the level of integration has increased or decreased over time. The final step is to analyse the pattern of integration of each individual market with the other country and regional markets. The analysis is performed with the help of various statistical tests as explained below.

1) Testing the Significance of Stock Price Co-movements

The existence of relationship among the rates of return in a sample of countries is determined by testing the significance of departure of the correlation matrix from orthogonality using Kullback-Jenrich χ^2-statistic [see, Kullback (1967) and Jenrich (1970)] as:

$$\chi^2 = (1/2)\, tr\,(Z^2) - dg'\,(Z)T^{-1}\, dg(Z) \qquad (1)$$

where

Z = $\sqrt{n}\mathrm{P}^{-1}(\overline{R}-\mathrm{P})$,
T = $(\delta_{ij}+r_{ij}\, r^{ij})$,
$\mathrm{tr}(Z^2)$ = trace of Z^2,
$\mathrm{dg}(Z)$ = diagonal of Z written as a column vector with dg'(Z) being its transpose,
n = sample size,
P = population correlation matrix,
R = estimate,
δ_{ij} = Kronecker delta,
r_{ij} = element in R, and
r^{ij} = element in R^{-1}.[2]

[1] Domestic influence on the stock price index of a particular country persists to the extent that the perfect arbitrage conditions do not hold.

[2] The second term in equation (1) is introduced by Jenrich (1970) as a correction over the χ^2-statistic proposed in Kullback (1967).

The χ^2-statistic has degrees of freedom equal to k(k–1)/2 where k is the number of variables in the correlation matrix. When the sample correlation matrix R is equal to the population correlation matrix P, which is an identity matrix under the null hypothesis, Z would be a null matrix and the χ^2-statistic will be equal to zero. A significant value of χ^2-statistic indicates/rejection of the null hypothesis.

2) Testing the Stability of Stock Price Co-movements

In order to test stability of stock price co-movements in a group of countries across m non-overlapping periods, we pose the null hypothesis: $P_1=P_2=...=P_m$ against the alternative $P_i \neq P_j$ for at least one $i \neq j$, where P_i is the population correlation matrix in period i.This null hypothesis can be tested using Kullback-Jenrich χ^2-statistic or Box-M statistic, which have been used in Kaplanis (1988) and Meric and Meric (1989). Denoting the estimate of the correlation matrix P_i based on a random sample of size n_i by R_i, Kullback-Jenrich χ^2 statistic can be written as:

$$\chi^2 = \sum_{i=1}^{m} [(1/2)tr(Z_i^2) - dg'(Z_i)S^{-1}\, dg(Z_i)] \qquad (2)$$

where

$Z_i = \sqrt{n_i}\, \bar{R}^{-1} (R_i - \bar{R})$,

$\bar{R} = \sum_{i=1}^{m} n_i R_i \Big/ \sum_{i=1}^{m} n_i$,

$S = (\delta_{ij} + \bar{r}_{ij}\, \bar{r}^{ij})$,

$\bar{r}_{ij}$ = element in the matrices $\bar{R}$, *and*

$\bar{r}^{ij}$ = element in the matrices $\bar{R}^{-1}$.

The statistic has degrees of freedom equal to (m–1)k(k–1)/2, where k is the number of variables in each of the m correlation matrices.[3]

The general form of Box-M statistic, given in Meric and Meric (1989) is as follows:

$$M = \lambda \sum_{i=1}^{m} [(n_i - 1)\ln | R_i^{-1} \tilde{R} |] \qquad (3)$$

where

$$\lambda = 1 - [\{2k^2+3k-1\} / \{6(k+1)(m-1)\}] \left[\sum_{i=1}^{m} (n_i-1)^{-1} - \left(\{\sum_{i=1}^{m} (n_i-1)\}^{-1}\right)\right],$$

$$\tilde{R} = \sum_{i=1}^{m} (n_i-1) R_i \Big/ \sum_{i=1}^{m} (n_i-1).$$

[3] The second term in the χ^2-statistic given by equation (2) is the correction suggested by Jenrich (1970) over Kullback's (1967) χ^2-statistic.

The Box-M statistic has degrees of freedom equal to k(k+1)/2.[4]

While the two tests do not specify as to how the number of non-overlapping periods m is chosen, it is understood that the choice of m should take into account the trade-off between the number of observations in each sub-period and the number of sub-periods.

3) Pair-Wise Test for the Significance of Correlation

Moving now to a detailed analysis, we start with pair-wise tests on the significance of correlation coefficient. Since the distribution of sample correlation coefficient is skewed unless the population correlation coefficient is zero, the standard t-statistic does not posses its required properties. The 'Fisher r to z transformation': $z = (1/2)[\ln(1+r) - \ln(1-r)]$ solves this problem by mapping the interval $[-1, +1]$ into $[-\infty, +\infty]$. The null hypothesis that the population correlation coefficient ρ is zero can be tested using the following statistic, which has a normal distribution because the standard deviation of z, $\sigma_z = (n-3)^{-1/2}$, is known (see Snedesor and Cochran (1967).

$$\zeta = (z/\sigma_z) = z\sqrt{n-3} \tag{4}$$

4) Pair-Wise Test of Correlation Stability

The testing procedure for the stability of correlation coefficients for each pair of stock markets is discussed in this section. Denoting the population correlation coefficient for period i by ρ_i, our null hypothesis is $\rho_1 = \rho_2 = \ldots = \rho_m$ against the alternative that $\rho_i \neq \rho_j$ for at least one $i \neq j$. We shall apply the χ^2 test based on Fisher transformation as explained in Snedesor and Cochran (1967) and applied to stock price data in Shaked (1985). The test statistic is:

$$\chi^2 = \sum_{i=1}^{m} [(z_i - \bar{z}) / \sigma_{z_i}]^2 \tag{5}$$

where z_i is the Fisher transformation:

$$z_i = (1/2)[\ln(1+r_i) - \ln(1-r_i)],$$

$$\bar{z} = \sum_{i=1}^{m} (1/\sigma^2_{z_i})\, z_i \Big/ \sum_{i=1}^{m} (1/\sigma^2_{z_i}), \text{ and}$$

$$\sigma_{z_i} = (n_i - 3)^{-1/2}.$$

The χ^2-statistic has m–1 degrees of freedom.

[4] Notice that the Box-M statistic fails if the number of observations in any period is less than the number of variables in the correlation matrix because the correlation matrix R_i becomes singular and its inverse does not exist.

5) Pair-Wise Test for Changes in Stock Price Co-movements

Although the above test indicates whether or not a correlation coefficient is stable over time, but it does not tell us whether the correlation coefficient has increased or decreased. Therefore in the final step, the pattern of changes in stock price co-movements across all the pairs of markets is determined. The purpose is to determine which stock markets have come closer to each other and which have moved apart. Following the above notations and assuming two periods, null hypothesis is set up as: $\rho_1 = \rho_2$ against the alternative: $\rho_1 > \rho_2$ or $\rho_1 < \rho_2$. The test statistic based on Fisher transformation [see Haney and Lloyd (1978)], which has standard normal distribution, is given by:

$$Z = (z_1 - z_2) / \sqrt{[1/(n_1-3)] + [1/(n_2-3)]} \qquad (6)$$

III. Data and Results

The study covers the period January 1992 to December 1998 for nine emerging markets from Asia (India, Indonesia, Japan, Korea, Malaysia, Pakistan, Philippines, Taiwan and Thailand) and other six from Latin America (Argentina, Brazil, Chile, Columbia, Mexico and Venezuela). In addition to inter-country co-movements, the study also analyzes inter-linkages of the emerging markets with some major financial markets (USA, UK and Japan), broader regional markets (Asia, Latin America, and Europe, Australia and the Far East) and the overall world market. The data is taken from various issues of Emerging Stock Markets Factbook, International Finance Corporation. For each country the study uses the local market index series.

The results of Kullback-Jenrich χ^2-test [equation (1)] are given in Table 1. The proposition that the rates of return in various countries move independently of each other is overwhelmingly rejected. For the Asian sample, the relationship is significant in all the periods while for the Latin American sample the relationship is significant for the smaller sub-periods not exceeding 24 months. The relatively weak relationship within the Latin American stock markets in early 1990s could most probably be the result of high level of volatility in the markets due to which market trends become less predictable and do not provide reliable signals to investors. With such a lack of information on stock prices, international capital movements do not necessarily serve to produce arbitrage conditions across markets. The above result along with the finding that the relationship in stock returns is significant for the pooled sample of Asia and Latin America, provides indirect evidence on inter-continental stock market inter-linkages. The nature of these linkages will become more evident in the later part of our analysis.

A noticeable observation is that for all the three groups of countries the average value of χ^2-statistic increases with a decrease in the length of the sample period. Since the degrees of freedom for the test are independent of the length of

time the period considered; so as we move to shorter time periods, the correlation matrix departs further from the identity matrix. A purely statistical explanation is that in general the absolute value of the correlation coefficient declines with an increase in sample size as is generally observed in regression analysis. However, in the present context this pattern can be justified on the following grounds. In smaller sub-samples there are fewer factors that link any two markets; but in larger samples which are obtained by combining many sub-samples, the number of such factors cancel each other (since all factors are not expected to move in same direction when the number of factors are large). Thus, the overall of increase in the length of data weakens the correlation across markets.[5] Another plausible explanation may

TABLE 1

Kullback-Jenrich χ^2-Test for the Significance of Correlation Matrix

Length of Periods	Periods	Asia	Latin America	Asia and Latin America
Full period	Jan 92 to Dec 98	124.76*	15.55	197.77*
Periods or 36 months	Jan 92 to Dec 94	130.09*	15.19	227.73*
	Jan 96 to Dec 98	142.45*	47.00*	310.97*
Periods of 24 months	Jan 93 to Dec 94	123.39*	35.85*	232.00*
	Jan 95 to Dec 96	158.96*	54.43*	383.17*
	Jan 97 to Dec 98	193.70*	43.44*	356.30*
Periods of 18 months	Jan 93 to Jun 94	154.87*	47.78*	318.57*
	Jul 94 to Dec 95	197.97*	45.41*	456.92*
	Jan 96 to Jun 97	172.45*	79.37*	456.26*
	Jul 97 to Dec 98	201.82*	74.40*	513.63*
Periods of 12 months	Jan 92 to Dec 92	195.96*	44.89*	467.60*
	Jan 93 to Dec 93	172.08*	43.05*	348.60*
	Jan 94 to Dec 94	208.79*	69.88*	486.38*
	Jan 95 to Dec 95	215.95*	58.23*	552.26*
	Jan 96 to Dec 96	198.07*	93.49*	564.85*
	Jan 97 to Dec 97	303.99*	48.66*	536.63*
	Jan 98 to Dec 98	237.08*	86.61*	588.33*

*Significant at 5 per cent level of significance.

[5] The authors are thankful to one of the referees of this paper for suggesting this line of reasoning.

be that in the short run stock markets over-react to news from the other stock markets and this reaction is based mostly on perceptions and partly on sentiments. However, with the passage of time more precise information comes through and by and large rationality over-rides sentiments. Thus, in the long run the returns in each market can follow a partially independent time path. This pattern was specially observed in the Latin American markets in the early 1990s.

Results on the stability of correlation matrices based on equations (2) and (3) are presented in Table 2. For samples of six or seven years there is no evidence of significant change in the correlation structure within Latin America. The same is the case with the Asian sample, except that the correlation structure could possibly have changed when annual correlation coefficients were compared over the seven-year period. Therefore, the correlation structure can be regarded as homogeneous. The evidence for the combined sample of Asian and Latin American markets suggests that the correlation structure is likely to have changed over time. It can therefore, be concluded that the intra-continental stock price co-movements are relatively more stable than the inter-continental co-movements. The results on stability over two consecutive periods of 12 to 24 months shows that in general the evidence on instability across Asian markets is stronger than the one across Latin American markets. The instability in co-movements in the combined sample is even more pronounced. The results further show that the degree of stability increases as the length of data series increases, and that the correlation structure becomes more stable in the long run. This result is consistent with the findings of Shaked (1985) based on the analysis of sixteen developed markets.

The above conclusion and results in Table 1 suggest that the short-term relationship between stock returns is stronger than the long-term relationship but the latter is more stable than the former. It can be argued that short term inter-linkages across stock markets are mostly based on perceptions, while the longer term inter-linkages are based on more precise and considered assessments. In other words, the market signals in short run are more like news, which may or may not confirm to realisation. Most of the trading activities in stock markets are driven by spontaneous reactions through which traders perceive how the market will respond to the news. The so-called "mass psychology", as Keynes (1939) puts it, can lead to over-reaction to the news. However, since realisation does not necessarily match the news, the short-term stock market inter-linkages are likely to be temporary. Another explanation that is equally plausible is as follows: In smaller sub-samples there are fewer exogenous factors that affect the markets, but in larger samples, since the number of the exogenous factors is large, their effect on the market cancel each other out. Thus the overall effect is a more stable correlation.

A more detailed analysis and study of the pattern of co-movements for each country in the sample is discussed in this section. The results of standard normal test [equation (4)] applied to the full sample period are presented in Table 3. These

TABLE 2

χ^2-Tests for Correlation Stability

Period	Asia		Latin America		Asia and Latin America	
	Kullback-Jenrich	Box-M	Kullback-Jenrich	Box-M	Kullback-Jenrich	Box-M
7 periods of 12 months: Jan 92 to Dec 98	282.53*	278.58	14.19	103.56	755.09*	
4 periods of 18 months: Jan 93 to Dec 98	89.37	133.78	8.17	64.55	250.76	443.66*
3 periods of 24 months: Jan 93 to Dec 98	40.74	71.28	1.67	27.38	114.42	234.70
2 periods of 36 months: Jan 93 to Dec 98	47.90	49.42	14.49	13.99	123.96*	137.28
2 Periods of 12 Months						
Jan 92 to Dec 92 and Jan 93 to Dec 93	133.61*	52.26	65.36*	23.93	390.06*	
Jan 93 to Dec 93 and Jan 94 to Dec 94	145.57*	58.60	62.67*	21.66	397.80*	
Jan 94 to Dec 94 and Jan 95 to Dec 95	158.11*	72.01*	59.64*	19.62	386.66*	
Jan 95 to Dec 95 and Jan 96 to Dec 96	189.88*	89.06*	54.20*	16.96	423.46*	
Jan 96 to Dec 96 and Jan 97 to Dec 97	127.35*	44.14	37.72*	10.99	416.78*	
Jan 97 to Dec 97 and Jan 98 to Dec 98	113.33*	40.54	41.05*	11.86	382.00*	
2 Periods of 18 Months						
Jan 93 to Jun 94 and Jul 94 to Dec 95	83.07*	44.38	47.74*	25.28	251.89*	168.45*
Jul 94 to Dec 95 and Jan 96 to Jun 97	108.09*	61.89*	28.89*	14.14	257.07*	184.29*
Jan 96 to Jun 97 and Jul 97 to Dec 98	94.33*	50.63	40.60*	20.51	256.16*	178.71*
2 Periods of 24 Months						
Jan 93 to Dec 94 and Jan 95 to Dec 96	58.27*	27.76	23.38	13.35	176.44*	121.83
Jan 95 to Dec 96 and Jan 97 to Dec 98	57.08*	37.73	23.61	14.58	176.01*	134.72

*Significant at 5 per cent level of significance.
Box-M χ^2 test is not applicable when the number of variables exceeds the number of observations.

TABLE 3

Pair-wise Standardised Normal Distribution Test for the Significance of Correlation Coefficients (Based on Fisher Transformation)

	Number of Significant Correlation Coefficients with								
	Asian Countries	LA Countries	World	Asia	LA	EAFE	USA	UK	Japan
India	2	0	0	0	0	1	0	0	1
Indonesia	4	2	1	1	0	0	0	0	0
Japan	5	3	1	1	1	0	0	1	–
Korea	4	1	1	1	0	1	0	1	1
Malaysia	6	5	1	1	1	1	1	1	1
Pakistan	1	1	0	0	0	0	0	1	0
Philippines	5	3	1	1	1	0	1	1	0
Taiwan	6	3	1	1	1	0	0	1	1
Thailand	7	3	1	1	1	1	0	0	1
Asian sample	*20*	*21*	*7*	*7*	*5*	*4*	*2*	*6*	*5*
(percentage)	*(55.6)*	*(38.9)*	*(77.8)*	*(77.8)*	*(55.6)*	*(44.4)*	*(22.2)*	*(66.7)*	*(62.5)*
Argentina	0	1	0	0	1	1	1	0	0
Brazil	3	3	1	0	1	0	1	0	1
Chile	4	1	1	1	1	0	0	0	1
Columbia	6	2	1	0	0	0	0	0	0
Mexico	7	2	1	1	1	0	1	0	1
Venezuela	1	1	0	1	0	0	0	0	0
L.A. sample	21	5	4	3	4	1	2	0	2
(percentage)	(38.9)	(33.3)	(66.7)	(50.0)	(66.7)	(16.7)	(33.3)	(0.0)	(33.3)
Full sample	**41**	**26**	**11**	**10**	**9**	**5**	**4**	**6**	**7**
(percentage)	**(45.6)**	**(37.7)**	**(73.3)**	**(66.7)**	**(60.0)**	**(33.3)**	**(26.7)**	**(40.0)**	**(50.0)**

Notes: Totals and percentages are corrected to avoid double counting.
L.A. and EAFE, respectively stand for Latin America and Europe, Australia and the Far East.

results show that in the Asian sample about 56 per cent of the correlation coefficients are significant, while in the Latin American sample this ratio is lower at 33 per cent. Thus, the stock market inter-linkages in Asia are stronger than the inter-linkages in Latin America. One of the reasons for this result could be that, as discussed earlier, the rates of return in the Asian markets are relatively more stable than in the Latin American markets. This result also implies that, although the Latin American markets are more volatile, the risk can be reduced through inter-market diversification of assets. Out of 54 cross continental correlation coefficients 21 (around 39 per cent) are statistically significant. Thus, the cross continental inter-linkages are almost as strong (or weak) as the inter-linkages within the two continents.

Most of the markets are significantly inter-linked with the Asian and Latin American composite indices. The inter-linkage of the markets located in one continent with the other continental composite index is almost as prominent as with the own continental composite index. The relationship of the individual markets with the composite indices of Europe, Australia and the Far East (EAFE) are not very strong. Inter-linkages with the major markets show a mixed pattern. Asian markets have stronger relationship with UK and Japan than with the USA. On the other hand, Latin American markets have no relationship with UK, and their relationship with the USA and Japan is not very strong either.

Among the Asian markets, Thailand has the strongest relationship with the other Asian markets, closely followed by Malaysia and Taiwan. On the other hand, Pakistan has the weakest relationship with the other markets, followed by India. In the Latin American sample the strongest relationship of an individual market with the other Latin American markets is found for Brazil, while Argentina, Chile and Venezuela have a weak relationship. The cross continental relationship is found to be the strongest for Malaysia, Mexico and Columbia, whereas the weakest cross continental relationship is observed for India, Korea, Pakistan, Argentina and Venezuela.

Most of the countries that have stronger stock market inter-linkages with the other countries have been experiencing stable growth and relatively more open economies (e.g., the Far Eastern countries except Korea), while the weakest inter-linkages are mostly found for the less developed countries. This suggests that inter-market capital movements depend not only on the stock market performance but also on economic performance and stability. Poor and inconsistent economic performance introduces added risk for the potential investors, thereby eroding the arbitrage process.

The χ^2 test, given by equation (5) for the stability of individual correlation coefficients over seven periods of 12 months each (that is January-December 1992 to January-December 1998) is applied. The results in Table 4 show that among the Asian markets 12 of the 36, or one-third of the correlation coefficients are unstable,

TABLE 4

Pair-Wise Box c2-Test for Correlation Stability
(Based on Fisher Transformation)

	Number of Significant Correlation Coefficients with								
	Asian Countries	LA Countries	World	Asia	LA	EAFE	USA	UK	Japan
India	1	1	1	1	0	1	0	0	1
Indonesia	3	2	1	1	1	0	1	0	0
Japan	1	1	0	0	0	1	0	0	–
Korea	1	0	1	1	0	0	0	0	0
Malaysia	4	1	1	1	0	1	0	0	0
Pakistan	2	1	0	0	0	0	0	0	0
Philippines	5	2	1	1	1	0	0	0	0
Taiwan	3	0	1	1	0	0	0	0	0
Thailand	4	1	1	1	0	0	1	0	0
Asian sample	*12*	*9*	*7*	*7*	*2*	*3*	*2*	*0*	*1*
(percentage)	*(33.3)*	*(16.7)*	*(77.8)*	*(77.8)*	*(22.2)*	*(33.3)*	*(22.2)*	*(0.0)*	*(12.5)*
Argentina	1	3	1	0	1	1	1	1	0
Brazil	0	1	0	0	1	0	0	0	0
Chile	3	1	1	0	1	0	0	0	1
Columbia	2	1	0	0	0	0	0	0	0
Mexico	3	1	1	0	1	1	0	0	0
Venezuela	0	1	0	0	0	0	0	0	0
L.A. sample	*9*	*4*	*3*	*0*	*4*	*2*	*1*	*1*	*1*
(percentage)	*(16.7)*	*(26.7)*	*(50.0)*	*(0.0)*	*(66.7)*	*(33.3)*	*(16.7)*	*(16.7)*	*(16.7)*
Full sample	**21**	**13**	**10**	**7**	**5**	**6**	**3**	**1**	**2**
(percentage)	**(23.3)**	**(18.8)**	(66.7)	**(46.7)**	**(33.3)**	**(40.0)**	**(20.0)**	**(6.7)**	**(14.3)**

Notes: Totals and percentages have been corrected to avoid double counting.
L.A. and EAFE, respectively stand for Latin America and Europe, Australia and the Far East.

while in the Latin American sample the percentage is 27. On the other hand only 9 of the 54 or 17 per cent inter-continental correlation coefficients are unstable. It can therefore be concluded that the inter-continental co-movements in stock prices are more stable than the intra-continental co-movements.

The above results are strongly supported by the observed percentages of unstable correlation coefficients of the Asian and Latin American markets with the regional indices of Asia and Latin America. The relative instability of intra-continental linkages, as compared to the inter-continental linkages, suggests that sentiments are likely to play a major role in determining the intra-continental capital flows wherein the inter-linkages are also stronger, while the cost of inter-continental transfers may be a hindering factor in producing similar behaviour for the inter-continental co-movements.

The highest number of unstable inter-country correlation coefficients is found for Philippines, followed by Indonesia, Malaysia and Thailand, while the smallest number of unstable correlation coefficients are estimated for Korea, Brazil, Venezuela, India, and Japan. In general, the markets that have stronger inter-linkages with other markets are also the ones that have unstable correlation coefficients. This result makes sense because only the markets that are inter-linked with the other markets can be exposed to instability in their relationship. It is further observed that instability in the market inter-linkages is relatively higher for the so-called Asian Tigers. Table 5 shows that out of the ten pairs of countries, only one has an insignificant correlation coefficient, which also happens to be stable. The remaining nine pairs of countries have significant correlation coefficient, out of which five are unstable.

TABLE 5

Significance and Stability of Correlation Coefficients among the 'Asian Tigers'

Country	Indonesia	Korea	Malaysia	Taiwan
Korea	Insignificant, Stable			
Malaysia	Significant, Unstable	Significant, Stable		
Taiwan	Significant, Stable	Significant, Unstable	Significant, Unstable	
Thailand	Significant, Unstable	Significant, Stable	Significant, Unstable	Significant, Stable

In the final stage, patterns of changes in correlation coefficients for each country market are studied by testing the difference in correlation coefficients across the periods January 1992 to December 1994 and January 1996 to December 1998. The results of standard normal test [equation (6)] are presented in Table 6. The first noticeable observation is that with this test the number of significant changes in correlation coefficients is smaller than with the χ^2-test in Table 4, despite the fact that the present test is a one-tailed test. This does not necessarily mean that the power of χ^2-test is stronger. The χ^2-test was based on correlation coefficients calculated using the sets of 12 month data, while the present test considers correlation coefficients computed from 36 month data. A simple interpretation, which is also consistent with our earlier results, is that the inter-linkages based on longer period are more stable than the ones based on shorter periods. Thus, the claim that the short-period stock markets inter-linkages are mostly unstable and temporary finds an overwhelming support from our statistical tests.

Most of the correlation coefficients have been stable across the two periods considered. From a total of 195 correlation coefficients, 24 (or 12 per cent) have increased significantly while only 8 (or 4 per cent) have decreased significantly.[6] Within the Asian sample the ratios are 11 per cent and 3 per cent respectively, while within Latin American sample these ratios stand at 7 per cent and zero per cent, respectively. Of the 54 inter-continental correlation coefficients 11 per cent have increased while 7 per cent have decreased. It can be further noted that in all the eight cases where the level of integration has decreased, the correlation coefficients over the entire sample period (1992-98) have also been significantly greater than zero. Among the 24 cases of significant increase in the level of integration, correlation coefficient over the entire sample period has been positive, negative and insignificant in 6, 4 and 14 cases, respectively.

In Asia the maximum number of changes in the correlation coefficient have occurred for India, followed by Indonesia and Japan. In the Latin American sample, Argentina stands at the top of the list, followed by Columbia, Chile and Mexico. All significant changes in the correlation coefficients for India, Indonesia, Argentina and Chile (6, 5, 6 and 4, respectively) have been in the positive direction. Changes in the correlation coefficients for Japan and Mexico have also been, mostly in the positive direction. Although, all the changes in the correlation coefficients for Malaysia have been in the negative direction, most of its correlation coefficients are still significantly greater than zero and one cannot suggest that Malaysia is isolated from the World financial system. Decrease in the level of integration with Japan

[6] The number of correlation coefficients are 36 within the Asian sample, 15 within the Latin American sample, 54 between the two continents and 90 within the world, regional and major market indices. Totals and percentages quoted in the text have been adjusted to avoid double counting.

TABLE 6

Significant Changes in Correlation Coefficients
between Jan 92-Dec 94 and Jan 96-Dec 98
(Normal Distribution Test on Fisher Transformation)

	India	Indonesia	Japan	Korea	Malaysia	Pakistan	Philippines	Taiwan	Thailand	Argentina	Brazil	Chile	Columbia	Mexico	Venezuela	World	Asia	L. A.	EAFE	USA	UK
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
India	NA		↑-			↑		↑	+			↑	↑				↑		+		
Indonesia		NA			+		+	+	+	↑			+	+		↑+	↑+	↑		↑	
Japan	↑-		NA	+	↓+			+	+	↑	+	↑-		+		+	+	+	↑		+
Korea			+	NA	+			+	+			↑		+		+	+		+		+
Malaysia		+	↓+	+	NA		+	+	+		+	+	↓+	↓+		+	+	+	+	+	+
Pakistan	↑					NA	+						+								+
Philippines		+			+	+	NA	+	↑+			+	↓+	+		+	+	+		+	+
Taiwan	↑	+	+	+	+		+	NA	+			+	+	+		↓+	↓+	+			+
Thailand	+	+	+	+	+		↑+	+	NA		+		↓+	+		+	+	+	+		
Argentina		↑	↑							NA				↑+		↑		↑+a	↑-	+	
Brazil			+		+				+		NA	+	+	+		+		+		+	
Chile	↑		↑-	↑	+		+	+			+	NA				+	+	+	↑		
Columbia	↑	+			↓+	+	↓+	+	↓+		+		NA		+	↓+					
Mexico		+	+	+	↓+		+	+	+	↑+	+			NA			+	↑+	↑	+	
Venezuela					-								+		NA		↑-				

Notes. The arrows ↑ and ↓ respectively indicate significant increase or decrease in the correlation coefficient, while + and - indicate that the correlation coefficient is significantly greater or less than zero.
Totals and percentages have been corrected to avoid double counting.

and Mexico could mean strengthening of the Malaysian stock market to absorb external shocks. Weakening relationship between Malaysia and Columbia is most likely a reflection on the latter's stock market as the correlation coefficient of stock prices in Columbia with those in Philippines and Thailand and the world index has also decreased significantly. Since half the correlation coefficients for Columbia are also statistically insignificant, one can suggest that Columbia has been isolated, at least partially, from the global financial system.

The countries with the most stable correlation structure are Korea, Pakistan, Philippines and Thailand in Asia, and Brazil and Venezuela in Latin America. Among these countries Korea, Philippines, Thailand and Brazil also had quite a large number of significant correlation coefficients over the entire period of analysis. These markets are, therefore well integrated with the World financial system and their level of integration has been stable. Pakistan and Venezuela especially, on the other hand, do not appear to be integrated with the world financial system and there are no signs of change in this position. The two markets, therefore, appear to be isolated from the world financial system.

Some of the developing countries, especially Argentina, Brazil, Columbia, Mexico, Pakistan and Taiwan, went through programmes of financial liberalisation and economic reforms during the 1990s.[7] However, the above results do not provide sufficient evidence to suggest that the financial reforms helped the emerging markets integrate with the World financial system. For example the level of integration for Columbia has decrease and the position for Brazil, Pakistan and Taiwan has not improved. One of the reasons could be that the reforms were not completely followed and their overall effect on the visible economic fundamentals was weak. In case of Pakistan, for example, abrupt changes in economic policies due to political instability and uncertainty, poor law and order conditions and threat of default continued to haunt the stock market. As a result, the pace of international equity capital inflow could not be maintained. Almost a similar situation was observed in the case of Columbia.

IV. Conclusions

This study finds that the emerging stock markets in Asia and Latin America are closely inter-linked, though the inter-continental co-movements in stock prices are weaker than the intra-continental co-movements. The inter-linkages in the short run are found to be stronger than the ones in the long run. However, the long run inter-linkages are more sustainable while the short run inter-linkages are mostly temporary. This result is prominent for the more volatile Latin American markets

[7] See, International Finance Corporation, 1990-1998.

References

Arshanapalli, Bala, and John Doukas, 1993, International stock market linkages: Evidence from the pre-and post-October 1987 period, Journal of Banking and Finance, 17(1): 193-208.

Claessens, Stijn, 1995, The emergence of equity investment in developing countries: Overview, The World Bank Economic Review, 9(1): 1-17.

DeFusco, R., J.M. Geppert and G.P. Tsetsekas, 1993, Emerging capital markets: Results from Co-integration Tests, Presentation at the annual meeting of the Financial Management Association, October 1993.

Dwyer Jr., G.P., and R.W. Hafer, 1988, Are national stock markets linked? Federal Reserve Bank of St. Louis, 70: 3-14.

Haney Jr., R.L., and W.P. Lloyd, 1978, An examination of the stability of the international relationships among national stock market indices, Nebraska Journal of Economics and Business, : 55-65.

Harvey, Campbell R., 1995, The risk exposure of emerging equity markets, The World Bank Economic Review, 9(1): 19-50.

International Finance Corporation, 1992-1999, Emerging stock markets factbook, Washington, D.C.

Jenrich, Robert I., 1970, An asymptotic Chi-Square Test for the equality of Two Correlation Matrices, Journal of the American Statistical Association, 65: 904-912.

Kaplanis, E., 1988, Stability and forecasting of the co-movement measures of international stock market returns, Journal of International Money and Finance, 7: 63-75.

Keynes, John Maynard, 1939, The general theory of employment, interest and money, London: MacMillan. .

Kullback, S., 1967, On testing Correlation Matrices, Applied Statistics, 16: 80-85.

Levy, Haim, and Marshall Sarnat, 1970, International diversification of investment portfolios, American Economic Review, 60(4): 668-675.

Meric, Ilhan, and Gulser Meric, 1989, Potential gains from international portfolio diversification and inter-temporal stability and seasonality in international stock market relationships, Journal of Banking and Finance, 13(4): 627-640.

Mullin, John, 1993, Emerging equity market in the global economy, Federal Reserve Bank of New York, Quarterly Review,: 54-83.

Shaked, Israel, 1985, International equity markets and the investment horizon, The Journal of Portfolio Management, : 80-84.

Snedesor, George W., and William G.. Cochran, 1967, Statistical methods, Sixth edition, AMES Iowa: USA.

than Asian markets. The study also finds that stock market inter-linkages are relatively stronger and unstable for the more developed countries as compared to the less developed countries. Finally, irrespective of the level of development, few markets have increased their level of integration with other markets.

Several conclusions follow from the study. The main conclusion is that with relatively high and unstable correlation in the rates of return across emerging markets in the short-run, the expected gains from diversification in terms of reducing the risk are neither very attractive nor predictable. On the other hand, in the long run, the inter-linkages among the markets become weaker but more stable. Thus, an investment strategy from the long run perspective is more likely to pay dividends than the one driven by reaction to short term changes in market performance. This conclusion is, however, subject to an important qualification. The markets which have relatively weak correlation are more volatile as well. This means that the benefits from diversification could be wiped-out or at least partially offset by the higher level of volatility, in the markets that have weak correlation.

As expected the study indicates that formulation of an optimal diversification strategy is not a simple task because there is not enough systematic pattern in returns, volatility and correlation structure that can provide clear guidelines to investors. Furthermore, any implication for portfolio diversification holds on average only. For small investors, there are hardly any options to avoid risk and also enjoy better than average returns. The results show that a sizeable negative correlation exists only between the rates of return in India and Japan. Thus, these two markets could figure prominently for the risk-averse investors. However, India and Japan also have relatively low average returns compared to the other markets, though Japan is a low risk market.

Another conclusion that can be reached is that most of the countries that have stronger stock market inter-linkages with other countries have experienced stable growth and relatively more open economies (e.g., the Far Eastern countries), while the weakest inter-linkages are found mostly for the less developed countries. This suggests that inter-market capital movements depend not only on stock market performance but also on economic performance and stability. Poor and inconsistent economic performance introduces added risk for the potential investors, thereby eroding the arbitrage process.

Department of Economics, Quaid-i-Azam University, and
Pakistan Institute of Development Economics, Islamabad.