



Does inter-region portfolio diversification pay more than the international diversification?

Nasir Ahmad^a, Mobeen Ur Rehman^{b,c}, Xuan Vinh Vo^d, Sang Hoon Kang^{e,f,*}

^a S&P Global, Islamabad, Pakistan

^b Institute of Business Research, University of Economics Ho Chi Minh City, Vietnam

^c South Ural State University, 76, Lenin Prospekt, Chelyabinsk, Russian Federation

^d Institute of Business Research and CFVG, University of Economics Ho Chi Minh City, Vietnam

^e PNU Business School, Pusan National University, Busan, Republic of Korea

^f UniSA Business, University of South Australia, Adelaide, Australia

ARTICLE INFO

Article history:

Received 15 June 2021

Received in revised form 28 August 2021

Accepted 28 October 2021

Available online 4 November 2021

Keywords:

Cointegration

VECM

Granger causality

FMOLS

ABSTRACT

Recent literature supports the view that returns of most of the international equity markets are significantly integrated. However, diversification based across different regions remains a focus of attention for the investment community. We examine the presence of returns integration among BRICS, Latin American, and emerging and frontier Asian equity markets by utilizing panel co-integration and panel regression, i.e., fully modified ordinary least square (FMOLS), to examine portfolio diversification opportunities. Our sampling of data comprises of daily stock return from 1st September 1997 to 30th November 2018. Our findings highlight that within the region, portfolio diversification does not provide optimal returns. Furthermore, empirical results from the vector error correction model (VECM) suggest the benefits of portfolio diversification in the short-run. In particular, not all equity markets are significantly linked with gold, oil, and forex markets. Our empirical analysis reveals that within the region, equity-commodity portfolios may lead to greater diversification gains.

© 2021 Board of Trustees of the University of Illinois. Published by Elsevier Inc. All rights reserved.

1. Introduction

A sound revolution in the field of information technology coupled with the permeation of high-speed internet connectivity. Such revolutions created a superhighway for the rapid flow of information from the host country towards the international market. Since the internationalization of capital markets, a rapid growth in international capital flow or investment is observed. These capital flows are considered very beneficial for both investors and the host country. This increase in cross-border transactions is the result of a decrease in the cost of information flow. The primary motivation for investing in more than one market is to avoid damaging

the overall returns of a portfolio by the poor performance of a single market. The poor performance of a single market may reduce the total returns of a portfolio comprising of securities from that market. However, modern portfolio theory thrives the attention of investors to diversify risk or volatility by investing in more than one market. It must be ensured that a diversified portfolio comprises of different investments, including stocks, commodities, or mutual funds, etc., with varying risk and returns. This plan is a practice of spreading total capital around so that our exposure to any single type of stock or security is limited. It is accepted that diversification does not guarantee against loss, but it is an important component of reaching out the long-run diversification goals.

Investment in international equity markets became popular in the early 1970s as international investors were provided sufficient information regarding portfolio diversification. However, such investments in the foreign equity markets were specific to the developed equity markets. Late in the 20th century, after the regional financial crisis, when Asian equity markets outperformed the developed equity markets, the focus of international investors deviated from developed to emerging equity markets. This deviation made it easy to diversify capital investment in more than one equity market across the border. For instance, studies on port-

Abbreviations: AFC, Asian financial crisis; ADF, Augmented Dicky Fuller; BRICS, Brazil, Russia, India, China, and South Africa; ECT, error correction term; EFA, emerging and frontier Asian; FMOLS, fully modified ordinary least square; IPS, 2003, Im, Pesaran and Shin (2003); LLC, 2002, Levin, Lin and Chu (2002); L.A., Latin America; MADCC, mixed asymmetric dynamic conditional correlation; U.S., United States; VECM, vector error correction model.

* Corresponding author at: PNU Business School, Pusan National University, Jangjeon2-Dong, Ge-umjeong-Gu, Busan 609-735, Republic of Korea.

E-mail addresses: Rehman@ueh.edu.vn (M.U. Rehman), vxvinh@yahoo.com (X.V. Vo), sanghoonkang@pusan.ac.kr (S.H. Kang).

<https://doi.org/10.1016/j.qref.2021.10.004>

1062-9769/© 2021 Board of Trustees of the University of Illinois. Published by Elsevier Inc. All rights reserved.

folio investments points that capital markets are mostly driven by market intelligence (Hengchao & Hamid, 2015; Yang, Khan, & Pointer, 2003). Thus, decisions regarding capital investment are found highly surrounded by a number of factors. These factors include the availability of complete information, the time perfection, and with minimum cost in comparison (Menon, Subha, & Sagar, 2009).

This study, therefore, brings into focus to examine optimal portfolio diversification opportunities among BRICS (i.e., Brazil, Russia, India, China, and South Africa), Latin American (LA, i.e., Mexico, Argentina, Chile, Peru), and Emerging and Frontier Asian (EFA, i.e., Pakistan, Philippines, Thailand, Korea, Sri Lanka, Malaysia, Indonesia) equity markets over the period ranging from 1st September 1997 to 30 November 2018. It is in line with the literature strand that explores diversification opportunities in the long-run between Emerging, American and the developed stock markets (Aloy, Boutahar, Gente, & Péguin-Feissolle, 2013; Gupta & Guidi, 2012; Karim, Chan, & Hassan, 2010; Karim, Kassim, & Arip, 2010; Mylonidis & Kollias, 2010; Narayan & Rehman, 2017; Ramchand & Susmel, 1998; Thomas, Kashiramka, & Yadav, 2017; Zhang & Li, 2014) using co-integration technique to scrutinize long run interconnection between international stock markets. Several of these studies find least integration suggesting strong benefits from diversification (Batareddy, Gopalaswamy, & Huang, 2012; Berger, Pukthuanthong, & Yang, 2011; Ergen, 2014; Guidi & Gupta, 2011; Sok-Gee, Karim, & Karim, 2010), while others fail to find benefits from diversification in the long-run (Narayan & Rehman, 2018; Rehman & Shah, 2016a, 2016b; Shahzad, Kanwal, Ahmed, & Rehman, 2016). For instance, Chiao, Yu, Li, and Chen (2008) mention that firms' subsidiaries pursuing internationalization and reinvesting in related businesses exhibit superior performance whereas Chang, Kogut, and Yang (2016) show that increase in volatility of markets during the 2008–09 global financial crisis rendered multinational networks more valuable. Likewise, Denis, Denis, and Yost (2002) find that global diversification results in average discounts equal to the industrial diversification. In contrast, Gande, Schenzler, and Senbet (2009) examine the effect of global diversification on firm value using set of US firms and report that global diversification enhances firm value whereas industrial diversification is not important to increase firm value.

Although existing studies document heterogeneous findings about the combination of stocks in a portfolio for achieving optimal returns, this intriguing questions still remains unanswered due to increasing number of investable assets. Our aim in this work is to examine diversification opportunities among a wide geographical sample comprising of BRICS, LA and EFA regions and to evaluate both short- and long-run opportunities for home biased investor. It is important to seek opportunities for a home-biased investor within region and not in a specific market because of an inherent bias. Therefore, our primary motivation remains in examining the regional diversification opportunities, based on the fact that international portfolio investments may be surrounded by different risk exposures compared to regional exposure (from the perspective of home-biased investor). Hence, primary focus in this work is to examine investment opportunities within sampled region rather than investing outside the regions. Our study contributes to the area of portfolio diversification in the following ways. First, studies of regional equity markets are still limited, and our analysis includes equity markets from three different regions. Second, our study incorporates frontier equity markets that are less explored in the literature. Third, we examine each single equity market (e.g., Brazil) against the portfolio of the rest of the equity markets in the region (e.g., Russia, India, China, & South Africa together with gold, oil, and forex markets) using readily applied panel co-integration and panel vector error correction model (VECM). Fifth, we include important markets, i.e., gold, oil and forex markets to provide an

alternative investment source when stock markets in the region are down.

The balance of this paper is structured as follows. Section 2 presents literature pertinent to the area of portfolio diversification. Section 3 explains applied methodologies whereas section 4 presents data and analysis. Finally, section 5 presents the conclusion with implications of our work.

2. Literature review

Since the earlier work of Markowitz (1952, 1959) and Grubel (1968), modern portfolio theory has divulged the merits of international portfolio diversification. Other earlier studies on international diversification gains and reductions have been well documented by Solnik (1974), Lessard (1973), Espitia and Santamaria (1994), and Bekaert and Harvey (1995), among others. For example, Espitia and Santamaria (1994) found a high degree of correlation between European and developed equity markets of the world. Accordingly, benefits from international portfolio diversification during the twentieth century were archived by Grubel (1968), Levy and Sarnat (1970), Lessard (1973), and others. Such studies on weak or insignificant correlations among the capital markets convey information on potential international portfolio diversification opportunities.

However, after the regional financial turbulence of the 1987 U.S. stock market crash, the Asian crisis in 1997–1998, and global liberalization of financial markets made international markets to be more linked than ever. The Asian financial crisis (AFC) in 1997–1998 evoked a wave of studies on Asian markets, some of which investigated the linkages between Asian stock markets. Certainly, it is argued that the U.S. market crash diminished the opportunity to diversify within countries most affected by the crisis (Arshanapalli & Doukas, 1993; Lee & Kim, 1993; Meric & Meric, 1997). Similarly, some empirical studies found that stock markets in Asian countries are more integrated as a result of crisis (Phylaktis & Ravazzolo, 2002; Ratanapakorn & Sharma, 2002; Roca, Selvanathan, & Shepherd, 1998; Yang et al., 2003). In other words, stock market interaction increased after the event of 1997 and thus undermined the argument of international portfolio diversification. In addition, Yang, Khan, and Pointer (2003) and Thomas et al. (2017) examined portfolio diversification opportunities in contrast to the Asian financial crisis and suggested that integration among stock markets is further strengthened during and after the crisis periods.

In addition, global financial disruption in 2007–2008 triggered a wave of studies on international equity markets and the spillover from major equity markets. Many studies used cointegration technique to scrutinize long run interconnection between international stock markets (Arfaoui & Rejeb, 2017; Kumar & Dhankar, 2017; Li, Zhu, & Yu, 2012; Narayan & Rehman, 2017; Narayan, 2015; Noor & Dutta, 2017; Rajwani & Mukherjee, 2013; Seth & Sharma, 2015; Shahzad et al., 2016; Wang, Chen, & Huang, 2011), among others. On the top, a weak form of co-integration among international stock markets is documented (Batareddy, Gopalaswamy, & Huang, 2012; Ergen, 2014; Guidi & Gupta, 2011; Sok-Gee et al., 2010; Zhang & Li, 2014). While some authors filed significant co-integrating association among international stock markets (Mukherjee & Bose, 2008; Narayan & Rehman, 2017, 2018; Rehman & Shah, 2016a, 2016b).

There is ample of evidence in the existing literature regarding integration among BRICS, LA and EFA (Chittedi, 2010; Cardona, Gutiérrez, & Agudelo, 2017; Rehman & Shah, 2016a, 2016b). For instance, Raza, Shahzad, Tiwari, and Shahbaz (2016) examine asymmetric relationship of gold, oil and emerging stock markets and report that gold is positively associated with BRICS stock markets whereas negatively correlated with stock markets of Mexico, Malaysia, Thailand, Chile and Indonesia. However, oil prices have

a negative impact on all emerging stock markets.¹ Kishor and Singh (2017) demonstrate bidirectional relationship among Indian, Brazilian and Russian stock markets whereas Indian stock market is positively correlated with rest of the BRICS stock markets. Similarly, Mensi, Hkiri, Al-Yahyaee, and Kang (2018) find that stock markets in the BRICS region co-move with crude oil in the long-run whereas find no evidence of co-movement between gold and BRICS stock markets highlighting benefits from diversification. Likewise, Patra and Panda (2021) show that high level of integration among BRICS stock markets returns whereas portfolio comprise of gold and BRICS stock markets provide benefits from diversification for investor outside the BRICS economies. While in case of Latin American markets, Aroui, Bellalah, and Nguyen (2010) examine co-movement among Latin American stock markets including Argentina, Brazil, Chile, Colombia, Mexico and Venezuela and report time-varying co-movement among these markets which increased since 1994. Likewise, Dias and Carvalho (2020) examine portfolio diversification benefits in Latin American stock markets including Argentina, Brazil, Chile, Peru and Mexico together with gold and silver and show that these markets are highly integrated thus limiting benefits from diversification. In terms of emerging and frontier Asian market, Baharumshah, Sarmidi, and Tan (2003) show strong integration among four Asian markets including Malaysia, Thailand, Taiwan and South and with the US and Japanese stock markets. Likewise, Mohti, Dionísio, Vieira, and Ferreira (2019) find long-run regional integration among emerging and frontier Asian stock markets as well as global integration of the Indonesia, Malaysia, Korea, Taiwan, Thailand and Pakistan with the US stock market in the long-run. Hanif (2020) report positive association between oil and Pakistan stock markets whereas negative relationship between gold, currency exchange and stock returns.

Typically, vector error correction model and co-integration were used to examine short-run diversification gains since long back (Al-Khazali, Darrat, & Saad, 2006; Narayan & Rehman, 2017; Nielsson, 2007; Ratanapakorn & Sharma, 2002; Rehman & Shah, 2016a, 2016b; Shahzad et al., 2016) among others. Similarly, many theoretical studies have been done with precise deliberation to the methodology of co-integration, including Johansen (1988), Kao (1999), Phillips and Moon (1999), Maddala and Wu (1999), Pedroni (1999, 2004) and Breitung and Das (2005). For instance, some empirical studies suggested mixed results using a co-integration technique to measure the degree of integration among international stock markets (Aladesanmi, Casalin, & Metcalf, 2019; Bundoo, 2017; Huyghebaert & Wang, 2010; Mylonidis & Kollias, 2010; Narayan, Ahmed, Sharma, & Prabheesh, 2014, among others).

As far as the relationship between gold prices and stock market fluctuation is concerned, an extensive literature has been done, and the overall results are best confirmative with each other (Baig, Shahbaz, Imran, Jabbar, & Ain, 2013; Bhunia & Das, 2012). For example, Li et al. (2012) confirmed a significant association between stock markets and the gold market. They argued that periods of increase in gold prices is the reason for instability in financial markets. Similarly, Gilmore, McManus, Sharma, and Tezel (2009) and Gaur and Bansal (2010) studied the relationship between gold prices and stock markets during the period of instability of the financial market. The authors confirmed that, during the period of crisis, rising gold prices always result due to a decline in equity markets.

Numerous existing literatures focused on bilateral linkages among oil prices and stock markets (Aroui & Rault, 2012; Miller & Ratti, 2009; Mollick & Assefa, 2013; Van Robays, 2016) among others. For instance, Zhang (2017) using mixed asymmetry

dynamic conditional correlation (MADCC) technique, investigated the impact of shocks (Iraq war in 2003 and the Global financial crisis in 2007) on the relationship between oil prices and stock markets and showed the increase in the correlation among oil and stock markets of the U.S. and China.

The relationship between equity markets and foreign exchange markets has been studied widely in the existing literature of developed, developing, and emerging countries (Bashir, Yu, Hussain, & Zebende, 2016; Swanson, 2003; Tai, 2007). The relationship between stock prices and the exchange rate is concerned, the published literature endows with some contradictory reasoning whereas the prior approach states that exchange rate leads stock prices, while the portfolio approach documented that stock market mechanism define exchange rate (Caporale, Pittis, & Spagnolo, 2002; Granger, Huangb, & Yang, 2000; Kang & Yoon, 2013; Olugbenga, 2012; Sekmen, 2011). For example, Kang and Yoon (2013) studied the volatility association between the stock market and foreign exchange market in South Korea during the period running from January 1990 to December 2009. The authors concluded that strong causality runs from stock price returns to foreign exchange rates.

3. Methodology

This study use panel Granger² causality proposed by Dumitrescu and Hurlin (2012), which allows all the coefficients to be different across the cross-sections. This technique is recently used by Narayan and Rehman (2018) to examine homogeneous causality in the case of EFA markets. The panel Granger causal relationship estimated is shown in the following equation:

$$P_{it} = \alpha_i + \sum_{m=1}^M y_i P_{i,t-m} + \sum_{m=1}^M \beta_i P_{j,t-m} + \varepsilon_{it} \quad (1)$$

In the above equation, P_{it} is each single country's returns and P_{jt} is the panel returns of other markets in the region. α_i represents intercept in the panel equation whereas y_i and β_i represents coefficients of the lag value of single country's returns and the panel returns of other markets, respectively. The null hypothesis states no causal links for any cross-section panels. In the table above, W-statistic is the average statistics related to the hypothesis of Homogeneous non-causality. Additionally, Z-Statistic indicated the standardized test statistics converging to chi-square distribution.

Next, we use two different panel co-integration techniques, namely Kao (1999) and Pedroni (1999, 2004). We aim to examine the following long-run association among the portfolio conditioned by gold, oil, and forex returns:

$$P_{it} = \delta_1 + \theta_1 P_{jt} + \theta_2 S\&P\ 500_{it} + \theta_3 Gold_{it} + \theta_4 Oil_{it} + \theta_5 Forex_{it} + \mu_{it} \quad (2)$$

In Eq. (2), Gold is gold market returns, Oil is oil market returns, and Forex is foreign exchange returns. In order to analyze the short-run relationship among the stock markets, we utilize the panel vector error correction model (VECM) which is a suitable estimation technique if a set of variables are found to have one or more cointegrating vectors. It adjusts to both short run changes in variables and deviations from equilibrium. The expression of panel VECM is

² According to Granger (2003), the definition of Granger causality is based on the "two precepts that the cause preceded the effect and the causal series had information about the effect that was not contained in any other series according to the conditional distributions. It allows all the coefficients to be different across the cross-sections and forecast the effect produced by the cause and provide suitable post sample tests (Granger, 1980).

¹ These stock markets include China, India, Brazil, Russia, South Africa, Mexico, Malaysia, Thailand, Chile and Indonesia.

Table 1
Descriptive statistics for daily BRICS stock returns.

Variables	Brazil	Russia	India	China	South Africa
Descriptive statistics					
Mean	0.0005	0.0003	0.0003	0.0000	0.0003
Median	0.0007	0.0010	0.0008	0.0002	0.0006
Maximum	0.2884	0.2697	0.1599	0.0940	0.0725
Minimum	−0.1721	−0.2066	−0.1181	−0.0926	−0.0808
Std. Dev.	0.0199	0.0249	0.0150	0.0151	0.0133
Skewness	0.7968	0.1345	−0.1160	−0.2587	−0.2372
Kurtosis	20.733	18.0308	10.8447	8.4192	6.0475
Correlation matrix					
Brazil	1	0.0324	0.1874	0.0844	0.0516
Russia		1	0.1123	0.0639	0.4039*
India			1	0.1675	0.1110
China				1	0.0640
South Africa					1

Note: * highlights significance at the 5% level.

as follows.

$$\begin{aligned} \Delta P_{it} = & \delta_2 + \theta_1 \sum_{k=1}^n \Delta P_{jt-k} + \theta_2 \sum_{k=1}^n \Delta S\&P\ 500_{it-k} \\ & + \theta_3 \sum_{k=1}^n \Delta Gold_{it-k} + \theta_4 \sum_{k=1}^n \Delta Oil_{it-k} + \theta_5 \sum_{k=1}^n \Delta Forex_{it-k} \\ & + \delta_1 ECT_{it-1} + \varepsilon_{it} \end{aligned} \quad (3)$$

All the variables in Eq. (3) is shown in this equation in the first difference form, denoted by Δ . Next, we use the error correction term (ECT), which is one lag of the residual from the long-run model. The ECT if negative and significant, further confirms a stable long-run association among the variables included in the model. The ECT, if positive and insignificant, provides evidence to diversify in the long run.

To examine the long-run relationship, we use fully modified ordinary least square (FMOLS) estimator which produces asymptotically unbiased estimates of the long-run elasticities and efficient, and the normally distributed standard errors. Moreover, the FMOLS uses a semi-parametric correction for endogeneity and residual autocorrelation. It is also allows for a high degree of heterogeneity in the panel.

4. Data and analysis

This study uses daily indices of BRICS region which include Brazil, Russia, India, China, South Africa. Latin American region include equity markets of Mexico, Argentina, Chile and Peru whereas EFA market comprises of seven Emerging and Frontier stock markets of Pakistan, Philippines, Thailand, Korea, Sri Lanka, Malaysia and Indonesia. We select our sample stock markets based on the Morgan Stanley Classification Index (MSCI) which determine each country's classification as a developed, emerging and frontier stock market. It aims to reflect the views and practices of international investment community by striking a balance between a country's economic development and the accessibility of its market while preserving index stability. We also include S&P 500, gold, oil and foreign exchange market over the period 1st September 1997, to 30th November 2018. Daily data is sourced from Thomson Reuters Data Stream. The data is sourced from different sources and expressed in U.S. dollars. Table 1 presents the descriptive properties of the data, which summarizes the elementary statistical properties of the daily returns for BRICS equity markets. Over a period of two decades, the stock market in China maintains the lowest mean daily return, while the stock market in Brazil exhibit the highest mean daily returns. Notably, Russia and Brazil "s stock markets highlights highest maximum and the lowest minimum values over

Table 2
Descriptive statistics for daily Latin American stock returns.

Variables	Mexico	Argentina	Chile	Peru
Descriptive statistics				
Mean	0.0004	0.0005	0.0003	0.0004
Median	0.0007	0.0008	0.0003	0.0004
Maximum	0.1215	0.1612	0.0668	0.0826
Minimum	−0.1034	−0.1430	−0.0625	−0.1329
Std. Dev.	0.0138	0.0217	0.0077	0.0132
Skewness	0.0821	−0.2733	−0.1380	−0.7817
Kurtosis	9.5011	8.1111	9.5370	13.4490
Correlation matrix				
Mexico	1	0.4676	0.0409	0.3693
Argentina		1	0.0373	0.3644
Chile			1	0.1209
Peru				1

Note: Similar to Table 1.

the period of twenty years. All the coefficient values of kurtosis entail leptokurtic distribution for the daily BRICS returns.

The unconditional pairwise correlation among BRICS markets over the period ranging from 1st September 1997 to 30 November 2018. All the values of unconditional correlation are statistically significant. Among other pairs, Russia's daily returns exhibit the highest correlation with South Africa, followed by Brazil "s market with India, while India maintains a high correlation with China. All the daily stock returns depict positive association with their other market in the respective pair.

Table 2 presents descriptive statistics of daily returns for Mexico, Argentina, Chile, and Peru. The daily return series is negatively skewed in all other cases with the exception of Mexico (0.0821), which is positively skewed. Next, we witness positive unconditional correlation among all the pairs. Among others, Mexico markets show a strong correlation with the stock market of Argentina.

Table 3 presents descriptive properties of daily returns for EFA markets. Over two decades, stock markets in the region exhibit a mean value of less than 1%. We witness moderate pairwise unconditional correlation for pairs including Thailand-Korea, Philippines-Malaysia, Malaysia-Thailand, Korea-Malaysia, Thailand-Indonesia, Korea-Indonesia and Malaysia-Indonesia.

Table 4 shows the results of three panel unit root tests, namely Augmented Dicky Fuller (ADF), IPS (Im, Pesaran, & Shin, 2003), and LLC (Levin, Lin, & Chu, 2002), indicating stationarity of the panels excluding one country at a time. This table presents the panel ADF, IPS, and LLC test results for the BRICS, LA, and EFA portfolios (countryjs), excluding a single country at a time. For example, excluding Brazil indicates the inclusion of the other four countries of the BRICS region except for Brazil. The panel ADF tests advocates stationarity of the daily stock indices of each panel at first difference. Other commonly applied panel unit root tests (IPS and LLC) are used, which confirms the hypothesis of data stationarity at first difference.

Table 5 reports the results of the panel Granger causality test, which sheds some light on the causal relationship between each single BRICS's stock market against the portfolio of four other BRICS stock markets. In the BRICS region, the Russian market does not Granger cause the portfolio of other regional markets. Similarly, in the EFA region, Pakistan and Korea stock markets do not granger cause their respective portfolios. Overall, we capture causal relationships among most pairs (i.e. each single market return and the portfolio returns of the rest of countries in the region included in this study). Our findings of bidirectional causality among the panels of EFA markets are consistent with earlier empirical work of Narayan and Rehman (2018) reporting that each of the EFA MSCI returns Granger causes the rest of the EFA MSCI returns.

Table 3
Descriptive statistics for daily Emerging and Frontier Asian stock returns.

Variables	Pakistan	Philippines	Thailand	Korea	Sri Lanka	Malaysia	Indonesia
Descriptive statistics							
Mean	0.0002	0.0003	0.0003	0.0003	0.0004	0.0006	0.0002
Median	0.0005	0.0000	0.0004	0.0006	0.0002	0.0009	0.0002
Maximum	0.0828	0.1618	0.1058	0.1129	0.1161	0.1149	0.2026
Minimum	−0.0894	−0.0825	−0.1606	−0.0993	−0.1391	−0.1273	−0.2416
Std. Dev.	0.0154	0.0137	0.0143	0.0164	0.0109	0.0151	0.0116
Skewness	−0.5559	0.8149	−0.0003	−0.1252	−0.9309	−0.1530	0.0877
Kurtosis	7.2611	16.320	12.745	7.2524	26.573	11.679	106.153
Correlation matrix							
Pakistan	1	0.0503	0.0211	0.0379	0.0175	0.0178	0.0263
Philippines		1	0.2881	0.2987	0.0806	0.3032*	0.2370
Thailand			1	0.3869*	0.0889	0.3834**	0.3281*
Korea				1	0.0575	0.3266*	0.3174*
Sri Lanka					1	0.0471	0.0225
Malaysia						1	0.3042*
Indonesia							1

Note: Similar to Table 1.

Table 4
Panel unit root test results.

	ADF		IPS		LLC		
	At level	1 st Difference	At level	1 st Difference	At level	1 st Difference	
Panel A: BRICS							
excluding Brazil		0.3379	620.66*	7.5531	−87.156*	12.302	−59.731*
excluding Russia		18.736	633.03*	4.1857	−85.741	12.209	−68.933*
excluding India		42.043*	232.16*	−2.4019	−127.11*	−0.3520	−120.00*
excluding China		34.924*	232.16*	−0.5265	−124.53*	1.7439	−119.23*
excluding South Africa		49.033*	232.16*	−2.8568	−124.84*	0.0070	−122.64*
Panel B: Latin American							
excluding Mexico		4.2138	664.48* 0.0764		−48.982* 0.0281		−28.222*
excluding Argentina		3.8461	659.28* 0.2018		−50.342* −0.1225		−33.695*
excluding Chile		3.3812	668.03* 0.3162		−48.784* 0.1839		−27.810*
excluding Peru		3.4372	665.99* 0.1314		−50.191* −0.6930		−28.216*
Panel C: Emerging and Frontier Asian							
excluding Pakistan	5.3028		110.52*	0.9171	−184.32*	0.3913	−206.11*
excluding Philippines	6.0378		110.52*	0.7287	−183.23*	0.2225	−205.00*
excluding Thailand	5.3587		1289.0*	0.7116	−68.218*	0.0456	−46.876*
excluding Korea	5.3285		1284.8*	0.7213	−68.585*	−0.0909	−48.808*
excluding Sri Lanka	6.1003		1289.2*	0.4862	−74.533*	0.0126	−55.126*
excluding Malaysia	4.8924		1262.6*	1.0958	−70.951*	0.4646	−52.561*
excluding Indonesia	5.2056		1280.0*	0.7473	−69.120*	−0.0049	−46.860*

Note: * denoted significance at the 5% level.

We begin to measure the long-run association among BRICS, LA, and EFA stock markets. We empirically analyze the markets for a typical investor in any of the BRICS, LA, and EFA countries, with a portfolio comprised of his or her own country's stock index and the rest of the market indices in the respective region. For instance, an investor living in Brazil who is holding a portfolio of stock market index of Brazil and the rest of four BRICS countries.

Table 6 displays the co-integration result, which implies the presence of at least one co-integrating relationship between the variables included in equation one. Overall the results show a stable long-run association among the variables included in the models. Our findings of long-run association among the LA equity markets are supported by Arouri et al. (2010) who report increase in integration among LA equity markets. Similarly, co-integration among EFA equity markets are consistent with previous empirical work by Narayan and Rehman (2017) who find stable long-run relationship between EFA equity markets. While in contrast, Thomas et al. (2017) report no long-run co-integrating association among China, Thailand, Pakistan and Sri Lanka. In contrast, our results are not in line with the work of Ouattara (2017), who documented no long-run association among BRICS markets.

All the variables are presented in the first difference form denoted by Δ two lag length, values in parenthesis are standard

deviation, and * denotes significance at the 5% level. Panel A of Table 7 display results for BRICS countries, panel B exhibit statistics for LA markets and panel C shows the results for EFA markets.

Panel A of Table 7 represents the VECM results for BRICS countries. We found evidence of a short-run relationship between daily returns of country i and j s suggesting minimum benefits in the short run. Further, it is noted that S&P 500 share a negative and statistically significant short-run relationship with Russia, China, and South Africa. While positive and significant links are shown in the case of Brazil and India. Moreover, the gold market maintains a positive and significant link with the returns of China stock market in the short run, while insignificant association with other markets suggest benefits in the short run. Similarly, the value of −0.0070 shows a negative but statistically insignificant relationship of exchange rate returns with returns of South Africa. Overall benefits in the short-run lack to hold the portfolio of BRICS stocks while portfolio comprising of investment in stocks, gold and oil are more beneficial for investors in BRICS region.

Next, panel B of Table 7 displays the results obtained from VECM depicting the linkages between single market returns and the portfolio returns of LA stock markets, the developed market, and returns of major commodities. The findings indicate significant linkages between a single country's returns and the respective portfolio

Table 5
Panel Granger causality tests.

Direction of Causality	Panel		
	W-Statistic	Zbar-Statistic	P-value
Panel A: BRICS			
Brazil → Country js	337.140	334.847	0.0000
Country js → Brazil	6.20821	4.20367	0.0000
Russia → Country js	2.37073	0.36954	0.7117
Country js → Russia	173.612	171.463	0.0000
India → Country js	156.587	154.450	0.0000
Country js → India	33.2780	31.2497	0.0000
China → Country js	27.9047	25.8817	0.0000
Country js → China	14.0678	12.0567	0.0000
South Africa → Country js	9.29433	7.28723	0.0000
Country js → South Africa	266.260	264.033	0.0000
Panel B: Latin American stock markets			
Mexico → Country js	367.720	316.441	0.0000
Country js → Mexico	7.54310	4.79562	0.0000
Argentina → Country js	205.102	175.730	0.0000
Country js → Argentina	5.02110	2.61330	0.0090
Chile → Country js	6.50993	3.90150	0.0001
Country js → Chile	896.262	773.783	0.0000
Peru → Country js	240.971	206.771	0.0000
Country js → Peru	27.1734	21.7794	0.0000
Panel C: Emerging and Frontier Asian stock markets			
Pakistan → Country js	0.97829	−1.25130	0.2108
Country js → Pakistan	17.5374	19.0111	0.0000
Philippines → Country js	7.65556	6.91943	0.0000
Country js → Philippines	55.9853	66.0588	0.0000
Thailand → Country js	32.8015	37.6882	0.0000
Country js → Thailand	9.02996	8.60087	0.0000
Korea → Country js	3.36875	1.67364	0.0942
Country js → Korea	6.46737	5.46509	0.0000
Sri Lanka → Country js	21.2332	23.5334	0.0000
Country js → Sri Lanka	7.38190	6.58439	0.0000
Malaysia → Country js	17.8159	19.3520	0.0000
Country js → Malaysia	9.54827	9.23531	0.0000
Indonesia → Country js	25.1574	28.3350	0.0000
Country js → Indonesia	7.00298	6.12068	0.0000

Note: Country js includes daily returns of markets other than each single country at a time.

returns in the short run. S&P 500 maintains a positive association with LA markets other than Chile. In commodities, gold returns share positive and significant linkages with Mexico, Chile, and Peru. Similarly, oil returns continues a significant positive relationship

with Argentina and Peru, which is the reverse of the negative and insignificant relationship in the case of Mexico and Chile. All other variables document significant links with Peru returns other than forex returns indicating benefits to diversify in the short run. The ECT is negative and significant in all cases, which indicates a stable long-run relationship among the variables included in the model. Long run stable relationship between S&P 500 and Mexico is not in line with the findings of [Al-Nasser and Hajilee \(2016\)](#).

Furthermore, our analysis shows the significant short-run association between each EFA country's returns and the portfolio returns of EFA stock markets. It means that investing only in stocks in the short will provide minimum returns. Notably, S&P 500 maintains a significant relationship with all EFA stocks in the short run. Both gold and oil returns share negative and insignificant links with returns of the Philippines and Sri Lankan stock market. The exchange rate is negative and significant in the case of Malaysia, Sri Lanka, Thailand, and Philippines. While positive and significant links are found in the case of Korea and Indonesia. A negative linkage indicates an increase or decrease in one market will cause a decrease of increase in other market returns, while a positive relationship indicates the change in a similar direction among both markets. The integration among regional equity markets is important to reduce cost of capital. Investors may rely more on regional stock markets rather than the world markets for the purpose of optimal diversification benefits. In this way, investors can reduce their exposure to external shocks ([Dewandaru, Masih, & Masih, 2017](#)). While on the other hand, the mix of positive and negative linkages among EFA stock markets, gold, oil and forex needs careful placement of securities in a portfolio. Overall, our results support holding a portfolio of stocks and commodities, which will provide higher returns in the short run. Negative and significant values of ECT confirm our results of stable long-run integration among the variables included in the model. The stable long-run relationship of emerging markets with the developed markets of the U.S (i.e., S&P 500) is also confirmed by [Thomas et al. \(2017\)](#) and [Robiyanto \(2018\)](#), among others.

Panel A of [Table 8](#) displays the outcome of FMOLS estimation for markets in BRICS region. It is noted that all other markets share a positive association with China's market except the oil market in the long run. Further, we also note that the Indian stock market is

Table 6
Panel co-integration test results.

	Kao Panel Co-integration	Pedroni Panel Co-integration Statistics						
	ADF-Stat.	Panel v	Panel rho	Panel P.P.	Panel ADF	Group rho	Group P.P.	Group ADF
Panel A: BRICS								
Brazil	−57.609*	243.27*	−715.07*	−126.97*	−81.988*	−787.67*	−152.13*	−98.023*
Russia	−52.072*	224.88*	−685.68*	−121.11*	−75.099*	−751.73*	−144.74*	−90.197*
India	−54.028*	195.73*	−681.12*	−122.74*	−80.211*	−750.30*	−147.07*	−95.898*
China	−45.112*	175.92*	−663.97*	−116.16*	−71.667*	−731.88*	−139.19*	−85.621*
South Africa	−53.724*	192.80*	−685.78*	−128.57*	−83.696*	−754.85*	−154.04*	−100.21*
Panel B: Latin American stock markets								
Mexico	−46.918*	163.45*	−575.22*	−105.85*	−74.18*	−631.14*	−126.53*	−88.678*
Argentina	−47.129*	283.48*	−507.61*	−87.91*	−55.90*	−558.79*	−105.22*	−66.733*
Chile	−38.195*	102.99*	−507.98*	−88.79*	−63.55*	−558.81*	−106.40*	−76.080*
Peru	−37.709*	115.89*	−646.00*	−101.78*	−67.34*	−712.68*	−122.08*	−80.522*
Panel C: Emerging and Frontier Asia stock markets								
Pakistan	−63.226*	386.82*	−772.53*	−128.68*	−74.948*	−847.25*	−153.90*	−89.120*
Philippines	−62.413*	320.57*	−733.74*	−125.42*	−82.597*	−805.08*	−150.15*	−98.805*
Thailand	−58.394*	283.93*	−847.15*	−139.62*	−81.605*	−924.55*	−167.01*	−97.346*
Korea	−66.974*	426.95*	−681.63*	−128.08*	−78.475*	−744.83*	−153.54*	−94.512*
Sri Lanka	−62.794*	243.57*	−720.97*	−122.04*	−84.985*	−798.77*	−146.23*	−101.85*
Malaysia	−52.450*	226.00*	−669.12*	−122.59*	−75.147*	−722.20*	−145.33*	−90.278*
Indonesia	−56.941*	233.40*	−687.27*	−125.48*	−86.402*	−752.74*	−150.48*	−103.77*

Note: [Kao \(1999\)](#) and [Pedroni \(2004\)](#) developed panel cointegration test based on regression errors from the hypothesized cointegrating regression to test the null hypothesis of no cointegration in nonstationary time series. The test statistics allow heterogeneity in the panel, both in the short-run dynamics as well as in the long-run slope and intercept coefficients. The test is contracted with seven test statistics of the group: ADF-statistic, group rho-statistic, group PP-statistic, panel v-statistic, panel rho-statistic, panel PP-statistic, and panel ADF-statistic. * denotes significance at the 5% level.

Table 7
VECM test results.

Dependent variables	Intrcpt.	Δ Portfolio (-1)	Δ Portfolio (-2)	Δ S&P 500 (-1)	Δ S&P 500 (-2)	Δ Gold(-1)	Δ Gold(-2)	Δ Oil (-1)	Δ Oil (-2)	Δ Forex(-1)	Δ Forex(-2)	ECT (-1)
Panel A: BRICS												
Brazil	0.0000 (0.0001)	0.0474* (0.0053)	0.0474* (0.0053)	0.9302* (0.0075)	0.9302* (0.0075)	0.0152 (0.0085)	0.0152 (0.0085)	0.0129* (0.0039)	0.0129* (0.0039)	0.2079* (0.0078)	0.2079* (0.0078)	−1.0470* (0.0087)
Russia	0.0001 (0.0002)	0.1166* (0.0089)	0.1166* (0.0089)	−0.2438* (0.0117)	−0.2438* (0.0117)	−0.0084 (0.0128)	−0.0084 (0.0128)	−0.0234* (0.0060)	−0.0234* (0.0060)	−0.2767* (0.0178)	−0.2767* (0.0178)	−0.9639* (0.0082)
India	0.0000 (0.0001)	0.0726* (0.0049)	0.0726* (0.0049)	0.1344* (0.0075)	0.1344* (0.0075)	0.0136 (0.0081)	0.0136 (0.0081)	0.0044 (0.0038)	0.0044 (0.0038)	−0.2095* (0.0207)	−0.2095* (0.0207)	−1.0182* (0.0088)
China	0.0001 (0.0001)	0.0718* (0.0059)	0.0718* (0.0059)	−0.0267* (0.0085)	−0.0267* (0.0085)	0.0199* (0.0093)	0.0199* (0.0093)	0.0085 (0.0044)	0.0085 (0.0044)	−0.0032* (0.0007)	−0.0032* (0.0007)	−0.9951* (0.0090)
South Africa	0.0001 (0.0001)	0.0828* (0.0040)	0.0828* (0.0040)	−0.1605* (0.0062)	−0.1605* (0.0062)	−0.0034 (0.0067)	−0.0034 (0.0067)	0.0061* (0.0031)	0.0061* (0.0031)	−0.0070 (0.0062)	−0.0070 (0.0062)	−1.0072* (0.0079)
Panel B: Latin American stock markets												
Mexico	−0.0001 (0.0001)	0.1254* (0.0049)	0.1254* (0.0049)	0.6588* (0.0059)	0.6588* (0.0059)	0.0181* (0.0061)	0.0181* (0.0061)	−0.0043 (0.0028)	−0.0043 (0.0028)	−0.1493* (0.0089)	−0.1493* (0.0089)	−0.9648* (0.0095)
Argentina	0.0003 (0.0002)	0.2856* (0.0148)	0.2856* (0.0148)	0.6547* (0.0130)	0.6547* (0.0130)	−0.0028 (0.0135)	−0.0028 (0.0135)	0.0160* (0.0061)	0.0160* (0.0061)	0.0355* (0.0172)	0.0355* (0.0172)	−0.9414* (0.0111)
Chile	0.0000 (0.0001)	−0.0234* (0.0034)	−0.0234* (0.0034)	−0.1261* (0.0043)	−0.1261* (0.0043)	0.0141* (0.0042)	0.0141* (0.0042)	−0.0027 (0.0020)	−0.0027 (0.0020)	−0.1917* (0.0077)	−0.1917* (0.0077)	−0.7841* (0.0088)
Peru	0.0000 (0.0001)	0.1327* (0.0060)	0.1327* (0.0060)	0.2831* (0.0072)	0.2831* (0.0072)	0.0219* (0.0074)	0.0219* (0.0074)	0.0172* (0.0034)	0.0172* (0.0034)	−0.0291 (0.0224)	−0.0291 (0.0224)	−0.8756* (0.0092)
Panel C: Emerging and Frontier Asian stock markets												
Pakistan	0.0000 (0.0001)	0.0168* (0.0065)	0.0168* (0.0065)	−0.0359* (0.0067)	−0.0359* (0.0067)	−0.0420* (0.0076)	−0.0420* (0.0076)	0.0118* (0.0035)	0.0118* (0.0035)	−0.0026 (0.0165)	−0.0026 (0.0165)	−0.9354* (0.0078)
Philippines	0.0001 (0.0001)	0.1652* (0.0050)	0.1652* (0.0050)	−0.1631* (0.0054)	−0.1631* (0.0054)	−0.0102 (0.0059)	−0.0102 (0.0059)	−0.0006 (0.0028)	−0.0006 (0.0028)	−0.0184* (0.0028)	−0.0184* (0.0028)	−0.8881* (0.0072)
Thailand	0.0000 (0.0001)	0.2539* (0.0054)	0.2539* (0.0054)	0.0698* (0.0057)	0.0698* (0.0057)	0.0140* (0.0065)	0.0140* (0.0065)	−0.0088* (0.0030)	−0.0088* (0.0030)	−0.0337* (0.0052)	−0.0337* (0.0052)	−0.9801* (0.0074)
Korea	0.0002 (0.0001)	0.4691* (0.0062)	0.4691* (0.0062)	0.0165* (0.0070)	0.0165* (0.0070)	−0.0039* (0.0079)	−0.0039* (0.0079)	−0.0160* (0.0036)	−0.0160* (0.0036)	0.0672* (0.0300)	0.0672* (0.0300)	−1.0358* (0.0081)
Sri Lanka	0.0002 (0.0001)	0.1402* (0.0041)	0.1402* (0.0041)	−0.0172* (0.0044)	−0.0172* (0.0044)	−0.0163 (0.0047)	−0.0163 (0.0047)	0.0007* (0.0022)	0.0007* (0.0022)	−0.0137* (0.0068)	−0.0137* (0.0068)	−0.8078* (0.0069)
Malaysia	−0.0002 (0.0001)	0.1771* (0.0041)	0.1771* (0.0041)	−0.0381* (0.0045)	−0.0381* (0.0045)	0.0011* (0.0049)	0.0011* (0.0049)	−0.0122* (0.0024)	−0.0122* (0.0024)	−0.1152* (0.0101)	−0.1152* (0.0101)	−0.9101* (0.0078)
Indonesia	−0.0001 (0.0001)	0.2470* (0.0057)	0.2470* (0.0057)	−0.0384* (0.0060)	−0.0384* (0.0060)	−0.0180* (0.0068)	−0.0180* (0.0068)	−0.0083* (0.0032)	−0.0083* (0.0032)	0.0447* (0.0057)	0.0447* (0.0057)	−0.8943* (0.0073)

Note: The values of standard error are given in parenthesis, * denotes significance at the 5% level.

Table 8
FMOLS regression results.

Variables	Ln Pjt	Ln S&P 500	Ln Gold	Ln Oil	Ln Forex
Panel A: BRICS					
Brazil	0.3190* (0.0470)	0.3724* (0.0157)	0.5352* (0.0121)	0.3554* (0.0134)	0.3172* (0.0147)
Russia	0.1948* (0.0233)	0.4366* (0.0509)	0.4273* (0.0316)	1.0080* (0.0289)	0.5229* (0.0807)
India	0.0502* (0.0060)	0.9029 (0.0165)	0.7344* (0.0115)	0.1814* (0.0111)	0.2038* (0.0319)
China	0.0448* (0.0099)	0.8223* (0.0387)	0.6941* (0.0326)	−0.2226* (0.0226)	2.7061* (0.1612)
South Africa	0.0638* (0.0058)	0.7561* (0.0151)	0.6269* (0.0110)	0.1521* (0.0114)	0.1992* (0.0162)
Panel B: Latin American stock markets					
Mexico	0.1129* (0.0069)	0.3716* (0.0158)	0.5178* (0.0146)	0.2894* (0.0115)	1.0162* (0.0339)
Argentina	0.2752* (0.0386)	0.9188* (0.0469)	0.1862* (0.0469)	−0.4211* (0.0363)	1.2197* (0.0366)
Chile	0.0912* (0.0060)	0.1423* (0.0131)	0.5902* (0.0114)	0.1971* (0.0097)	−0.0555* (0.0025)
Peru	0.1222* (0.0130)	0.1949* (0.0331)	1.0088* (0.0274)	0.5075* (0.0267)	0.2809* (0.0775)
Panel C: Emerging and Frontier Asian stock markets					
Pakistan	0.2705* (0.0175)	0.4685* (0.0271)	0.1841* (0.0230)	0.3382* (0.0177)	1.9502* (0.0358)
Philippines	0.1484* (0.0080)	0.7671* (0.0149)	0.6340* (0.0119)	−0.0313* (0.0123)	−0.4936* (0.0224)
Thailand	0.2142* (0.0092)	0.4805* (0.0183)	0.2797* (0.0200)	0.0860* (0.0122)	−0.3521* (0.0735)
Korea	0.1459* (0.0074)	0.3123* (0.0135)	0.2829* (0.0115)	0.3005* (0.0101)	−0.1023* (0.0207)
Sri Lanka	0.0951* (0.0098)	0.2459* (0.0168)	0.8008* (0.0152)	−0.0222 (0.0119)	1.1087* (0.0314)
Malaysia	0.1068* (0.0053)	0.3630* (0.0103)	0.2306* (0.0080)	0.1830* (0.0072)	−0.0498* (0.0187)
Indonesia	0.2025* (0.0088)	0.6367* (0.0159)	1.0054* (0.0124)	0.1031* (0.0114)	0.0157 (0.0097)

Note: The values of standard error are given in parenthesis, * denotes significance at the 5% level.

highly integrated in the long run with the rest of the markets in the region. This is further in line with the findings of [Rajiv Menon, Subha, and Sagarán \(2009\)](#) and [Zhang and Li \(2014\)](#). Similarly, all markets share positive and significant association with the respective portfolios. Next, Panel B of [Table 8](#) presents the results of FMOLS for LA stock markets. Overall, we witness positive relationship in the long-run between the countries *js* and the lagged closing prices of each LA stock market. However, oil market returns are negatively associated with stock market of Argentina whereas Forex market has a negative relationship with Chile stock market highlighting benefits from diversification in the long-run.

Panel C of [Table 8](#) shows a stable long-run relationship between the countries *js* and the lagged closing prices of each EFA stock market. Further, gold prices maintains a significant relationship with the prices of all seven EFA markets. While in the case of oil, negative association is observed with Thailand. The foreign exchange market is found negatively associated with four individual EFA countries. Overall, the findings reveal that holding a portfolio of EFA stock will provide minimum benefits in the long run.

5. Conclusion

This paper attempts to examine portfolio diversification opportunities both in the long run and short run over the period 1st September 1997 to 30th November 2018. Different techniques are applied to gauge short-run and long-run relationships among the stock market. In the long run, we document that each single stock market is closely related to other markets in the region. In addition, the S&P 500 is the most dominant market showing strong links with all stock markets in the region. Commodities returns

are found to have both positive and negative linkages with equity markets' returns in short and in the long run. A stable relationship between the markets suggests minimum benefits from diversification in those markets.

In the short run, the S&P 500 returns are negatively linked with the returns of Russia and China in the BRICS region, with daily returns of Chile in the LA region, and with all markets other than Thailand and Korea of the EFA region. In the case of gold returns, a positive association with the daily returns of Thailand and the Malaysian stock market is shown. In addition, both gold and oil returns are insignificant in the short run. Notably, the foreign exchange market is negatively linked with all the EFA stock markets with the exception of Korea. While insignificant relationship is evident between the daily stock returns of Pakistan and the forex. The findings are in line with our aim and provide answers to lower diversification benefits at a regional level. However, in the short run, a portfolio comprising of stock and commodities are more beneficial for some investors. Using FMOLS, our results further indicate that investing only in stock within the region will provide minimum returns.

In particular, our study indicates that investing only in stocks is less beneficial both in short and in the long run within the region. However, holding equity-commodity portfolio are more promising for regional investors. For the future research avenue, it would be interesting to extend this study by examining portfolio diversification opportunities among emerging and G7 equity markets. It is also important to study integration by grouping of equity markets based on market capitalization or magnitude of returns coherence among them. Furthermore, our work can also be extended by including other asset classes i.e. commodities, metal markets, energy futures and cryptocurrencies. In addition, future studies can also address the presence of structural break in the returns pattern by dividing the complete analysis period into different crises periods e.g. Asian financial crisis, global financial crisis, Eurozone crisis and the COVID-19 crisis period.

Author statement

There are no conflicts of interest to declare.

Acknowledgements

This research is partly funded by the University of Economics Ho Chi Minh City, Vietnam. This work was also supported by the Ministry of Education of the Republic of Korea and the National Research Foundation of Korea (NRF-2020S1A5B8103268).

References

- Aladesanmi, O., Casalin, F., & Metcalf, H. (2019). *Stock market integration between the U.K. And the U.S.: Evidence over eight decades*. *Global Finance Journal*, 41, 32–43.
- Al-Khazali, O., Darrat, A. F., & Saad, M. (2006). *Intra-regional integration of the GCC stock markets: The role of market liberalization*. *Applied Financial Economics*, 16(17), 1265–1272.
- Al-Nasser, O. M., & Hajilee, M. (2016). *Integration of emerging stock markets with global stock markets*. *Research in International Business and Finance*, 36, 1–12.
- Aloy, M., Boutahar, M., Gente, K., & Péguin-Feissolle, A. (2013). *Long-run relationships between international stock prices: Further evidence from fractional co-integration tests*. *Applied Economics*, 45(7), 817–828.
- Arfaoui, M., & Rejeb, A. B. (2017). *Oil, gold, U.S. Dollar and stock market interdependencies: A global analytical insight*. *European Journal of Management and Business Economics*, 26(3), 278–293.
- Arouri, M. E. H., & Rault, C. (2012). *Oil prices and stock markets in GCC countries: Empirical evidence from panel analysis*. *International Journal of Finance & Economics*, 17(3), 242–253.
- Arouri, M. E. H., Bellalah, M., & Nguyen, D. K. (2010). *The comovements in international stock markets: New evidence from Latin American emerging countries*. *Applied Economics Letters*, 17(13), 1323–1328.

- Arshanapalli, B., & Doukas, J. (1993). International stock market linkages: Evidence from the pre-and post-October 1987 period. *Journal of Banking & Finance*, 17(1), 193–208.
- Baharumshah, A. Z., Sarmidi, T., & Tan, H. B. (2003). Dynamic linkages of Asian stock markets. *Journal of the Asia Pacific Economy*, 8(2), 180–209.
- Baig, M. M., Shahbaz, M., Imran, M., Jabbar, M., & Ain, Q. U. (2013). Relationship between gold and oil prices and stock market returns. *Economica*, 9(5), 28–39.
- Bashir, U., Yu, Y., Hussain, M., & Zebende, G. F. (2016). Do foreign exchange and equity markets co-move in Latin American region? Detrended cross-correlation approach. *Physica A Statistical Mechanics and Its Applications*, 462, 889–897.
- Batareddy, M., Gopalaswamy, A. K., & Huang, C. H. (2012). The stability of long-run relationships: A study on Asian emerging and developed stock markets (Japan and U.S.). *International Journal of Emerging Markets*, 7(1), 31–48.
- Bekaert, G., & Harvey, C. R. (1995). Time-varying world market integration. *The Journal of Finance*, 50(2), 403–444.
- Berger, D., Pukthuanthong, K., & Yang, J. J. (2011). International diversification with frontier markets. *Journal of Financial Economics*, 101(1), 227–242.
- Bhunia, A., & Das, A. (2012). Association between gold prices and stock market returns: Empirical evidence from NSE. *Journal of Exclusive Management Science*, 1(2), 1–7.
- Breitung, J., & Das, S. (2005). Panel unit root tests under cross-sectional dependence. *Statistica Neerlandica*, 59(4), 414–433.
- Bundoo, S. K. (2017). Stock market development and integration in SADC (Southern African Development Community). *Review of Development Finance*, 7(1), 64–72.
- Caporale, G. M., Pittis, N., & Spagnolo, N. (2002). Testing for causality-in-variance: An application to the East Asian markets. *International Journal of Finance & Economics*, 7(3), 235–245.
- Cardona, L., Gutiérrez, M., & Agudelo, D. A. (2017). Volatility transmission between US and Latin American stock markets: Testing the decoupling hypothesis. *Research in International Business and Finance*, 39, 115–127.
- Chang, S., Kogut, B., & Yang, J. S. (2016). Global diversification discount and its discontents: A bit of self-selection makes a world of difference. *Strategic Management Journal*, 37(11), 2254–2274.
- Chiao, Y. C., Yu, C. M. J., Li, P. Y., & Chen, Y. C. (2008). Subsidiary size, internationalization, product diversification, and performance in an emerging market. *International Marketing Review*, 25(6), 612–633.
- Chittedi, K. R. (2010). Global stock markets development and integration: With special reference to BRIC countries. *International Review of Applied Financial Issues and Economics*, 2(1), 18–36.
- Denis, D. J., Denis, D. K., & Yost, K. (2002). Global diversification, industrial diversification, and firm value. *The Journal of Finance*, 57(5), 1951–1979.
- Dewandaru, G., Masih, R., & Masih, M. (2017). Regional spillovers across transitioning emerging and frontier equity markets: A multi-time scale wavelet analysis. *Economic Modelling*, 65, 30–40.
- Dias, R., & Carvalho, L. C. (2020). Hedges and safe havens: An examination of stocks, gold and silver in Latin America's stock market. *Revista de Administração da UFPA*, 13(5), 1114–1132.
- Dumitrescu, E. I., & Hurlin, C. (2012). Testing for Granger non-causality in heterogeneous panels. *Economic Modelling*, 29(4), 1450–1460.
- Ergen, I. (2014). Tail dependence and diversification benefits in emerging market stocks: An extreme value theory approach. *Applied Economics*, 46(19), 2215–2227.
- Espitia, M., & Santamaria, R. (1994). International diversification among the capital markets of the EEC. *Applied Financial Economics*, 4, 1–10.
- Gande, A., Schenzler, C., & Senbet, L. W. (2009). Valuation effects of global diversification. *Journal of International Business Studies*, 40(9), 1515–1532.
- Gaur, A., & Bansal, M. (2010). A comparative study of gold price movements in Indian and global markets. *Indian Journal of Finance*, 4(2), 32–37.
- Gilmore, C. G., McManus, G. M., Sharma, R., & Tezel, A. (2009). The dynamics of gold prices, gold mining stock prices and stock market prices co-movements. *Research in Applied Economics*, 1(1), 1–19.
- Granger, C. W. J. (2003). Some aspects of causal relationships. *Journal of Econometrics*, 112, 69–71.
- Granger, C. W. J. (1980). Testing for causality. *Journal of Economic Dynamics & Control*, 2, 329–352.
- Granger, C. W., Huang, B. N., & Yang, C. W. (2000). A bivariate causality between stock prices and exchange rates: Evidence from recent Asian flu. *The Quarterly Review of Economics and Finance*, 40(3), 337–354.
- Grubel, H. G. (1968). Internationally diversified portfolios: Welfare gains and capital flows. *The American Economic Review*, 58(5), 1299–1314.
- Guidi, F., & Gupta, R. (2011). Are ASEAN stock market efficient? Evidence from univariate and multivariate variance ratio tests. *Discussion Papers in Finance*, 201113, 488–502.
- Gupta, R., & Guidi, F. (2012). Co-integration relationship and time varying co-movements among Indian and Asian developed stock markets. *International Review of Financial Analysis*, 21, 10–22.
- Hanif, M. (2020). Relationship between oil and stock markets: Evidence from Pakistan stock exchange. *International Journal of Energy Economics and Policy*, 10(5), 150–157.
- Hengchao, Z., & Hamid, Z. (2015). The impact of subprime crisis on Asia-Pacific Islamic stock markets. *Journal of Asia-Pacific Business*, 16(2), 105–127.
- Huyghebaert, N., & Wang, L. (2010). The co-movement of stock markets in East Asia: Did the 1997–1998 Asian financial crisis really strengthen stock market integration? *China Economic Review*, 21(1), 98–112.
- Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, 115(1), 53–74.
- Johansen, S. (1988). Statistical analysis of co-integration vectors. *Journal of Economic Dynamics & Control*, 12(2–3), 231–254.
- Kang, S. H., & Yoon, S. M. (2013). Revisited return and volatility spillover effect in Korea. *Korea and the World Economy*, 14(1), 121–145.
- Kao, C. (1999). Spurious regression and residual-based tests for co-integration in panel data. *Journal of Econometrics*, 90(1), 1–44.
- Karim, M., Chan, S.-G., & Hassan, S. (2010). Bank efficiency and non-performing loans: Evidence from Malaysia and Singapore. *Prague Economic Papers*, 2010(2), 118–132.
- Karim, B. A., Kassim, N. A. M., & Arip, M. A. (2010). The subprime crisis and Islamic stock markets integration. *International Journal of Islamic and Middle Eastern Finance and Management*, 3(4), 363–371.
- Kishor, N., & Singh, R. (2017). Contagion effect among the BRICS stock market indices. *Journal of Poverty, Investment and Development*, 31, 33–46.
- Kumar, R., & Dhankar, R. S. (2017). Financial instability, integration and volatility of emerging South Asian stock markets. *South Asian Journal of Business Studies*, 6(2), 177–190.
- Lee, S. B., & Kim, K. J. (1993). Does the October 1987 crash strengthen the co-movements among national stock markets? *Review of Financial Economics*, 3(1), 89–102.
- Lessard, D. R. (1973). International portfolio diversification: A multivariate analysis for a group of Latin American countries. *The Journal of Finance*, 28(3), 619–633.
- Levin, A., Lin, C. F., & Chu, C. S. J. (2002). Unit root tests in panel data: Asymptotic and finite-sample properties. *Journal of Econometrics*, 108(1), 1–24.
- Levy, H., & Sarnat, M. (1970). International diversification of investment portfolios. *The American Economic Review*, 60(4), 668–675.
- Li, S. F., Zhu, H. M., & Yu, K. (2012). Oil prices and stock market in China: A sector analysis using panel co-integration with multiple breaks. *Energy Economics*, 34(6), 1951–1958.
- Maddala, G. S., & Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test. *Oxford Bulletin of Economics and Statistics*, 61(S1), 631–652.
- Markowitz, H. (1952). Portfolio selection. *The Journal of Finance*, 7(1), 77–91.
- Markowitz, H. (1959). *Portfolio selection: Efficient diversification of investments*. New York: Wiley.
- Menon, N. R., Subha, M. V., & Sagarani, S. (2009). Cointegration of Indian stock markets with other leading stock markets. *Studies in Economics and Finance*, 20(2), 87–94.
- Mensi, W., Hkiri, B., Al-Yahyaee, K. H., & Kang, S. H. (2018). Analyzing time-frequency co-movements across gold and oil prices with BRICS stock markets: A VaR based on wavelet approach. *International Review of Economics & Finance*, 54, 74–102.
- Meric, I., & Meric, G. (1997). Co-movements of European equity markets before and after the 1987 crash. *Multinational Finance Journal*, 1(2), 137–152.
- Miller, J. I., & Ratti, R. A. (2009). Crude oil and stock markets: Stability, instability, and bubbles. *Energy Economics*, 31(4), 559–568.
- Mohti, W., Dionísio, A., Vieira, I., & Ferreira, P. (2019). Regional and global integration of Asian stock markets. *Research in International Business and Finance*, 50, 357–368.
- Mollick, A. V., & Assefa, T. A. (2013). U.S. Stock returns and oil prices: The tale from daily data and the 2008–2009 financial crisis. *Energy Economics*, 36, 1–18.
- Mukherjee, P., & Bose, S. (2008). Does the stock market in India move with Asia? A multivariate cointegration-vector autoregression approach. *Emerging Markets Finance and Trade*, 44(5), 5–22.
- Mylonidis, N., & Kollias, C. (2010). Dynamic European stock market convergence: Evidence from rolling co-integration analysis in the first euro-decade. *Journal of Banking & Finance*, 34(9), 2056–2064.
- Narayan, S. (2015). Are Asian stock market returns predictable? *Emerging Markets Finance and Trade*, 51(5), 867–878.
- Narayan, S., & Rehman, M. U. (2017). Diversification opportunities between emerging and frontier Asian (EFA) and developed stock markets. *Finance Research Letters*, 23, 223–232.
- Narayan, S. W., & Rehman, M. U. (2018). Portfolio diversification opportunities within emerging and frontier stock markets: Evidence from ten Asian countries. *Buletin Ekonomi Moneter Dan Perbankan*, 21(1), 1–22.
- Narayan, P. K., Ahmed, H. A., Sharma, S. S., & Prabheesh, K. P. (2014). How profitable is the Indian stock market? *Pacific-Basin Finance Journal*, 30, 44–61.
- Nielsson, U. (2007). Interdependence of Nordic and Baltic stock markets. *Baltic Journal of Economics*, 6(2), 9–27.
- Noor, M. H., & Dutta, A. (2017). On the relationship between oil and equity markets: Evidence from South Asia. *International Journal of Managerial Finance*, 13(3), 287–303.
- Olugbenga, A. A. (2012). Exchange rate volatility and stock market behaviour: The Nigerian experience. *European Journal of Business and Management*, 4(5), 31–39.
- Ouattara, B. S. (2017). Re-examining stock market integration among Brics countries. *Eurasian Journal of Economics and Finance*, 5(3), 109–132.
- Patra, S., & Panda, P. (2021). Spillovers and financial integration in emerging markets: Analysis of BRICS economies within a VAR-BEKK framework. *International Journal of Finance & Economics*, 26(1), 493–514.
- Pedroni, P. (1999). Critical values for co-integration tests in heterogeneous panels with multiple regressors. *Oxford Bulletin of Economics and Statistics*, 61(S1), 653–670.

- Pedroni, P. (2004). Panel co-integration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory*, 20(3), 597–625.
- Phillips, P. C., & Moon, H. R. (1999). Linear regression limit theory for nonstationary panel data. *Econometrica*, 67(5), 1057–1111.
- Phylaktis, K., & Ravazzolo, F. (2002). Measuring financial and economic integration with equity prices in emerging markets. *Journal of International Money and Finance*, 21(6), 879–903.
- Rajiv Menon, N., Subha, M. V., & Sagar, S. (2009). Cointegration of Indian stock markets with other leading stock markets. *Studies in Economics and Finance*, 26(2), 87–94.
- Rajwani, S., & Mukherjee, J. (2013). Is the Indian stock market co-integrated with other Asian markets? *Management Research Review*, 36(9), 899–918.
- Ramchand, L., & Susmel, R. (1998). Volatility and cross correlation across major stock markets. *Journal of Empirical Finance*, 5(4), 397–416.
- Ratanapakorn, O., & Sharma, S. C. (2002). Interrelationships among regional stock indices. *Review of Financial Economics*, 11(2), 91–108.
- Raza, N., Shahzad, S. J. H., Tiwari, A. K., & Shahbaz, M. (2016). Asymmetric impact of gold, oil prices and their volatilities on stock prices of emerging markets. *Resources Policy*, 49, 290–301.
- Rehman, M. U., & Shah, S. Z. A. (2016). Determinants of return's Co-movement for effective portfolio diversification among regional stock markets. *Revista Evidenciação Contábil & Finanças*, 4(1), 84–96.
- Rehman, M. U., & Shah, S. M. A. (2016). Does Bilateral market and financial integration explain international co-movement patterns. *International Journal of Financial Studies*, 4(2), 1–13.
- Robiyanto, R. (2018). Indonesian stock market's dynamic integration with Asian stock markets and World stock markets. *Jurnal Pengurusan (UKM Journal of Management)*, 52, 181–192.
- Roca, E. D., Selvanathan, E. A., & Shepherd, W. F. (1998). Are the ASEAN equity markets interdependent? *ASEAN Economic Bulletin*, 15(2), 109–120.
- Sekmen, F. (2011). Exchange rate volatility and stock returns for the U.S. *African Journal of Business Management*, 5(22), 9659–9664.
- Seth, N., & Sharma, A. K. (2015). International stock market efficiency and integration: Evidences from Asian and U.S. Markets. *Journal of Advances in Management Research*, 12(2), 88–106.
- Shahzad, S. J. H., Kanwal, M., Ahmed, T., & Rehman, M. U. (2016). Relationship between developed, European and South Asian stock markets: A multivariate analysis. *South Asian Journal of Global Business Research*, 5(3), 385–402.
- Sok-Gee, C., Karim, M. A., & Karim, M. A. (2010). Volatility spillovers of the major stock markets in ASEAN-5 with the U.S. And Japanese stock markets. *International Research Journal of Finance and Economics*, 44, 161–172.
- Solnik, B. (1974). Why not diversify internationally rather than domestically? *Financial Analysts Journal*, 30, 48–54.
- Swanson, P. E. (2003). The interrelatedness of global equity markets, money markets, and foreign exchange markets. *International Review of Financial Analysis*, 12(2), 135–155.
- Tai, C. S. (2007). Market integration and contagion: Evidence from Asian emerging stock and foreign exchange markets. *Emerging Markets Review*, 8(4), 264–283.
- Thomas, N. M., Kashiramka, S., & Yadav, S. S. (2017). Determinants of stock market integration between developed and emerging equity markets of Asia Pacific region. *Journal of Advances in Management Research*, 14(3), 332–351.
- Van Robays, I. (2016). Macroeconomic uncertainty and oil price volatility. *Oxford Bulletin of Economics and Statistics*, 78(5), 671–693.
- Wang, K., Chen, Y. H., & Huang, S. W. (2011). The dynamic dependence between the Chinese market and other international stock markets: A time-varying copula approach. *International Review of Economics & Finance*, 20(4), 654–664.
- Yang, J., Khan, M. M., & Pointer, L. (2003). Increasing integration between the United States and other international stock markets?: A recursive co-integration analysis. *Emerging Markets Finance and Trade*, 39(6), 39–53.
- Zhang, B. (2017). How do great shocks influence the correlation between oil and international stock markets? *Applied Economics*, 49(15), 1513–1526.
- Zhang, B., & Li, X.-M. (2014). Has there been any changes in the comovement between the Chinese and US stock markets? *International Review of Economics & Finance*, 29, 525–536.