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DIVERSIFICATION POTENTIAL AMONG THE N-10 COUNTRIES: AN EMPIRICAL INVESTIGATION

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Abstract

Emerging nations like Indonesia, South Korea, Bangladesh, Egypt, Mexico, Nigeria, Pakistan, Turkey, the Philippines, Iran and Vietnam have developing stock markets which may offer ample opportunities to investors for their portfolio returns. The emerging next ten countries (N-10) in the present paper have been explored for diversification opportunities for investors. The study has incorporated eight years' (2013-2020) time series data for N-10 countries' stock market indices. Portfolio diversification strategies between Pakistan and other markets have been indicated as per the findings of Granger causality, Johansen Cointegration techniques, VECM and Wald test. The unidirectional and bidirectional linkages analysis has shown fewer possibilities between Bangladesh and Egypt stock markets with diversification benefits. Thus, investors may utilise the findings of the study in planning their portfolio among these stock markets.

Keywords: N-10 countries, diversification, Granger Causality, Cointegration, VECM, Stock markets

JEL Classification: *D53, G-11, G-15, F-21, F-15*

1 Introduction

Integration analysis among group of nations may be of immense hint for an investor to explore diversification opportunities. Various eminent economists and researchers have studied such relationships among group of nations like SAARC, MINT, BRICS, G20, G7, EU, OPEC, etc. (Al-Mohamad et al, 2020; Al-Muwallad & Ahmad 2021; Chen & Chiang, 2022; Yadav & Pandey, 2019). Majorly, diversification opportunities for investors and arbitrageurs have been the base for such studies. Stock market indices have been used as proxy data to determine the linkages (long term and short-term) amongst various nations. Cointegrated stock markets may not be able to provide exploitable opportunities to investors for diversifying their portfolios.

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A sample group of nations (Indonesia, South Korea, Bangladesh, Egypt, Mexico, Nigeria, Pakistan, Turkey, the Philippines, Iran and Vietnam) have strong potential as developing nations. Several parameters with appropriate models confirm the potential for these developing nations (Gupta and Bhatia, 2022; O'Neill et al., 2005; Onaizi and Gadhoum, 2017). Thus, investors may explore stock markets of such potential nations for probable opportunities to maximize gains and also diversify their portfolio constituents.

Investors may be categorized into various classes viz retail, institutional, foreign nationals who plug in their money depending upon their risk appetite and return expectations. Primarily, any investor would be looking out for surplus profits on the portfolio built from various financial instruments split into national and international markets. The theories from standard finance also indicate that an investor takes a call on choice of portfolio mix based on his risk and return expectations (Mangram, 2013). In addition, uncertain global events need strategical planning with mean-variance concept for portfolio optimization (De Jong, 2018). The hedging and diversification strategies may be helpful in dealing with price fluctuations and risk management in case of a portfolio (Alshubiri, 2021). Thus, portfolio diversification plays a vital role in managing risk and return expectations for investors. Tactful planning and timely management of portfolio mix can enhance the returns for both investors national and international (Awaludin and Rahman, 2021; Castro et al., 2021).

In line with the above discussion, the present study examines this new group of nations for portfolio diversification strategies. Excerpts of the study deliver newer insights to stakeholders of these nations' markets which have not been explored in this particular theme of portfolio management.

Major objectives:

1. To examine the causal linkages between the stock exchanges of Indonesia, South Korea, Bangladesh, Egypt, Mexico, Nigeria, Pakistan, Turkey, the Philippines, Iran and Vietnam.
2. To explore conceivable prospects for investors/arbitrageurs/portfolio managers while framing their investment forms.

Remaining paper is divided into five sections; second section narrates literature review, third section explains the methodology adopted during the study, fourth section shows the findings and analysis in the study, fifth section concludes the study and highlights future scope of the study.

2 Literature Review

The portfolio mechanism and its associated strategies on the basis of relationship between world stock market indices have been studied with varied methodologies. The findings have been assorted across different nations and time periods. Some of the popular studies indicating least or limited scope for diversification benefits on one hand and high possibilities on the other hand have been presented in Table 1 below:

Table 1: Popular studies across the world indices

Stock Markets	**Author & Year**	**Methodology**	**Portfolio Diversification Opportunity**
US, Canada, Japan, Sweden and the UK	Tagoe and Chiou, 2021	Johansen cointegration and VECM	Almost Nil (However, this study has been carried within US crisis time period)
India, Malaysia, the Philippines and the US markets.	Lingaraja et al., 2015	Corerlation and Granger Causality	Least
Brazil, Argentina, Colombia, Chile, Venezuela and Mexico markets.	Yarovaya et al., 2016	Cointegration techniques	Limited scope
Malaysia, South Korea, China, India and Taiwan	Kumar, Srivastava & Chauhan, 2017	Johansen cointegration and VECM	High
South-eastern countries	Sheng & Tu, 2000; Forbes & Rigobon, 2002; Evans & McMillan, 2009; Balazs & Evzen, 2007	Johansen cointegration techniques	High

As mentioned in Table 1 above, there have been varied time periods and indices which have been studies across the world. The literature shows low, moderate or high possibility for diversification among the indices studied. In this segment, to explore the research gap literature review has been carried in two phases of US financial crisis of 2011. After 2011, the integration of stock markets became more rampant due to the interdependence of nations across the globe for trade and other linkages. Hence, a close look and differentiation between two phases has been done to deduce the research gap.

Recent studies post 2011 US financial crisis

A study revealed that the UK, the US, Canada, Sweden, and Japan are integrated. The study employed Johansen cointegration and VECM test and highlighted that the relationship stays strong both in the long-run and the short-run, but its magnitude varies due to the financial crisis (Tagoe and Chiou, 2021). Stock markets of South Korea, India, Singapore, Japan, Hong Kong, Malaysia, Taiwan, China and Indonesia have been examined using Granger Causality. Findings highlighted that diversification strategies may be useful in short-run due to transitory fluctuations. Moreover, long-run equilibrium is found, thus leaving no scope of diversification (Palamalai & Devakumar, 2013).

Polish and Spanish stock markets have been observed to be cointegrated with the help of a non-linear autoregressive distributed lag model (Jareno et al., 2021). These markets react to positive and negative shocks in a similar way. Relationship between the US markets and the developing Asian markets (India, Malaysia, the Philippines, China, Indonesia, Korea, Taiwan and Thailand) has been explored (Lingaraja et al., 2015). Correlation and Granger Causality revealed that India, Malaysia and The Philippines has a long-run dynamic relationship with the US markets. The remaining five markets are not in long-run equilibrium and hence are not dominated by the US markets (Lingaraja et al., 2015). Another study established limited scope for diversification among Brazil, Argentina, Colombia, Chile and Mexico stock markets. Although, cointegration results indicated interdependencies for these markets in the long-run (Yarovaya et al., 2016).

There existed a short-run dynamic linkage between (Turkey, Mexico, Brazil, China, and Russia) and markets of the US, Germany and the UK. Long-run linkages have been found for emerging markets with only German markets. Thus, diversification possibilities may be present for investors in the long-run (Al Nasser and Hajilee, 2016). There has been no causal linkage for markets of Malaysia, South Korea, China, India and Taiwan from each other (Kumar, Srivastava & Chauhan, 2017). South Africa, Hungary, Brazil,Mexico, Poland and Taiwan have been cointegrated with Indian markets. Over the period of time, this relationship has been stronger and positive. Therefore, it may be difficult to diversify within these markets and India in a portfolio (Tripathi & Sethi, 2012).

The new set of nations CIVETS (Vietnam, Columbia, Indonesia, Egypt, South Africa and Turkey) from 2009 have been tested for interdependence using causality tests. CIVETS stock markets may reflect a higher degree of interdependence showing inter/intra-regional connections (Korkmaz et al., 2012; Abu et al., 2021). India, Indonesia and Malaysia

impacted Sri Lanka stock market indices, but Pakistan markets have been found in isolation from all these markets. Indian and Pakistan markets have their inter-connections; else, long-run equilibrium has been absent (Jebran, 2014).

The results from causal tests indicated that European markets had been integrated after the launch of a common currency (Euro). However, this phenomenon could not be generalized for all sub-periods in the study (Mylonidis & Kollias, 2010; Ramakrishna & Smita, 2017). MIST (Turkey, Mexico, South Korea, and Indonesia) economies have been examined compared to developed nations like Singapore, US, Germany, the UK, Japan and Hong Kong using bivariate cointegrations tests and the DCC-GARCH model. These markets have been explored as one of the segments from the N-11 group of nations and have been found to carry huge potential for international investors (Madhavan, 2013; Oloko, 2018).

Earlier studies prior to 2011 US crisis

Most of the stock markets had become cointegrated by the year 2010 as per a study conducted with US stock market and developed/developing markets. China, Malaysia and Austria had been behaving differently when short-run diversification opportunities were explored. These markets provided ample scope to diversify a portfolio and explore the timing of returns for investors (Khan, 2011). The equity market of Pakistan has not been related to Singapore, the UK, Taiwan, US and Malaysia suggesting the existence of diversification opportunities. However, there has been cointegration between Pakistan, India, China, Japan and Indonesia (Ali et al., 2011). Egypt markets have determined Israel market prices according to the results from cointegration and GARCH models. Information may be observed to reflect faster in Egyptian markets than Israel (Floros, 2011). The return and risk of Vietnamese stock markets have been influenced by Singapore and Japanese markets. The asymmetric effect has also been found significant for Vietnam markets (Chang and Su, 2010).

The linkages between stock markets of Singapore, the Philippines and Indonesia have been significant with Japanese stock market. The cointegration between the US markets and India, Korea, Hong Kong, Malaysia has been strong in the long- run. However, Japan and the US markets have no causal relationship with Asia-9 Pacific markets in the long-run (Ghosh & Saidi, 1999). Weak form efficiency has been found for five stock markets of Taiwan, South Korea, the US, Singapore, Hong Kong and Japan. In the long-run, their relationship has not been evident, thereby not impacting each other (Chan & Pan, 1992). In another study, it is

explored that Bahrain and Kuwait are cointegrated in the long-run. Although, these markets have not been caused by short term variations, and only their trend values could be correlated (Hassan, 2003). The long-run integration exists between Japan, India, the UK and the US markets. However, these linkages have not been strong in the short run for Japan and the US markets (Wong et al., 2004).

There has been a reversal effect for Pacific and OECD countries from Asian markets during the US recession crisis. These markets were not cointegrated in the normal period and caused each other in the crisis period (Elubueni, 2011). The stock prices in the US, both during the monthly and quarterly period, have been cointegrated with the bubble crisis experienced in 1929 (Rappoport, 1993). A study on stock markets of Asia-Pacific nations showed no signs of cointegration during the normal period. However, during the crisis period, signs for integration have been observed for south-eastern nations only (Sheng & Tu, 2000; Forbes & Rigobon, 2002; Evans & McMillan, 2009; Balazs & Evzen, 2007).

There has been no cause-and-effect relationship between German, British and Irish markets pre and post 1987 crisis. There have been only a few signs of linkages after the crisis was over (Gallagher, 1995). Interesting results have been developed with a study of normal and crisis period for Japan, Hong Kong and India. The markets had no signs of cointegration before the US crisis had hit the world markets. During the crisis period, cointegration became strong and thereafter resorted back to normal (Gupta & Guidi, 2012). A study of emerging stock markets (Thailand, Singapore, Malaysia and Hong Kong) with the US and the UK markets reflected strong linkages (Masih & Masih, 1999; Ayse & Can, 2000).

Russia and the US markets have been integrated in the long-run, and the stock markets movements in Russia have been caused by the stock markets in Japan too. Interestingly, Russian markets have not been influenced by similar markets in Russia rather by Asian markets (Hanna, 1999). The increased instability related to the political and economic environment led to the independence of the Czech Republic, Russia, Hungary and Poland markets. Though, the indices were cointegrated in the long-run before the crisis, the reversal effect was observed post-crisis (Theodore et al.,1995; Eun & Shim, 1989). The diversification possibility has been observed for Austria, Malaysia and China markets with US markets. There has been a strong linkage of the US markets with other developed and developing markets in the study (Khan, 2011).

Research Gap

The examination of portfolio diversification opportunities remains a grey area and has been studied with in different capacities for both developed and developing nations' markets. The area of interest for investors lies in newer possibilities wherein they can explore and develop strategies to hedge themselves from market adverse movements. A rational investor is always on a look out for maximizing his portfolio return and minimizing his portfolio risk. There have been various studies regarding relationship among world stock market indices in this domain both in short as well as long-run pre and post 2011 crisis (Hassan, 2003; Tagoe and Chiou, 2021; Chen & Chiang, 2022; Yadav & Pandey, 2019).

The association has been studied with the help of various methods like cointegration, correlation, autoregressive distributed lag models and volatility models for spillover behavior (Eun & Shim, 1989; Ayse & Can, 2000; Ramakrishna & Smita, 2017; Ghosh & Saidi, 1999). However, none of the studies has examined N-10 stock markets for diversification potential from investors' and policymakers' points of view in recent studies (Masih, 1999; Kumar, Srivastava & Chauhan, 2017; Al Nasser and Hajilee, 2016). Hence, the present study has attempted to discover the diversification opportunities between these markets using various econometric models. The study's outcomes shall bring out association among these developing markets, and results thereof shall be useful for investors/arbitrageurs/portfolio managers/policymakers.

3 Methodology

3.1 Data and Model Specification

The current study tries to examine a causal relationship between stock exchanges of N-10 nations in both short run and long-run period. The historical daily closing prices of these N-10 nations' stock indices, namely Bangladesh, Egypt, Indonesia, South Korea, Mexico, Nigeria, Pakistan, the Philippines, Turkey and Vietnam, are used in the study. The analysis period consists of the daily dataset of 8 years from 2013 to 2020 of all the N-10 nations' stock indices, and the dataset is balanced. As the study involves the analysis of both short term and long term nature, It is desirable to use the daily data for superior analysis. The data points is collected from the official website of stock exchanges and open platforms in case of incomplete data set on their websites. The closing prices have been transformed into log returns to remove the problem of heteroscedasticity while exploring both short run and long-run interdependence among these market indices. The following equations reflecting the

relationship between each N-10 nation with remaining others are examined in the next section.

Table 2: List of N-10 Nations' Stock Exchanges and Their Indices

Nation	Stock Exchange	Stock Index
Bangladesh	Dhaka Stock Exchange	DSE 30
Egypt	The Egyptian Exchange	S&P/ESG
Indonesia	Indonesia Stock Exchange	IDX composite
Mexico	Mexican Stock Exchange	S&P/BMV IPC
Nigeria	Nigerian Stock Exchange	NSE 30
Philippines	Philippine Stock Exchange	PSEI 30
Pakistan	Karachi Stock Exchange	KSE 30
South Korea	Korea Stock Exchange	FTSE Korea
Turkey	Borsa Istanbul	BIST 100
Vietnam	Ho Chi Minh City Stock Exchange	VN 30

Source: Author's presentation

$$BAN_t = \beta 0_t + \beta 1_t EGY_t + \beta_t 2IND_t + \beta 3_t MEX_t + \beta 4_t PHI_t + \beta 5_t TUR_t + \beta 6_t NIG_t + \beta 7_t PAK_t + \beta 8_t SK_t + \beta 9_t VIE_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (1)$$

$$EGY_t = \beta 0_t + \beta 1_t\ BAN_t + \beta_t 2IND_t + \beta 3_t MEX_t + \beta 4_t PHI_t + \beta 5_t TUR_t + \beta 6_t NIG_t + \beta 7_t PAK_t + \beta 8_t SK_t + \beta 9_t VIE_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (2)$$

$$IND_t = \beta 0_t + \beta 1_t EGY_t + \beta_t 2BAN_t + \beta 3_t MEX_t + \beta 4_t PHI_t + \beta 5_t TUR_t + \beta 6_t NIG_t + \beta 7_t PAK_t + \beta 8_t SK_t + \beta 9_t VIE_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (3)$$

$$MEX_t = \beta 0_t + \beta 1_t EGY_t + \beta_t 2IND_t + \beta 3_t BAN_t + \beta 4_t PHI_t + \beta 5_t TUR_t + \beta 6_t NIG_t + \beta 7_t PAK_t + \beta 8_t SK_t + \beta 9_t VIE_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (4)$$

$$PHI_t = \beta 0_t + \beta 1_t EGY_t + \beta_t 2IND_t + \beta 3_t MEX_t + \beta 4_t BAN_t + \beta 5_t TUR_t + \beta 6_t NIG_t + \beta 7_t PAK_t + \beta 8_t SK_t + \beta 9_t VIE_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (5)$$

$$TUR_t = \beta 0_t\ \beta 1_t EGY_t + \beta_t 2IND_t + \beta 3_t MEX_t + \beta 4_t PHI_t + \beta 5_t BAN_t + \beta 6_t NIG_t + \beta 7_t PAK_t + \beta 8_t SK_t + \beta 9_t VIE_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (6)$$

$$NIG_t = \beta 0_t + \beta 1_t EGY_t + \beta_t 2IND_t + \beta 3_t MEX_t + \beta 4_t PHI_t + \beta 5_t TUR_t + \beta 6_t BAN_t + \beta 7_t PAK_t + \beta 8_t SK_t + \beta 9_t VIE_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (7)$$

$$PAK_t = \beta 0_t + \beta 1_t EGY_t + \beta_t 2IND_t + \beta 3_t MEX_t + \beta 4_t PHI_t + \beta 5_t TUR_t + \beta 6_t NIG_t + \beta 7_t BAN_t + \beta 8_t SK_t + \beta 9_t VIE_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (8)$$

$$SK_t = \beta 0_t + \beta 1_t EGY_t + \beta_t 2IND_t + \beta 3_t MEX_t + \beta 4_t PHI_t + \beta 5_t TUR_t + \beta 6_t NIG_t + \beta 7_t PAK_t + \beta 8_t BAN_t + \beta 9_t VIE_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (9)$$

$$VIE_t = \beta 0_t + \beta 1_t EGY_t + \beta_t 2IND_t + \beta 3_t MEX_t + \beta 4_t PHI_t + \beta 5_t TUR_t + \beta 6_t NIG_t + \beta 7_t PAK_t + \beta 8_t SK_t + \beta 9_t BAN_t + \varepsilon_t \ldots\ldots\ldots\ldots\ldots (10)$$

Notes: *BAN is Bangladesh stock index, EGY is Egypt stock index, IND is Indonesia stock indices, MEX is Mexico stock indices, PHI is Philippine's stock index, TUR is Turkey stock index, NIG is Nigeria stock index, PAK is Pakistan stock index, SK is South Korea stock index, and VIE is Vietnam stock index. t is the time period, and ε is the error term.*

Based on the current econometric model, the interlinkages among the N-10 nation's stock exchanges' indices is investigated in this study. The model employed in such investigations is

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the "Vector Autoregressive Model (VAR)". This model comes with an assumption that all the data do not have a unit root, i.e. it is stationary. If the time series is found nonstationary, the stability form required for VAR is not achieved.

It becomes a prerequisite to ascertain the cointegration of the time series in our study to know whether the VECM model fits best for investigating the interlinkage among the stock indices of N10 countries. Cointegration can be investigated using the Johansen cointegration test (Johansen and Juselius, 1990; Yoo & Ku, 2009)). If the variables in the model are cointegrated, we can construct both short term (VAR) and long-run (VECM) models. On the other hand if the variables in the model are not cointegrated than only short run (VAR) model can be constructed. The main equation of VECM is used to analyse the long-run relationship of the study variables and Wald test is applied to identify the short-run causality between the stock markets.

Stationarity

The findings and inferences from the regression model are considered spurious if the time series employed in the study has a unit root, and hence findings are useless. Thus, it is crucial to examine the stationarity of the time series. A stochastic trend is examined by testing unit root in time series (Nelson and Plosser, 1982;Elliot, Rothenberg, & Stock, 1996; Dritsaki & Dritsaki-Bargiota, 2005). The Augmented Dickey-Fuller test, is applied to check the robustness (Dickey & Fuller, 1979). The findings are summarized in the section on results and discussion. The Augmented Dickey-Fuller model is:

$$\Delta Z_t = \alpha_1 + \alpha_2 t + \alpha_3 Z_{t-1} + \sum_{i=1}^{p} \beta_i \Delta Z_{t-I} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

where ADF regression tests for the existence of unit root of Zt, the logarithmic values of all model variables at time t.

Cointegration

In econometrics, if the time series come out to be nonstationary, it is transformed into stationary by differencing for further empirically investigating the series. Engel and granger (1987) disclosed that to investigate the nonstationary series at level, all the data series are integrated at the same order and cointegrated. According to their research work, in the case of cointegrated series, a long-run equilibrium relationship may exist even in the case of nonstationary data (Dickey, Jansen, & Fuller, 1991).

$Y_t = A_1 Yt_{\,1} + A_2 Yt_{\,2} \ldots\ldots + A_k Yt_{\,k} + BX_t + ft$ ……..*(12)*

where, Y_t = a k-vector of non-stationary I (1) variables, X_t = the vector of deterministic variables,

The findings of stationarity and cointegration ultimately determine the model (VAR/ VECM) we then employ in the study to underline both the short-run and long-run linkages among the selected stock indices of N10 nations. The results reflect both the non-stationary and cointegrated nature of the variables. It is advisable to employ the vector error correction model (VECM) to estimate the model. The VECM model is:

$$\Delta y_{1,t} = \alpha_1 \left(y_{2,t-1} - \beta y_{1,t-1}\right) + \varepsilon_{1,t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 13$$

$$\Delta y_{2,t} = \alpha_2 \left(y_{2,t-1} - \beta y_{1,t-1}\right) + \varepsilon_{2,t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 14$$

The right-hand side variable in the above model is defined as the error correction term. This term in zero in the long-run equilibrium. The only concern in estimating any VAR model is the proper specification of the model. The study has used the Schwarz Bayesian Criterion (Schwartz, 1978) and Akaike Information Criterion (Akaike, 1974) and to solve this problem (Maddala, 1992; Mills & Prasad, 1992).

The short-term causal linkages have been examined with the help of the Granger test of causality (Hiemstra and Jones, 1994) to locate unidirectional and bi-directional relationships (Granger, 1969, 1988). Following are the equations related to the Causality test:

$$Y_t = \sum_{i=1}^{n} \alpha_i Y_{t-i} + \sum_{j=1}^{n} \beta_j X_{t-j} + u_{1t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 15$$

$$X_t = \sum_{i=1}^{n} \lambda_i Y_{t-i} + \sum_{j=1}^{n} \sigma_j X_{t-j} + u_{2t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 16$$

where Yt and Xt are the time series.

4 Findings

The current study deals with investigating the interlinkage among the stock exchanges of N-10 nations. It focuses on analyzing both the long-run and short-run relationship between the selected stock exchanges, namely, Vietnam, Bangladesh, Turkey, Egypt, the Philippines, Indonesia, Pakistan, South Korea, Nigeria and Mexico stock markets.

4.1 Descriptive Statistics

The stock indices time series employed in the current study is checked for normality using Jarque Bera Normality Test, *Jarque* and *Bera* (1980, 1987) and are depicted in Table-3. The difference between maximum and minimum values is less, which is desirable for the model testing. Indonesia stock market is giving the highest return in the study period followed by Bangladesh stock market. On the other hand, Pakistan stock market has the least and a negative return during the study period followed by Mexico stock market. Mexican stock index return has the highest standard deviation, and Egypt stock index return has the lowest standard deviation. The p-value of Jarque Bera Normality Test highlights that the null hypothesis indicating that the data is normally distributed is not accepted for any of the stock market.

Table 3: Descriptive Statistics

Variable	Maximum	Minimum	Mean	S.D	Jarque Bera	P-value
BAN	0.227844	-0.227666	5.85	0.008128	3055876.0	0.000***
EGY	0.048554	-0.074527	0.00014	0.006011	32966.46	0.000***
IND	0.042145	-0.029554	6.19	0.004498	5592.35	0.000***
MEX	0.764417	-0.760552	-7.89	0.0241	80647871	0.000***
PHI	0.031146	-0.062201	2.73	0.005194	26727.04	0.000***
TUR	0.027088	-0.048047	0.000134	0.006102	2091.221	0.000***
NIG	0.036584	-0.024747	1.45	0.004615	2826.162	0.000***
PAK	0.022577	-0.033603	-8.95	0.005621	947.9304	0.000***
SK	0.037997	-0.034387	0.000102	0.00431	6642.84	0.000***
VIE	0.021853	-0.028512	0.000132	0.004646	2227.672	0.000***

Note 1: *BAN is Bangladesh stock index, EGY is Egypt stock index, IND is Indonesia stock indices, MEX is Mexico stock indices, PHI is the Philippines stock index, TUR is Turkey stock index, NIG is Nigeria stock index, PAK is Pakistan stock index, SK is South Korea stock index, and VIE is Vietnam stock index*
Note 2: "** Significant at 10%, **Significant at 5 %, ***Significant at 1 % level of significance"*
Source: *Authors' presentation*

Confirming the stationarity of the time series is a very crucial step. So, it becomes essential to analyze the stationarity of all the time series employed in the current study. For examining the same, the test used is the Augmented Dickey-Fuller test. The data for stock indices of Vietnam, Bangladesh, Turkey, Egypt, the Philippines, Indonesia, Pakistan, South Korea, Nigeria and Mexico stock markets are examined for stationarity (Refer Table 4).

Table 4: Stationary Test Results

Variable	ADF	Probability
BAN	-43.99984	0.0001***
EGY	-27.83881	0.0000***
IND	-43.45738	0.0000***
MEX	-26.39068	0.0000***
PHI	-45.51516	0.0001***
TUR	-46.10013	0.0001***
NIG	-31.52268	0.0000***
PAK	-40.83013	0.0000***
SK	-29.18363	0.0000***
VIE	-29.72119	0.0000***

Note 1: *BAN is Bangladesh stock index, EGY is Egypt stock index, IND is Indonesia stock indices, MEX is Mexico stock indices, PHI is the Philippines stock index, TUR is Turkey stock index, NIG is Nigeria stock index, PAK is Pakistan stock index, SK is South Korea stock index, and VIE is Vietnam stock index*

Note 2:** Significant at 10%, **Significant at 5 %, ***Significant at 1 % level of significance*

Note 3: *Table shows test statistics at first difference*

Source: *Authors' presentation*

Cointegration Test

The variables are stationary at the first order of integration. The next step is to test cointegration between the variables. The study employs the Johansen cointegration test to investigate the cointegration, and the findings obtained reject the null hypothesis, Johansen and Juselius (1990). In other words, cointegration exists between the stock market indices of the N-10 nation, refer table 5.

Table-5: Co-integration Test

Hypothesized No. of Co-integrating Equations	Trace Stat	Probability
None **	268.7581	0.0011
At most 1	182.7987	0.2074
At most 2	132.0239	0.5624
At most 3	93.7606	0.7829
At most 4	62.16276	0.9203
At most 5	42.07917	0.9095
At most 6	26.08364	0.8866
At most 7	14.98594	0.781
At most 8	7.546335	0.5151
At most 9	1.500446	0.2206

Note 1: ** Significant at 10%, **Significant at 5 %,***Significant at 1 % level of significance*

Source: *Authors Calculations*

VECM Results (Long-run Test)

This highlights that there exists a well-defined long-run equilibrium relationship among the stock markets of N-10 nations, and the stock market indexes move together. Therefore, it can be concluded that portfolio diversification has meagre advantage across these stock markets in the long-run. Thus, it is now advisable to use VECM to analyse the interlinkages between the selected stock exchanges, namely, Bangladesh, Egypt, Indonesia, South Korea, Mexico, Nigeria, Pakistan, the Philippines, Turkey, and Vietnam stock markets. Based on the non-stationary time series and the cointegration results, it is suitable to apply the Vector Error Correction model to examine both the short term and long-run relationship between the stock market indices of N10 nations and examine the equations. The findings of VECM are reflected in Table 6. The long-run relationship is examined with the error correction term in the VECM. From the table, when BAN serves as the dependent variable, the lagged error-correction term generally is statistically insignificant at a 1% level. This implies that BAN, a measure of Bangladesh stock index, tend to converge to its long-run equilibrium path in response to changes in its regressors, Egypt, Indonesia, Mexico, and Nigeria, Pakistan, the Philippines, South Korea, Turkey and Vietnam stock exchanges indices. A similar result is depicted when the dependent variable is the Egypt stock index. However, the findings also highlight that for all the remaining stock indices, significant dependency is witnessed. It suggests that the remaining eight stock indices have long-run casual linkages with other stock indices. So, it can be further concluded that long-run granger causality runs among stock exchanges of Indonesia, Mexico, Nigeria, Pakistan, Philippines, South Korea, Turkey and Vietnam except for Bangladesh and Egypt exchanges.

Table-6: VECM Results

Variable	Coefficient	t-Statistic	Prob.
BAN	0.0010	1.4114	0.1582
EGY	0.0007	0.1709	0.8643
IND	0.0083	5.2250	0.0000
MEX	0.0293	2.6664	0.0077
NIG	0.0018	3.9511	0.0001
PAK	0.0024	4.4836	0.0000
PHI	0.0090	3.7569	0.0002
SK	0.0006	6.4517	0.0000
TUR	0.0012	3.3222	0.0009
VIE	0.0018	7.0480	0.0000

Note 1: *BAN is Bangladesh stock index, EGY is Egypt stock index, IND is Indonesia stock indices, MEX is Mexico stock indices, PHI is the Philippines stock index, TUR is Turkey stock index, NIG is Nigeria stock index, PAK is Pakistan stock index, SK is South Korea stock index, and VIE is Vietnam stock index*

Note 2: ** Significant at 10%, **Significant at 5 %, ***Significant at 1 % level of significance*

Source: *Authors' presentation*

Wald test (Short run test)

Wald test is applied to identify the short-run causality between the stock markets. The findings depicted in table 7 reflect a short-run causality running from the Pakistan stock exchange to the Bangladesh stock exchange. Causality is also observed from the Vietnam stock exchange to the Egypt stock exchange in short run. Indonesia, Mexico, the Philippines, South Korea, Nigeria, Turkey, Pakistan and Vietnam stock exchanges are significantly influenced by all the stock exchanges in the short run.

Table 7: Short-Run Block Exogeneity Wald Test Based on VECM

Variable	Value	df	Probability
BAN	138.548	3	0.000
EGY	26.996	3	0.000
IND	89.892	10	0.000
MEX	68.255	7	0.000
NIG	57.871	2	0.000
PAK	33.949	3	0.000
PHI	70.593	8	0.000
SK	90.899	8	0.000
TUR	27.892	4	0.000
VIE	59.348	4	0.000

Note 1: *BAN is Bangladesh stock index, EGY is Egypt stock index, IND is Indonesia stock indices, MEX is Mexico stock indices, PHI is the Philippines stock index, TUR is Turkey stock index, NIG is Nigeria stock index, PAK is Pakistan stock index, SK is South Korea stock index, and VIE is Vietnam stock index*

Note 2: ** Significant at 10%, **Significant at 5 %, ***Significant at 1 % level of significance*

Source: *Authors' presentation*

Granger Causality

Table 8: Granger Causality Results

Country	Bangladesh	Egypt	Indonesia	Mexico	Philippines	Turkey	Nigeria	Pakistan	South Korea	Vietnam
Bangladesh		NO	→	NO	NO	NO	NO	NO	NO	NO
Egypt	NO		↔	↔	←	↔	←	↔	→	↔
Indonesia	←	↔		↔	←	→	←	↔	→	←

Mexico	NO	↔	↔		↔	↔	←	↔	↔	←
Philippines	NO	←	→	↔		→	↔	←	↔	↔
Turkey	NO	↔	←	↔	←		←	↔	↔	←
Nigeria	NO	→	→	→	↔	→		→	→	NO
Pakistan	NO	↔	↔	↔	→	↔	←		↔	←
South Korea	NO	←	←	↔	↔	↔	←	↔		↔
Vietnam	NO	↔	→	→	↔	→	NO	→	↔	

Notes: → *indicates causality from row to a column,* ← *indicates causality from column to row,* ↔ *indicates causality from both row to column and vice versa, NO means no causal linkage.*

The short-run linkages have been further verified with the granger causality test and shown in Table 8 for all the stock markets from N-10 countries. Similar to VECM results described in Table 6, causal linkages have not been found between Bangladesh and other countries' markets except Indonesia. VECM results had shown that long-run causal linkages have not been present among Bangladesh and Egypt. Granger causality results reflect the same phenomenon in the short run for Bangladesh bearing its relationship with Indonesia. Apart from these two markets, Nigeria and Vietnam have not shown any linkages among their markets in the short run. Bi-directional short-run causality existed for Egypt with Indonesia, Mexico, Turkey, Pakistan and Vietnam. The Philippines, Nigeria and South Korea have shown unidirectional linkages with Egypt in the short run. Markets from Indonesia have shown bi-directional causality with Mexico and Pakistan and unidirectional linkages with the remaining N-10 markets. Mexico possessed bi-directional causality with all the markets except with Nigeria and Vietnam, with which it has shown unidirectional relations. Mexico, Nigeria, South Korea, and Vietnam markets had bi-directional causality with the Philippines, unlike Egypt, Indonesia, Turkey and Pakistan. Nigeria has shown bi-directional linkages with the only the Philippines and no linkages with Bangladesh and Vietnam. The Philippines, Nigeria, and Vietnam had unidirectional linkage with Pakistan markets, and the remaining markets had unidirectional relationships except for Bangladesh. South Korea reflected bi-directional relations with all markets except Bangladesh and Egypt, Indonesia and Nigeria. Vietnam markets are related two-way with Egypt, the Philippines, South Korea.

5 Discussion

The findings of this study through light on the opportunity of diversification among the N-10 nations specially Bangladesh and Egypt stock exchanges in the long-run as the relationship of other N-10 nations' stock exchanges with these two are not significant. This highlights that the opportunity of portfolio diversification among the N-10 nations are quite low. The findings are quite similar to that of Lingaraja et al., 2015 who studied the relationship among India, Malaysia, the Philippines and the US markets using Corerlation and Granger Causality test and its finding showed a very limited scope of diversification opportunity. In another study by Yarovaya et al., 2016 which was conducted among Argentina, Brazil, Chile, Colombia, Mexico and Venezuela stock markets to analyse the linkages for diversification using cointegration techniques, similar results were identified. Tagoe and Chiou, 2021 utilised Johansen cointegration techniques and tested some of the developed markets for portfolio opportunities and the results were quite similar to the findings of the current study and indicated both short run and long-run causality among the stock markets.

Although, the findings are contradictory to the results of some earlier studies like one of the study conducted on the stock markets of Pakistan, the US, the UK, Taiwan, Malaysia and Singapore revealed a very high chance of portfolio diversification as the cointegration among the selected stock markets was negligible, Ali et al., 2011. Similar is the case of Kumar, Srivastava & Chauhan, 2017 who studies the Malaysia, South Korea, China, India and Taiwan and found that the long-term relationship among the stock markets' returns is low and one can invest in these stock markets and develop a profitable portfolio.

6 Conclusion

The pivotal idea of the present study has been to sightsee outlay occasions and diversification potential for investors in stock markets of Bangladesh, Egypt, Indonesia, South Korea, Mexico, Nigeria, Pakistan, the Philippines, Turkey and Vietnam. The linkages between these stock markets have been empirically investigated with cointegration dynamics both in the long and short run. These emerging markets have shown varied combinations for diversification possibilities for investors. The unidirectional, bi-directional and no linkage within markets have been discovered in various groupings. The cointegration results have shown that it might be difficult for investors to diversify their investment patterns within these set of emerging markets in the long-run. However, Bangladesh and Egypt markets have

not shown cause and effect relationship for each other. Hence, investors may utilize this phenomenon to plan their investment options. The same continues in the short run as per the results of Granger Causality tests, but these results have not been reflected in the Wald test. The latter has shown that all the markets have been causing each other in the short run. Thus, the results indicate an assorted latent for investors in these markets. It has been found with Granger Causality during the study that investors may discover a broadening outlook while plugging money in the stocks listed at these stock exchanges. However, a cautious approach shall be desired while doing such portfolio allotment as, in various cases, many of the markets have been found to cause each other.

6.1 Managerial Implications

The policymakers and regulators may pay attention to the causal linkages across these set of nations. The presence of both long-run and short run association among stock exchanges of Indonesia, Mexico, Nigeria, Pakistan, the Philippines, South Korea, Turkey and Vietnam may be taken as a base to develop trade policies and also make the financial and retail investors alert about such linkages. The financial and non-financial institutions may devise strategies for investment patterns on national and global levels in these countries based on no association between the stock markets of Bangladesh and Egypt exchanges with any other N-10 nations' stock markets. The arbitrageurs may take benefit of results and devise methodologies to grab maximum gains.

Scope for further study

The stock markets chosen for the present study may be referred to as emerging and developing markets after various established group of nations. Hence, these markets may be further studied along with various nations to examine relationships and divergence possibilities for domain and international investors. N-10 markets may offer various angles for researchers in future, and policies may be devised with innovative studies for these markets. Bivariate/multivariate GARCH models may be applied to study further the cause-and-effect relationship and their volatile behaviour towards each other.

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