South Asian Journal of Management Sciences
Vol 11(2): 109-123, 2017
DOI: 10.21621/sajms.2017112.02

Heterogeneous Panel Analysis among Equity Returns for Portfolio Diversification: Evidence from Emerging and Frontier Asian Equity Markets

Mobeen Ur Rehman * Syed Jawad Hussain Shahzad†

Abstract: *Our study investigates the linkage between frontier and emerging equity markets of Asia from January 2000 to December 2016. To deal with heterogeneous panels, we applied pooled mean group framework proposed by Pesaran, Shin, and Smith (2001). Our findings reveal both short and long run relationships among sampled markets thereby supporting the feedback hypothesis. The magnitude of relationship is strong from frontier to emerging equity markets. Results of the study suggest that emerging markets are more integrated with Pakistani equity markets as compared to Sri Lankan equity market suggesting the presence of regional equity market connectedness.*

Keywords: Heterogeneous panels, emerging and frontier markets, equity returns, co-integration, pooled mean analysis.
JEL Classification: G10, G11, F65

Introduction

Current literature highlight three main reasons attributed for the growing relationship among frontier, emerging and developed equity market returns. First, emerging and frontier markets are more sensitive to changes in developed markets as compared to their counterparts. Second, international investors grade investments in emerging markets as more rewarding. Third, regulations in these emerging and frontier markets are more supportive and relaxed for developed markets investors (M. Rehman & Shah, 2016). Existing studies present evidence of interconnectedness among international equity returns mostly comprising of developed markets. However, few studies report the relationship of developed with emerging equity returns. Recent literature has evidence of return co-movement of developed markets with the emerging markets of MENA, Latin America and CEE markets however literature solely investigating interconnectedness between emerging and frontier markets is scarce. In our study, we fill this gap by covering not only all the emerging but frontier markets of Asia according to the classification of Morgan Stanley Capital Investment (MSCI). We apply panel co-integration framework to check short and long run relationship followed by Pooled Mean Group (PMG) analysis to investigate the presence

*Shaheed Zulfikar Ali Bhutto Institute of Science and Technology (SZABIST), Islamabad, Pakistan.
†Monpellier Business School, Montpellier, France.

of causal relationship. This application of pooled mean group (Pesaran, Shin, & Smith, 1999) is rarely used in finance literature. Traditional dynamic fixed effect techniques only estimate similar short and long run relationships. This can result in the estimation of inconsistent parameters because of long time dimension thereby producing misleading estimates. PMG framework not only deals with heterogeneous panels but also provides consistent and efficient long run estimates. By applying this technique we can find the presence of short and long term relationship, if any among our sampled emerging and frontier markets of Pakistan, Sri Lanka and Bangladesh.

Existing studies presents the inter relationship of equity returns among developed markets however emerging and frontier markets have rarely been investigated. Some studies consider emerging markets along with the develop equity markets in their analysis however complete sample of emerging markets following any index is missing. Some recent studies although presents emerging markets as effective and prospective for equity investments however discussion of frontier markets is scarce. Therefore, our contribution in this study is as follows. First, we analyze interconnectedness between the emerging and frontier equity markets of Asia. These frontier and emerging stock markets remained untapped for measuring international equity returns relationship. Second, we use the PMG methodology proposed by Pesaran et al. (1999) for measuring short and long run relationship between frontier and emerging Asian equity markets. This methodology allows the variation of short run parameters while keeping the long run coefficients constant.

Results of our study highlight the presence of both short and long run relationship among our sampled markets. We conclude the presence of bi-directional causality over short and long run period. Emerging Asian markets show sensitivity to changes in frontier markets of Sri Lanka, Pakistan and Bangladesh however these three frontier markets show less sensitivity from their emerging counter parts. Further analysis show that emerging markets are more sensitive to changes in Pakistani equity markets as compared to the equity market of Sri Lanka and Bangladesh. The results of panel co-integration analysis and pooled mean group framework provide consistent estimates for predicting variance in emerging markets due to frontier markets. Our results have implications for investors interested in the diversification of their equity portfolios within Asian region. For international investors making equity investments in emerging and frontier Asian markets, this study provides important findings that can be useful in rebalancing their portfolios among the selection of stocks between frontier and emerging equity markets.

Rest of the paper is structured as follows. Section 2 presents review of literature. Section 3 describes the methodology. Section 4 presents data analysis. Finally, Section 5 concludes the study.

Literature Review

Relationship between the equity returns of emerging and developed financial markets presents an important topic as integration among international equity markets has increased significantly over the last couple of decades. This equity market integration has strong implications for risk minimization by portfolio diversification. This integration

increases significantly during periods of financial turbulence as spillover of returns from developed to emerging markets is widely observed. Eun and Shim (1989) reported that Asian and European emerging markets are more sensitive to US markets during crises periods. According to Benkato and Darrat (2003), Turkish equity returns are less integrated in short run with the developed stock markets of Europe, US and Japan however, retain their association in the long run thus preventing ultimate breakaway. According to Yang (2006), Korean equity returns exhibit significant variations due to returns movement in the stock markets of Indonesia, Singapore and Malaysia. Besides these emerging markets, developed markets of US also have major influence on Korean equity returns. Similarly, current literature by Cheung and Mak (1992); Eun and Shim (1989); Voronkova (2004); Darrat and Zhong (2000) highlights the influential role that developed markets exercise on the stability of emerging market returns.

Frontier markets now are also considered an attractive investment opportunity along emerging markets. Aurangzeb and Dilawer (2012) suggests that factors like international trade, increase in capital mobility, relaxation of controls on capital movement and various alignments in policy control can affect bilateral equity return co-movements. Global financial crisis of 2008-09 revealed the impact of US equity returns on global equity returns (i.e. developed, emerging, frontier) in the form of contagion. According to Didier, Love, Martinez, and Maria (2010), US equity market returns not only affect emerging but other developed market returns as well. Karolyi and Stulz (1996) reported high return correlation between Japanese and US markets during high volatile periods thus reducing diversification benefits. However, Longin and Solnik (1995) suggested that emerging markets are less integrated with the developed markets because of low exposure to global factors. This results in low sensitivity of emerging with the developed markets. During the financial crisis of 2008-09, major developed markets affected emerging market returns, however impact of US equity returns was the strongest among all thus retaining its most influential position among international financial markets. Johnson and Soenen (2002) concluded that emerging and frontier markets of Asia are more co-integrated with Japanese equity markets than any other developed market. According to Ciarlone, Piselli, and Trebeschi (2009), integration between developed and emerging stock markets can increase with an improvement in emerging market fundamentals. They also reported vulnerable behavior of emerging markets to the changes in developed equity markets.

Due to an increasing level of co-integration between Japan and emerging Asian markets, Yang (2006) applied DCC-GARCH framework to measure role of market conditions on bilateral equity co-movement. Significant dynamic correlation is also reported by P. Wang and Moore (2008) to measure co-integration between developed and Central Eastern European (CEE) markets. Aktar, Demiric, and Ozturk (2009) highlight globalization whereas M. Rehman (2016) identified macro-economic factors as a major determinant for such high co-integration levels among international equity returns. Floros (2005) highlighted long term relation between US, Japan and Europe suggesting return spillover among developed markets as well. Results indicated the presence of unidirectional causal effect from S&P 500 to Nikkei 225, FTSE100 to S&P 500 and bidirectional causality between FTSE100 and Nikkei 225. Masih and Masih (1997) found co-integrating vectors among equity returns of major South Asian countries i.e. Taiwan, Singapore, South Korea, Hong Kong and

Japanese equity markets. Similar findings are also reported by Goh (2005); M. U. Rehman and Shah (2016) for co-integration among the equity returns of Singapore, Philippines, Indonesia, Thailand and Malaysia.

Dependence structure among international equity market returns has gained a lot of attention by various theorists, research community and practitioners especially after the global financial crisis of 2008. According to L. Wang (2014), this financial crisis was the worst of its kind after the great depression of 1930 which was further triggered by the demise of Lehman Brothers. This affected not only the developed but also the emerging and frontier markets of the world. The resulting financial uncertainty and instability also led subsequent crises and turmoil mainly including the Eurozone crisis, the London movement and public reactions in Greece, Italy, Turkey and Egypt. Events of such nature and magnitude questioned the way through which fundamental of stock market co-movements needs to be analyzed. All these events followed by financial uncertainty and disturbances raised many concerns regarding the determinants of stock market co-movements, especially on their stability and underlying commonality. Moreover, it became apparent that co-movements of asset price fundamentals can only provide important information on simultaneous deterioration of wealth in larger group of countries (Uygur & Tacs, 2014).

Despite many evidences of stock market co-integration between developed and emerging countries, some researchers (for example see Arshanapalli, Coggin, and Doukas (1998); Berger, Pukthuanthong, and Yang (2011)) were unable to find any short and long run relationship. According to them, more diversification and investment opportunities exist for international investors due to lower level of equity market co-integration. In similar context, Bekaert, Harvey, and Lundblad (2011) examined 23 developed and emerging markets and reported no increase in international co-movement pattern however European countries exhibit slight increase in return co-movement from 1980 to 2005. Agenor (2005) support these results and concluded that international investors started making sizable investments in Pacific basin, Central and Eastern Europe and East Asia only after 1980. This increase in investments in emerging Asian markets can also be attributed to improved stock market regulations and reforms for attracting foreign capital.

Methodology

We applied pooled mean group (PMG) framework to measure short run dynamics and identical long run relationship between heterogeneous panels. According to Pesaran et al. (1999), different factors like common technologies, arbitrage conditions, budget constraints etc. can have identical effects on all selected groups that can result in identical long run coefficients. Therefore, because of similarity in political and economic linkages we consider common coefficients for long term relationship. Short run coefficients differ because of dynamic specification. One important reason for considering heterogeneity among participant countries over short run period is the sensitivity of emerging market returns to the fluctuation in frontier market equity returns.

Empirical models used in past studies for handling dynamic panels mainly include generalized method of moments that captures long run dynamics among variables of interest.

The application of pooled mean group allow us to measure both short and long run dynamics (see Arellano and Bover (1995)). PMG technique not only deals with the heterogeneous panels but also provides consistent and efficient long run estimates. In applying PMG estimation under the assumption of parameter homogeneity, efficiency of the long run estimates can be broken down [1]. This test also allows variance of short run dynamics among the groups because of their unique intrinsic characteristics whereas traditional dynamic fixed effect techniques only estimate similar short and long run relationships. This can result in the estimation of inconsistent parameters because of long run dimension and therefore provide misleading results. According to Pesaran et al. (2001), PMG framework can deal with long run coefficients under the assumption of homogeneous subsets. Expression of PMG with error correction term (ECT) is as follows.

$$\Delta y_{it} = \phi_i \mu_{i,t-1} + \sum_{l=1}^{p-1} \Delta y \alpha'_{il} \Delta y_{i,t-1} + \sum_{j=0}^{q-1} \beta'_{ij} \Delta X_{i,t-j} + \gamma'_i Z'_{it} + \mu'_i \nu'_{it} + \epsilon_{it} \quad (1)$$

$$\mu_{i,t-1} = y_{i,t-1} - \phi' X_{it}$$

In equation (1), y_{it} is the dependent variable and X_{it} represent all the independent variables with long and short run effect on y_{it}. Z_{it} has long run variance on y_{it}, ϵ_{it} represents error term and ν_{it} shows deterministic vectors i.e. time trend, constant and dummy variables. ϕ_i represent error correction coefficient for short run that provides convergence to long run equilibrium. $\mu_{i,t-1}$ in the above expression measures deviation from long run. ϕ shows long run common coefficient vector that measures impact on y_{it} by vectors in X_{it}. α, β and γ represents coefficient vectors measuring short term responses for each corresponding variable due to Δy_{it}. μ_i represents country specific effects. We used Schwarz Bayesian Information Criteria (BIC) for selecting lag orders p and q. According to Pesaran et al. (2001), maximum likelihood estimators can provide consistent values with normal distribution. Application of PMG framework is used in the past for macroeconomic variables but it is not common for financial variables. In our study, we used PMG framework to investigate short and long run relationship between emerging and frontier Asian equity market returns and by including oil prices and exchange rates as a robustness measure.

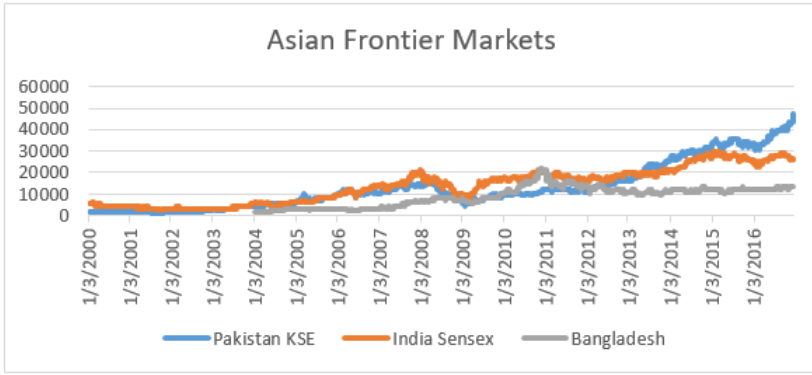
Analysis and Discussion

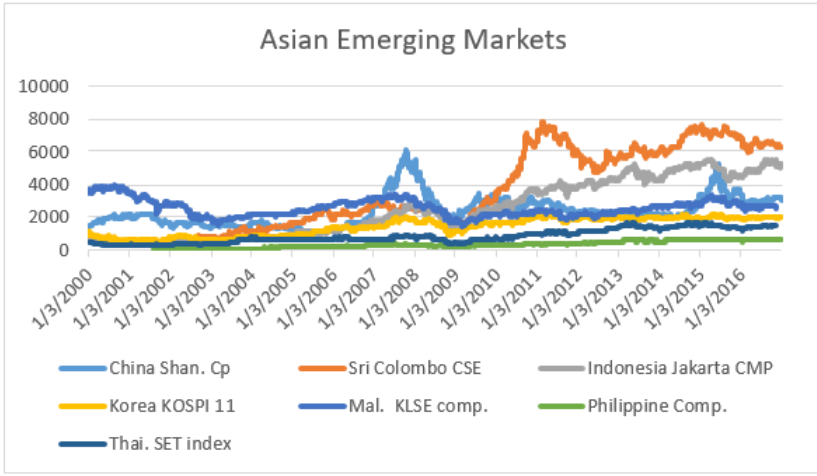
Sample markets that we include are according to Morgan Stanley Capital Investment (MSCI) emerging and frontier Asian equity market index. Frontier Asian markets include Pakistan, Sri Lanka and Bangladesh. Emerging Asian markets include India, China, Indonesia, Thailand, Malaysia, Korea and Philippine. Monthly data for stock prices is collected from Jan 2000 to December 2016. Our sample period incorporates all the major economic and financial events to measure short and long run relationship for the included

[1] According to Pesaran et al. (2001), MG estimation takes average of the individual regression estimates over the period of long and short run.

markets. Data for the sampled emerging and frontier equity markets is sources from Thomson Reuters Data Stream Financials.

Figure 1
Daily Equity Pricing from January 2000-December 2016





Preliminary Analysis of the Data

Figure 1 highlights joint dynamics for selected equity market returns. We can see that all the indices follow almost similar patterns and time trend with long run relationship. During the global financial crisis of 2008-09, most of the financial markets demonstrated decline in their share prices that prompted the investigation of underlying long and short run relationships in the presence of such turmoil periods and crisis.

Table 1
Descriptive Statistics

Variables	Pak	Sri Lanka	Bangladesh	China	India	Indonesia	Korea	Malaysia	Philippine	Thailand
Mean	0.018	0.014	0.003	0.004	0.009	0.011	0.003	0.004	0.007	0.005
Max.	0.267	0.225	0.101	0.243	0.249	0.183	0.203	0.127	0.154	0.212
Min.	-0.448	-0.176	-0.098	-0.283	-0.273	-0.377	-0.263	-0.165	-0.275	-0.244
Std. dev.	0.083	0.071	0.022	0.078	0.071	0.069	0.069	0.045	0.063	0.050
Skew.	-1.500	0.271	0.253	-0.548	-0.508	-1.130	-0.428	-0.423	-0.690	-0.659
Kurt.	6.701	0.665	7.180	1.627	1.457	4.679	1.036	1.385	1.903	7.624
ARCH	46.22*	38.42*	180.0*	30.82*	23.60*	42.96*	42.12*	26.83*	41.21*	19.28
JB	404.32*	5.547*	0.823*	0.503*	0.293*	1.800*	1.616*	0.961*	0.203*	3.398*

Notes: * represents the rejection of null hypothesis at 5 percent or better. JB is the Jarque Bera normality test.LB is the test for, autocorrelation and represents Ljung-Box of order 12. Conditional heteroscedasticity is represented by ARCH values of order 12.

Table 1 highlights equity return characteristics for selected market to have a closer look at their descriptive and statistical properties. For EFA markets, monthly average return ranges between the lowest for Bangladesh and Korea i.e. 0.3 percent and the highest for Pakistan i.e. 1.8 percent. Pakistan equity returns exhibit maximum risk whereas Bangladesh returns have minimum value (i.e. 2.2 percent). Error variance among included groups in PMG framework is supported by the fact that risk factor varies across each equity market because of their different structures, regulation and many other inherent characteristics. Except Bangladesh and Sri Lanka, all equity returns are negatively skewed whereas kurtosis coefficient is less than three for majority of the stock markets. ARCH effect is present in all the equity markets whereas only KSE 100 index of Pakistan rejects normality hypothesis.

Table 2
Correlation Analysis

Variables	Pak	Sri Lanka	Bangladesh	China	India	Indonesia	Korea	Malaysia	Philippine	Thailand
Pak	1	0.200*	0.017	0.098	0.104	0.144	0.213*	0.235*	0.135	0.132
India		1	-0.023	0.340*	0.233*	0.629*	0.628*	0.497*	0.542*	0.288*
Bangladesh			1	-0.029	-0.068	-0.061	-0.049	-0.019	-0.041	-0.079
China				1	0.035	0.249*	0.284*	0.342*	0.218*	-0.024
Sri Lanka					1	0.243*	0.202*	0.172*	0.199*	0.022
Indonesia						1	0.562*	0.500*	0.642*	0.290*
Korea							1	0.406*	0.514*	0.403*
Malaysia								1	0.368*	0.203*
Philippine									1	0.442*
Thailand										1

Notes: * represents the rejection of null hypothesis at 5 percent or better.

Table 2 presents correlation analysis in which all the three frontier markets returns have low correlation values with other emerging market returns. Indian market has high correlation values Indonesia, Korea and Philippine equity markets . Moderate correlation is found among frontier markets. It can also be seen that more correlation is evident among emerging market returns as compared to their correlation with frontier equity markets suggesting more diversification opportunities. The statistics presented above gives us an indication of the connectedness between emerging and frontier Asian markets but more sophisticated techniques like panel co-integration and PMG will enable us to have a clear and better understanding of short and long run dynamics.

Panel Unit Root Test

Before applying panel co-integration test, we check the stationarity of our sampled equity markets. For this purpose, we used Im, Pesaran et al. (1999); Levin, Lin, and Chu (2002) framework. The power of Levin-Lin-Chu is its probability of rejecting null hypothesis if false (presence of unit root). The expression of Augmented Dickey Fuller (ADF) test for cross sectional groups is given below.

$$\Delta y_{it} - \rho_i y_{i,t-1} + \sum_{L=1}^{pi} \theta i L \Delta y_{it-L} + \alpha_{mi} d_{mt} + \varepsilon_{it} \tag{2}$$

After testing equation (1) and estimating residuals Δy_{it} and Δy_{it-L}, we standardized them. Finally, we estimated pooled OLS regression presented below.

$$\hat{e}_{it} - \rho \hat{v}_{i,t-1} + \bar{\epsilon}_{it} \tag{3}$$

As our panel data is balanced, we applied IPS with LLC statistic. Both test statistics present similar results suggesting stationary at level.

Table 3
Panel Unit Root Analysis

Series	Levin, Lin & Chu		Im, Pesaran and Shin	
	Statistic	Prob.	Statistics	Prob.
Emerging Markets	-0.8396*	0.0003	-13.0956*	0
Pakistan	-0.8743*	0.0136	-9.5396*	0
Sri Lanka	-0.9376*	0.0029	-15.5876*	0
Bangladesh	-0.7596*	0.0159	-18.9863*	0

Notes: * represents the rejection of null hypothesis at 5 percent or better.

Panel Co-Integration Test

To investigate long term dependence among stock markets, we applied Pedroni cointegration test, expression of which is presented below [2].

$$y_{it} = \delta_{1i} + \delta_{2i} t + \theta_{1i} X_{1,it} + \theta_{2i} X_{2,it} + \theta_{3i} X_{3,it} \epsilon_{it} \tag{4}$$

We check co-integration in every possible case as the direction of relationship among emerging and frontier markets is unknown. Therefore, any variable can play the role of forcing variable. For that reason, we ran four different models with changing dependent variable. In model 1, y_{it} represents emerging Asian markets whereas $X_{1,it}$ represents Pakistani equity returns, $X_{2,it}$ is Bangladesh stock returns and $X_{3,it}$ is Sri Lankan stock returns. In model 2, y_{it} represents Pakistani equity returns, $X_{1,it}$ is Sri Lankan stock returns, $X_{2,it}$ is Bangladesh stock returns whereas $X_{3,it}$ represents emerging Asian market returns. In model 3, y_{it} represents Sri Lankan stock returns whereas $X_{1,it}$ is Bangladesh equity returns, $X_{2,it}$ is emerging market returns and $X_{3,it}$ is Pakistani stock market returns. In model 4, y_{it} represents Bangladesh stock returns, $X_{1,it}$ is emerging market returns, $X_{2,it}$ is Sri Lankan stock returns and $X_{3,it}$ is Bangladesh equity returns.

[2]Two statistics that we have used in this paper are panel rho statistics for homogeneity among the groups and group rho statistic used for the heterogeneity among groups.

Table 4
Panel Cointegration Analysis

Model	Rho Statistics (Panel)	Rho Statistics (Group)
Model 1	-49.56*	-59.39
	(–53.20)	-31.59
Model 2	-68.36*	-59.89*
	(-47.86)	(-43.50)
Model 3	-59.69*	-49.89*
	(-28.63)	(-53.96)
Model 4	-51.59*	-39.89*
	(-43.12)	(-55.63)

Notes: * represents the rejection of null hypothesis of no co-integration among the series. Values in parenthesis represents t values.

Results of Table 4 shows that emerging and each of the frontier equity markets i.e. Pakistan, Sri Lanka and Bangladesh stock returns are integrated with each other. These findings can be useful for international investors because of such underlying common trends. However, according to Madaleno and Pinho (2010), existing relationship between stock markets may change during financial crises periods that can results in risk despite of common trends in returns.

Pooled Mean Group (PMG) Estimations

After applying co-integration tests, we investigated causal linkage of frontier Asian markets i.e. Pakistan, Sri Lanka and Bangladesh with Asian emerging markets by applying PMG framework presented in eq (1). We tested all four models in which y_{it} represents emerging Asian markets as a dependent variable in model 1, Pakistan stock returns in model 2, Bangladesh stock returns in model 3 whereas Sri Lanka equity returns in model 4. All remaining variables act as independent variables in each model as X_{it}. Control variables are not included in the model as variables in X_{it} vectors are tested only. Statistical significance will testify the presence of short and long run causal linkage among these markets in our model. The application of PMG allows variance of short run dynamics among the groups because of their unique intrinsic characteristics. According to Pesaran et al. (2001), PMG framework can deal with long run coefficients under the assumption of homogeneous subsets. Also, the similarity in the long run coefficients among the participating countries are due to reasons having a common effect among all the markets. This is the main advantage of the application of pooled mean variance techniques as it allows the short run parameters to vary whereas keeping long run coefficients constant. Another added advantage by PMG is that it highlights the adjustment factor between short run and long run coefficients which the traditional dynamic panel tests like Fully Modified OLS and Dynamic OLS do not offer as making assumptions about short term dynamics and error variances to be same seems less compelling.

Results of Table 5 highlight long run relationship between emerging and equity returns of Sri Lanka, Bangladesh, Pakistan returns and sensitivity of each market is also evident. In our first model, Bangladesh returns induces maximum variance of 23 percent in emerging Asian markets whereas Sri Lankan equity returns produces variation of 5.23 percent.

Table 5
PMG Long Run Estimation

Dependent Variables	Emerging markets	Pakistan	Bangladesh	Sri Lanka
Emerging markets	-	0.1398*	0.3561*	0.5632*
		-0.0365	-0.0632	-0.0596
Pakistan	0.1926*	-	0.5963*	0.4986*
	-0.0395		-0.0488	-0.3261
Bangladesh	0.2956*	0.0896*	-	0.9863*
	-0.0896	-0.0356		-0.0986
Sri Lanka	0.0896*	0.0598*	0.0965*	-
	-0.0536	-0.0563	-0.0236	

Notes: * represents the rejection of null hypothesis at 5 percent or better.
Values in parenthesis represents standard error.

For other models, except Bangladesh returns, all indices produce an optimal variation in their panel counterparts suggesting that exogenous variables produce more variations than other dependent variables. Another point of consideration is the positive coefficient values for each market suggesting that impact of long run causal relationship is more important for investors than the direction of relationship.

Table 6
PMG Short Run Estimation

Dependent Variables	Emerging markets	Pakistan	Bangladesh	Sri Lanka
Emerging markets	-	0.0896*	0.3259*	0.1839*
		-0.0397	-0.0398	-0.0765
Pakistan	0.0953*	-	0.1896*	0.4539*
	-0.0568		-0.0532	-0.0536
Bangladesh	0.3132*	0.1396*	-	0.6895*
	-0.0598	-0.0056		-0.0236
Sri Lanka	0.0598*	0.0537*	0.0696*	-
	-0.0089	-0.0022	-0.0036	

Notes: * represents the rejection of null hypothesis at 5 percent or better.
Values in parenthesis represents standard error.

Table 6 shows that long run causal relationship among all equity markets is driven by short run adjustment. We can see in Table 6 that Bangladesh stock returns produce maximum variation in emerging markets whereas moderate changes are induces by Sri Lankan and Pakistani stock returns. For other models, Pakistani and Bangladesh stock returns induces significance variations in Sri Lankan equity returns. We can see that short run variations play an important role in driving long run relationship between these markets. These short run variations also converge towards long run relationship between and among frontier and emerging markets. However, magnitude of variations is positive and more significant in long run as compared to short run. Table 6 and Table 7 also highlights the fact that magnitude of relationship (i.e. variance of forcing variables on dependent variable) in each model is different and not equally sensitive. Emerging markets are more sensitive to changes in frontier markets than if the direction is reversed. Equity returns of Sri Lanka and Bangladesh tend to induce more changes than emerging markets as compared to Pakistani stock returns. However, in case of relationship among frontier markets only, Sri Lankan stock returns play more important role in inducing changes in its other frontier market counterparts i.e. Bangladesh and Pakistani equity markets. Results

of PMG framework are consistent with preliminary findings and co-integration results for both short and long run. Our results also highlight some common trends among all the sample equity indices because of their strong interrelationship and increased equity market integration.

Table 7
PMG Long Run Estimation

		Dependent Variables			
		Emerging markets	**Pakistan**	**Bangladesh**	**Sri Lanka**
Independent Variables	Emerging markets	-	0.1632*	0.2698*	0.1031
			-0.0596	-0.0536	-0.0914
	Pakistan	0.2659*	-	0.5365*	0.3990*
		-0.0532		-0.0596	-0.0178
	Bangladesh	0.2868*	0.0269*	-	0.8499*
		-0.0569	-0.0365		-0.016
	Sri Lanka	0.0596*	0.0298*	0.0896*	-
		-0.0563	-0.0536	-0.0236	
	Exchange Rate	-0.0037*	-0.0005*	0.0003	0.0007
		-0.0003	-0.0002	-0.0001	-0.0001
	Brent Oil	-0.0029*	-0.0003	0.0005**	0.0004
		-0.0003	-0.0002	-0.0022	-0.0001

Notes: * represents the rejection of null hypothesis at 5 percent or better.
Values in parenthesis represents standard error.

Robustness Test

As a robustness test for causal bidirectional long and short run relationship, we apply sensitivity analysis. To check long and short run dynamics among emerging Asian and frontier equity markets, we introduced Brent oil prices and exchange rates as control variables.

Table 8
PMG Short Run Estimation

		Emerging markets	**Pakistan**	**Bangladesh**	**Sri Lanka**
Independent Variables	Emerging markets	-	0.0896*	0.2532*	0.1569*
			-0.0365	-0.0365	-0.0262
	Pakistan	0.2363	-	0.1598*	0.4365*
		-0.0365		-0.0236	-0.0235
	Bangladesh	0.3329*	0.2365*	-	0.3962*
		-0.0563	-0.0089		-0.0336
	Sri Lanka	0.0239*	0.0563*	0.0639*	-
		-0.0043	-0.0006	-0.0029	
	Exchange Rate	0.0039*	-0.0004*	-0.0007	0.0033*
		-0.0026	-0.0003	-0.0004	-0.0002
	Brent Oil	-0.0006	-0.0004*	-0.0029*	-0.0027*
		-0.0004	-0.0002	-0.0002	-0.0003

Notes: * represents significance level at 1 percent, ** at 5 percent and *** at 10 percent.
Values in parenthesis represents standard error.

Z_{it} in eq (1) represent vectors along auxiliary variables i.e. Brent oil prices and exchange rates. Table 7 and Table 8 report both long and short run relationship between emerging and frontier Asian markets with control variables. Both long and short run bidirectional causality exist between frontier and emerging Asian markets. Direction of relationship

before and after the inclusion of control variables remains unchanged. Among frontier Sri Lankan, Pakistani and Bangladesh equity market returns, low coefficient values highlight moderate relationship however emerging markets are sensitive to the changes in Pakistani stock markets both over long and short run. Both exchange rate and Brent oil have moderate negative values for Pakistani and emerging Asian equity returns whereas positive values for Sri Lankan and Bangladesh equity returns over long run. To sum up, both exchange rates and Brent oil have moderate negative coefficient values for emerging Asian markets.

Conclusion

Although a lot of work is done on the relationship between developed and emerging Asian equity markets but very few have discussed return connectedness between emerging and frontier equity markets. We applied pool mean group (PMG) framework to deal with dynamic heterogeneous panels and for checking long and short run relationship. To check bidirectional causal relationship, we selected almost monthly returns data from January 2000 to December 2016 for Asian frontier and emerging equity markets. Results of our study confirm strong short and long run relationship between frontier and emerging markets whereas mild short and long run relationship among frontier markets both before and after the inclusion of Brent oil prices and exchange rates as control variables.

Results of our study have important implications for policy makers, academicians and practitioners. Bidirectional causal relationship of emerging Asian with frontier markets can help policy makers and investment community of these markets to devise strategies keeping in view the sensitivity of these emerging markets to frontier market returns. This can also be helpful in predicting emerging and frontier markets over short and long run.

International investors willing to make investments both in emerging and frontier Asian markets can benefit from the results of our study in making diversified portfolios. The direction and magnitude of relationship can also guide in selecting equity stocks that need to be selected with the rest. This can enable these investors to get maximum diversification benefits by minimizing risk resulting from returns spillover or financial contagion.

Future implication of this study can be to investigate the factors responsible for such co-movement patterns. Rather relying only on correlation values to determine bilateral co-movement, important determinants for such pattern needs to be explored. With an increase in globalization, its impact on the co-movement pattern is of utmost importance. Along with exchange rates and Brent oil prices, more extraneous variables can play an important role like global investor sentiment spillover, oil prices shocks, momentum effect etc. Volatility spillover between these markets can also be explored as the nature of relationship may vary from existing equity return co-integration. It can also be helpful for investors to investigate the extent of volatility transmission among these associated markets as these can have varying coefficients influenced by such factors. Sectoral return co-movement can also have different results e.g. co-movement among energy sectors of Emerging, frontier and developed markets and important implications for international investors. The underlying rationale is that at the national level, stock prices can hide such characteristics specific to

sectors and each sector reacts differently to various events, news and other sector returns.

References

Agenor, R., P. (2005). The analytics of segmented labor markets. *Centre for Growth and Business Cycle Research Discussion Paper Series*, *52*(4), 1–80.

Aktar, I., Demiric, N., & Ozturk, L. (2009). Can unemployment be cured by economic growth and foreign direct investment? *Sosyal Ekonomik Aracstirmalar*, *11*(17), 452–467.

Arellano, M., & Bover, O. (1995). Another look at the instrumental variable estimation of error-components models. *Journal of Econometrics*, *68*(1), 29–51.

Arshanapalli, G., B, Coggin, D., T, & Doukas, J. (1998). Multifactor asset pricing analysis of international value investment strategies. *The Journal of Portfolio Management*, *24*(4), 10–23.

Aurangzeb, D., & Dilawer, T. (2012). Impact of terrorism on stock returns: Evidence from Pakistan. *Universal Journal of Management and Social Sciences*, *2*(8), 1–23.

Bekaert, G., Harvey, R., C, & Lundblad, C. (2011). Financial openness and productivity. *World Development*, *39*(1), 1–19.

Benkato, M., O, & Darrat, F., A. (2003). Interdependence and volatility spillovers under market liberalization: The case of Istanbul stock exchange. *Journal of Business Finance & Accounting*, *30*(7-8), 1089–1114.

Berger, D., Pukthuanthong, K., & Yang, J., J. (2011). International diversification with frontier markets. *Journal of Financial Economics*, *101*(1), 227–242.

Cheung, L., Y, & Mak, C., S. (1992). The international transmission of stock market fluctuation between the developed markets and the Asian-Pacific markets. *Applied Financial Economics*, *2*(1), 43–47.

Ciarlone, A., Piselli, P., & Trebeschi, G. (2009). Emerging markets' spreads and global financial conditions. *Journal of International Financial Markets, Institutions and Money*, *19*(2), 222–239.

Darrat, A. F., & Zhong, M. (2000). On testing the random-walk hypothesis: a model-comparison approach. *Financial Review*, *35*(3), 105–124.

Didier, T., Love, I., Martinez, P., & Maria, S. (2010). What explains stock markets' vulnerability to the 2007-2008 crisis? *Applied Financial Economics*, *8*(2), 1–34.

Eun, S., C, & Shim, S. (1989). International transmission of stock market movements. *Journal of Financial and Quantitative Analysis*, *24*(2), 241–256.

Floros, C. (2005). Price linkages between the US, Japan and UK stock markets. *Financial Markets and Portfolio Management*, *19*(2), 169–178.

Goh, H., B. (2005). The dynamic effects of the Asian financial crisis on construction demand and tender price levels in Singapore. *Building and Environment*, *40*(2), 267–276.

Johnson, R., & Soenen, L. (2002). Asian economic integration and stock market comovement. *Journal of Financial Research*, *25*(1), 141–157.

Karolyi, A., G, & Stulz, M., R. (1996). Why do markets move together? An investigation of US-Japan stock return comovements. *The Journal of Finance*, *51*(3), 951–986.

Levin, A., Lin, F., C, & Chu, S. J., C. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics*, *108*(1), 1–24.

Longin, F., & Solnik, B. (1995). Is the correlation in international equity returns constant: 1960-1990? *Journal of International Money and Finance*, *14*(1), 3–26.

Madaleno, M., & Pinho, C. (2010). Relationship of the multiscale variability on world indices. *Revista De Economia Financiera*, *20*(2), 69–92.

Masih, M., A, & Masih, R. (1997). Dynamic linkages and the propagation mechanism driving major international stock markets: An analysis of the pre-and post-crash eras. *The Quarterly Review of Economics and Finance*, *37*(4), 859–885.

Pesaran, H., M, Shin, Y., & Smith, J., R. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326.

Pesaran, H., M, Shin, Y., & Smith, P., R. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American Statistical Association*, *94*(446), 621–634.

Rehman, M. (2016). Changing nature of financial contagion in EFA markets in crisis periods: A multivariate GARCH dynamic conditional correlation framework. *Lahore Journal of Economics*, *21*(2), 121–151.

Rehman, M., & Shah, M. A., S. (2016). Determinants of return's co-movement for effective portfolio diversification among regional stock markets. *Revista Evidenciaccao Contabil & Financas*, *4*(1), 84–96.

Rehman, M. U., & Shah, S. M. A. (2016). Factors influencing co-movement of diversified portfolio between Pakistan and India. *International Journal of Economics, Management and Accounting*, *24*(2), 163–181.

Uygur, U., & Tacs, O. (2014). The impacts of investor sentiment on different economic sectors: Evidence from Istanbul stock exchange. *Borsa Istanbul Review*, *14*(4), 236–241.

Voronkova, S. (2004). Equity market integration in central European emerging markets: A cointegration analysis with shifting regimes. *International Review of Financial Analysis*, *13*(5), 633–647.

Wang, L. (2014). Who moves East Asian stock markets? The role of the 2007-2009 global financial crisis. *Journal of International Financial Markets, Institutions and Money*, *28*, 182–203.

Wang, P., & Moore, T. (2008). Stock market integration for the transition economies: Time-varying conditional correlation approach. *The Manchester School*, *76*(1), 116–133.

Yang, Y. (2006). China's integration into the world economy: Implications for developing countries. *Asian-Pacific Economic Literature*, *20*(1), 40–56.