STOCK MARKETS INTEGRATION: EXAMINING LINKAGES BETWEEN SELECTED WORLD MARKETS

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In recent years, globalisation, economic assimilation and integration among countries and their financial markets have increased interdependency among major world stock markets. This increased interdependency among the worldwide stock markets may have impacts on the global investors for their assets allocation decision and on the economic policies of economies for ensuring economic stability. Hence, there is a need to study the extent of integration among the world stock markets which is the objective of this paper. It examines the relationships between the selected Asian and the US stock markets over a period, 19/10/1999 to 25/04/2008, using daily closing data of twelve stock markets. Results of the present study show that stock markets under study are integrated. The degree of correlation between the markets, but Japan, varies between moderate to very high. Furthermore, it provided that no stock market is playing a very dominant role in influencing other markets. The US influence is not noticeable as in the earlier researches. It is expected that the results will be useful for the global investors in managing their international portfolios.

Key Words: ***Stock Market Integration, Unit Root Test, Co-integration and Granger Causality***

INTRODUCTION

IN a dynamic economic environment, knowledge of international stock market structure is important for the investors, portfolio managers and policy makers. Various theories in finance suggest that it is the degree and direction of correlation among the returns of securities as well as those of the stock markets which decide whether an investor is going to have any gains of diversification across the securities and the markets. For instance, if the stock markets of different countries move together, then investing in different stock markets would not generate required portfolio diversification gains. Hence, it is important for the investors to know whether diversification across the global stock markets will provide desired diversification gains. For this, it is imperative for them to have an accurate estimate of the degree and nature of correlation among the returns across the global stock markets. Also, if the policy makers of a particular economy understand fully the way the global markets are integrated, then suitable economic policies could be designed so as to take care of the economic crisis traveling to domestic market from other international markets; especially it is more important for the policy makers of emerging markets because they need to develop a greater understanding the way their economies are growing and integrating with other world markets. Therefore, a comprehensive study on stock market integration will carry a lot of importance in the present day situation. The present paper is a humble attempt in this direction and examines the interdependence particularly among different Asian markets vis-à-vis with other global markets especially with the US markets.

The paper is organised as thus: Section 2 presents a review of existing literature related with the study. The details about the research methodology adopted for the paper are presented in Section 3. Section 4 gives comprehensive analysis of the results obtained. Lastly, Section 5 concludes the study.

LITERATURE REVIEW

Various studies are undertaken in different parts of the world regarding linkages and integrations among the stock markets by many researchers; some important ones are reviewed as under: Wheatley (1988) analysed the data, of the US and 17 other countries, by applying VAR and unit root tests, for the period 1960 - 1985, and supported the notion of equity-market integration. Dwyer and Hafer (1988) concluded that there were considerable interactions among stock market indexes, with one-way causality running from the US to other markets, including Hong Kong and Japan. Eun and Shim (1989) analysed daily stock market returns of Australia, Hong Kong, Japan, France, Canada, Switzerland, Germany, the US and the UK. They found existence of substantial interdependence among the national stock markets with the US being the most influential market.

Using daily and intraday price and stock returns data, Hamao *et al.,* (1990) find that there are significant spillover effects from the US and the UK stock markets to the Japanese market but not the other way round. Rao and Naik (1990) got same result when they attempted to examine the inter-relatedness of the US, Japanese and Indian Stock Markets. Their findings pointed out that Japanese market acts like an independent factor in relation to the US and Indian stock markets. Fischer and Palasvirta (1990) also found a high level of interdependence between stock markets of 23 countries; they further concluded that the US index prices lead almost every country index in the sample. Becker et al., (1990) too reported that the Japanese market has only a small impact on the U.S. return during the period of study. Mathur and Subrahmanyam (1990) used the concept of Granger causality to examine interdependencies among the stock market indices for four Nordic countries and the U.S. The results indicate that the Nordic stock markets are less than fully integrated. Further Malkamäki (1992) examines the interdependence of stock markets in Sweden, Finland and their biggest trading partners in the period 1974 - 89 and finds that the Scandinavian markets seem to be led by the German and the UK market. Chan *et al.,* (1992) uses unit root and co-integration tests to examine the relationships among the stock markets in Hong Kong, South Korea, Singapore, Taiwan, Japan, and the United States. Their findings suggest that the stock prices in major Asian markets and the United States are weak-form efficient individually and collectively in the long run. Cheung and Mak (1992) concluded that the US market can be considered as a 'global factor' and is found to lead most of the Asian - Pacific emerging markets with the exception of three relatively closed markets: Korea, Taiwan and Thailand. The Japanese market is found to have a less important influence on the Asian - Pacific emerging markets.

Confirming the previous study Smith *et al.,* (1993) also find evidence of Granger unidirectional causality running from the US to the other countries immediately after the October 1987 worldwide crash. Park and Fatemi (1993) examine the linkages between the equity markets of the Pacific-Basin countries to those of the US, the UK and Japan. It was again noticed that the US market is the most influential compared to that of the UK and Japan. It was found that Australia is most sensitive to the US market. Singapore, Hong Kong and New Zealand form the next group and exhibit moderate linkages.

Another study that confirms the US dominated role is done by Choudhury (1994), he examine the relationship among the Asian Newly Industrialised Economies (NIEs), Japan and the US. By applying variance decomposition and impulse response functions, they found that the US led the NIEs and that there were significant linkages between the markets. Blackman *et al.,* (1994) further suggests that, while such relationships were unlikely before 1980, markets are now expected to move together. Arshanapalli *et al.,* (1995) documents the presence of a common stochastic trend between the U.S. and the Asian stock market movements during the post-October 1987 period. The evidence suggests a co-integrating structure. Sewell *et al.,* (1996) also examined five Pacific Rim countries and the US, documenting evidence of varying degrees of market co-movements. Karolyi and Stulz (1996) study the daily return co-movements between the Japanese and the U.S. stocks from 1988 to 1992 and find evidence that correlations are high when there are significant market movements. Markellos and Siriopoulos (1997) too examined the diversification benefits available to the U.S. and Japanese investors over the period 1974 - 94 in seven of the smaller European stock markets. Cointegration analysis found no significant common trend shared between the U.S. and Japanese markets. Palac-McMiken (1997) uses the monthly ASEAN market indices (Indonesia, Malaysia, the Philippines, Singapore and Thailand) between 1987 and 1995 and finds that with the exception of Indonesia, all the markets are linked with each other. Kanas (1998) discovered that the US stock market does not have pair wise co-integration with any of the European markets. These results imply that there are potential benefits from diversifying in the US stocks as well as stocks in

European markets. Janakiramanan and Lamba (1998) empirically examine the linkages between the Pacific-Basin stock markets. The influence of the US market on the Australasian markets has diminished over more recent years, and the emerging market of Indonesia is becoming more integrated with these markets. Elyasiani *et al.,* (1998) found no significant interdependence between the Sri Lankan market and the equity markets of the US and the Asian markets considered. Liu *et al.,* (1998) had tried to examine the stability of the interrelationship among the emerging and developed stock markets of Thailand, Taiwan, Japan, Singapore, Hong-Kong and the US. They found an increase in the general stock market interdependence. Ramchand and Susmel (1998) find that the correlations between the U.S. and other world markets are on average 2 to 3.5 times higher when the U.S. market is in a high variance state as compared to a low variance regime. They also find that, compared to a GARCH framework, the portfolio choices resulting from their SWARCH model lead to higher Sharpe ratios. In their paper, Gerrits and Yuce (1999) test the interdependence between stock prices in Germany, the UK, the Netherlands and the US. Results of the tests show that the US exerts a significant impact on European markets. Moreover, the three European markets influence each other in the short and long run. Masih and Masih (1999) also found high level of interdependence among markets in Thailand, Malaysia, the U.S., Japan, Hng Kong, and Singapore from 1992 to 1997.On the other hand Christofi and Pericli (1999) investigate the short turn dynamics between five major Latin American stock markets (Argentina, Brazil, Chile, Columbia, and Mexico) from 1992 to 1997. They find significant first and second moment time dependencies. Cross spectral analysis is applied by Smith (1999) to six of the G-7 markets to determine whether frequency domain correlations have increased post-crash relative to the pre-crash period. The results indicate that correlations have increased for most of the markets studied. Sheng and Tu (2000) use a co-integration and variance decomposition analysis to examine the linkages among the stock markets of 12 Asia–Pacific countries, before and during the period of the Asian financial crisis. In addition, Granger's causality test suggests that the US market still 'causes' some Asian countries during the period of crisis, reflecting the US market's persisting dominant role. Ng (2000) examines the magnitude and changing nature of volatility spillovers from Japan and the US to six Pacific-Basin equity markets. The study finds that regional and world factors are important for the market volatility in the Pacific-Basin region, though world market influence tends to be greater. Roca and Selvanathan (2001) analysed price linkages between the equity market of Australia and those of Hong Kong, Singapore and Taiwan, covering the period 1975 - 1995. The results show that the Australian market is not significantly linked with any of these markets. Scheicher (2001) studied the regional and global integration of stock markets in Hungary, Poland and the Czech Republic. The empirical result is the existence of limited interaction.

Johnson and Soenen (2002) find that the equity markets of Australia, China, Hong Kong, Malaysia, New Zealand, and Singapore are highly integrated with the stock market in Japan. Kumar (2002), in his study, confirmed that stock index of Indian stock market was not co- integrated with that of developed markets. Mishra (2002) investigated the international integration of Indian stock market. He found no co-integrating vector between BSE and NASDAQ indices that signifies there was no long-run relationship between these two stock exchanges. Darrat and Zhang (2002) examined the linkages between eleven emerging Asia-Pacific markets with the US and Japan. They argued that the effect of the movements in the Japan market on Asia-Pacific region is only transitory. Ng (2002) found no evidence to indicate a long–run relationship among the South–East Asian stock markets. Correlation analyses also indicate that the South–East Asian stock markets are becoming more integrated. Nath and Verma (2003) analysed the level of capital market integration by examining the transmission of market movements among three major stock markets in the Asian region, viz., India, Singapore and Taiwan; they suggested that international investors could achieve long term gains by investing in the stock markets because of the independencies of the stock markets. Bessler and Yang (2003) concluded that the US market is highly influenced by its own historical innovations, but it is also influenced by the market innovations from the UK, Switzerland, Hong Kong, France and Germany. Darrat and Benkato (2003) analysed stock returns and volatility relations between the Istanbul Stock Exchange (ISE) and the stock markets in the US, the UK, Japan and Germany. They realised that the two matured markets of the US and the UK shoulder significant responsibility for the stability and financial health of the smaller emerging markets like the ISE.

Yang *et al.,* (2003) uniquely examined the relationships among the five largest emerging African stock markets and the US market. There is evidence of

both long-run relationships and short-run causal linkages between these markets. Baharumshah *et al.*, (2003) examines the dynamic interrelationship among four Asian markets (Malaysia, Thailand, Taiwan and South Korea). The evidence shows that the degree of integration between the Asian emerging markets and the US increased following the deregulation period, and that the relationship has intensified since the onset of the Asian crisis. Hatemi and Roca (2004) examines the equity market price interaction between Australia and the European Union. They concluded that Australia also had no causal links with Germany and France but it had with the UK, with causality running from the UK to Australia but not vice-versa.

Working in line with above researches, Narayan *et al.*, (2004) examines the dynamic linkages between the stock markets of Bangladesh, India, Pakistan and Sri Lanka using Granger causality approach. In the short run there is unidirectional Granger causality running from the stock prices in Pakistan to India, stock prices in Sri Lanka to India and from stock prices in Pakistan to Sri Lanka. Bangladesh is the most exogenous of the four markets. Click and Plummer (2005) concluded that ASEAN-5 stock markets are integrated in the economic sense, but that integration is far from complete. Maghyereh (2006) investigated the interdependence among the daily equity market returns for the four major Middle Eastern and North African (MENA) emerging markets, Jordanian, Egyptian, Moroccan and Turkish markets. Evidence indicates that none of the MENA markets is completely isolated and independent. After analysing the markets of 23 different countries Mukherjee and Mishra (2007) identified increasing tendency of integration among the markets and discovered that the countries of same region are found to be more integrated than others.

The above literature review is indicating clearly that researchers over a period of time started getting evidence, though weak, of increasing integration across the global stock markets, yet there is a need to provide further necessary strong evidence about the degree and nature of integration so that the 'reality' about integration of worldwide stock markets could be firmly grounded. It is hoped that the present study would contribute to the existing body of literature by using longitudinal rather than cross sectional based methodology and filling the time gap of researches on the Asian and the US markets. It also examines TA 100 of Israel for which earlier literature is scarce.

METHODOLOGY

Sample

The present study is based on the secondary data related to daily closing figures of various stock indices of various global stock markets over the period from 19/10/1999 to 25/04/2008. Table 1 shows the general stock indices of the countries used for the present study. The data is taken from Yahoo Finance.

The daily returns/prices of the sample stock markets are matched by the calendar date. It is assumed that the timing of the trading sessions of the stock exchanges may not completely be related and it will not add any value by taking into account the real trading time of different stock market under study; therefore, the same has not been taken into account.

Table 1: Stock Exchanges and Stock Indices under Study

S. No	Country /Region	Index	Symbol
1.	China	Shanghai Composite	SC
2.	Hong Kong	Hang Seng	HS
3.	India	BSE 30	BSE
4.	Indonesia	Jakarta Composite	JC
5.	Malaysia	KLSE Composite	KLSE
6.	Japan	Nikkei 225	NIKKEI
7.	Singapore	Straits Times	ST
8.	S. Korea	Seoul Composite	SEOUL
9.	Taiwan	Taiwan Weighted	TAIWAN
10.	Israel	TA-100	TA
11.	USA	DJIA	DJIA
12.	USA	S&P 500	S&P

Hypotheses

To address the objective of the study and after the review of literature, the following hypotheses are formulated and put on test using collected data.

Hypothesis 1: Stock Markets return are not normally distributed

Hypothesis 2: Moderate to very high correlation among all markets

Hypothesis 3: Existence of Unit Root (non stationarity) in stock markets

Hypothesis 4: No co-integration among stock markets

Hypothesis 5: No Causality is found between the US and other markets

Methodology

Return of the indexes are used to find out the correlation among the stock markets, and daily returns have been calculated by taking the natural logarithm of the daily closing price relatives, i.e. $r = \ln (P_t/P_{t-1})$ where P_t is the closing price the t^{th} day.

Following methods/tools are used to test correlation; stationarity of time series, co- integration and causalities between the stock markets using Eviews 5.1:

- The Jarque-Bera Test is used to test whether returns of stock markets follow the normal probability distribution
- Pearson correlation is used to find correlation between the stock markets returns.
- Testing for stationarity (unit root test) is done by using, both the Augmented Dickey- Fuller and the Phillips-Perron tests.
- Johansen Co-integration test is used for pinpointing the long run relationships among the markets under study.
- For Causality Test, Gragner test is used, which identify the direction of the influence from one series to another..

Analysis of Empirical Results

Descriptive Statistics

Table 2a provide summary statistics about index prices, namely sample means, minimums, maximums, medians, standard deviations, skewness, kurtosis and the Jarque-Bera.

Table 2a: Characteristics of Distributions of the Stock Indices under Study

Symbol	Mean	Median	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	Observations
SC	2022.477	1632.495	6092.060	1011.500	1090.082	1.992805	6.067799	2084
HS	14990.62	14064.31	31638.22	8409.010	4567.395	1.132808	4.119408	2084
BSE	7264.714	5356.400	20873.33	2600.120	4638.936	1.148419	3.182092	2084
JC	976.1633	707.6500	2830.260	337.4800	657.3296	1.209354	3.422680	2084
KLSE	880.9380	851.7850	1516.220	553.3400	221.0280	1.013457	3.290571	2084
NIKKEI	13285.81	12586.85	20833.21	7607.880	3163.565	0.263959	1.930115	2084
ST	2142.572	2006.390	3875.770	1213.820	629.1339	0.906239	3.056618	2084
SEOUL	993.5899	860.6100	2064.850	468.7600	399.1620	0.893771	2.768682	2084
TAIWAN	6418.869	6073.060	10202.20	3446.260	1463.741	0.519530	2.530363	2084
TA	601.8380	534.5800	1189.040	249.1900	256.5341	0.707056	2.242992	2084
DJIA	10644.92	10542.77	14164.53	7286.270	1366.983	0.346261	3.083578	2084
S&P	1217.936	1211.890	1565.150	776.7600	185.0220	-0.19	2.263954	2084

It is noted from table 2a that standard deviation in BSE return is highest, thus showing the highest volatility during the period of study. HS closely followed BSE in terms of volatility. S&P 500, KLSE and TA are found to be least volatile during the period under consideration. It is further noted that all but one (DJIA) shows positive skewness. The values of skewness and kurtosis shown in the table also suggest that the stock prices are not normally distributed. To see whether the returns of the stock indices under study are normally distributed, Jarque-Bera Test Statistics are used and the same are given in Table 2b.

Table 2b: Jarque Bera Test for Distribution of Returns of the Stock Indices under Study

Symbol	Jarque-Bera	Probability
SC	2196.578	0.000000
HS	554.5253	0.000000
BSE	460.9657	0.000000
JC	523.5018	0.000000
KLSE	364.0761	0.000000
NIKKEI	123.5944	0.000000
ST	285.5325	0.000000
SEOUL	282.1054	0.000000
TAIWAN	112.9012	0.000000
TA	223.4026	0.000000
DJIA	42.25075	0.000000
S&P	59.66850	0.000000

The results show that the returns are not normally distributed, which may open the door to the issue of stationarity of the time series of returns under study.

Correlation

Table 3 shows the return correlations among the various indices under study.

It can be clearly seen from the above that correlations among the returns of the countries under study are high. It may be seen as first indication for the existence of interdependency among them. The highest of correlations is among BSE and JC (over 98%) and the lowest between NIKKEI and TA (about 42%). It must also be pointed out that the NIKKEI shows low correlations with all other Asian markets (but Taiwan); it is relatively highly correlated with the US markets. The BSE is found to be highly correlated, with other Asian markets with the exception of NIKKEI and Taiwan, which is not as connected as other Asian markets.

BSE is more related with Dow Jones than S&P. TA is found to correlated also, but this relation is relatively lesser with NIKKEI and Taiwan, where as NIKKEI and Taiwan are related to an extent of 80%. TA is also relatively lesser related with S&P and DJIA .In fact, among both the US markets, only DJIA is highly related, above 90%, with ST.

Very high degree of correlations among few stock markets may indicate the way their financial markets are integrated and also, help in studying the flows of money from one country to another.

The correlations need to be further verified for the direction of influence by the Granger causality test and for long-term movements among the returns of stock markets, by the co-integration. All these tests will provide more robust results if the underlying are stationary over the time and therefore, there is a need of a stationarity test for the time series under study which is done below.

Unit Root Test

A unit root test is used to test a time series for stationarity. The most appropriate and widely used tests are the Augmented Dickey-Fuller (ADF) test and Phillips-

Table 3: Correlations of Returns of the Stock Indices under Study

Symbol	SC	HS	BSE	JC	KLSE	NIKKEI	ST	SEOUL	TAIWAN	TA	DJIA	S&P
SC	1	0.8538	0.7775	0.7847	0.7982	0.4728	0.7927	0.7323	0.6570	0.6747	0.7622	0.6103
HS	0.8538	1	0.9107	0.8938	0.9024	0.6982	0.9434	0.8727	0.8177	0.7856	0.9162	0.8338
BSE	0.7775	0.9107	1	0.9855	0.9346	0.5322	0.9430	0.9638	0.6689	0.9301	0.8603	0.6550
JC	0.7847	0.8938	0.9855	1	0.9512	0.4743	0.9363	0.9590	0.6585	0.9306	0.8434	0.6195
KLSE	0.7982	0.9024	0.9346	0.9512	1	0.5695	0.9465	0.9283	0.7862	0.8388	0.8575	0.6966
NIKKEI	0.4728	0.6982	0.5322	0.4743	0.5695	1	0.6807	0.5523	0.8087	0.4223	0.7089	0.8893
ST	0.7927	0.9434	0.9430	0.9363	0.9465	0.6807	1	0.9394	0.7797	0.8791	0.9345	0.7997
SEOUL	0.7323	0.8727	0.9638	0.9590	0.9283	0.5523	0.9394	1	0.7108	0.9088	0.8323	0.6335
TAIWAN	0.6570	0.8177	0.6689	0.6585	0.7862	0.8087	0.7797	0.7108	1	0.4703	0.7654	0.8353
TA	0.6747	0.7856	0.9301	0.9306	0.8388	0.4223	0.8791	0.9088	0.4703	1	0.7977	0.5450
DJIA	0.7622	0.9162	0.8603	0.8434	0.8575	0.7089	0.9345	0.8323	0.7654	0.7977	1	0.8922
S&P	0.6103	0.8338	0.6550	0.6195	0.6966	0.8893	0.7997	0.6335	0.8353	0.5450	0.8922	1

Table 3: Frequency Distribution of Herding Measure of Individual Stocks

Class Intervals (%)	Frequency	Cumulative Frequency
0-2	9	9
2-4	13	22
4-6	4	26
6-8	2	28
8-10	1	29

Table 4: Augmented Dickey-Fuller (ADF Test)

	Level			First Difference		
Symbol	**Lag Length**	**ADF Statistic**	**P-value**	**Lag Length**	**ADF Statistic**	**P-value**
SC	4	-1.2176	0.6690	3	-20.6739	0.0000
HS	5	-2.0549	0.2634	4	-22.3045	0.0000
BSE	1	-2.0060	0.2844	0	-41.6291	0.0000
JC	1	-1.9478	0.3104	0	-42.4824	0.0000
KLSE	3	-1.7498	0.4059	2	-23.2309	0.0000
NIKKEI	0	-0.9336	0.7779	0	-46.0432	0.0001
ST	0	-1.6317	0.4661	0	-46.7011	0.0001
SEOUL	0	-2.0714	0.2565	1	-33.9266	0.0000
TAIWAN	0	-1.9256	0.3206	0	-44.5893	0.0001
TA100	1	-1.1313	0.7055	0	-49.1816	0.0001
DJIA	0	-2.1606	0.2211	0	-47.6170	0.0001
S&P	0	-1.5774	0.4940	0	-47.9677	0.0001

Exogenous: Constant

Lag Length: Automatic based on SIC, MAXLAG=25

*MacKinnon (1996) one-sided p-values.

Deterministic terms: Intercept

The critical values from MacKinnon (1996) for rejection of H0: intercept	1% level	-3.433291
	5% level	**-2.862726**
	10% level	-2.567447

Perron (PP) test. Both tests use the existence of a unit root as the null hypothesis.

Augmented Dickey-Fuller (ADF Test)

Inferring from table 4, one can conclude that the null hypothesis about the existence of a unit root cannot be rejected for all the variables using intercept terms in the test equation at the level form. However, for the first differences of all the variables the null hypothesis of a unit root is strongly rejected. So it can be said that all the variables contain a unit root, that is, non-stationary in their level forms, but stationary in their first differenced forms.

Phillips-Perron Test

The Phillips-Perron test is less restrictive and provides an alternative way for checking the stationarity of a time-series. Table 5 summarises necessary output related to Phillips-Perron Test and it also supports the conclusion inferred from the Dickey-Fuller tests above.

Keeping in consideration the fact that the time series of various stock indices under study are non-stationary at their level but are stationary at their first difference as inferred from the ADF Test and the P-P Test, the co-integration test and the Granger causality test are performed accordingly.

Co-integration Test

Co-integration is a property of two or more variables moving together through time, and despite following their own individual trends will not drift too far apart since they are linked together in some sense. The results of the unit root test show that the time series of indices of share prices related to various stock exchanges under study are I(1). Therefore, co-integration will be a suitable means for correctly testing hypotheses concerning the long-term relationship among the time series under the study. It tests a set of null hypothesis that there exist no co-integrating equations among variables.

First part of the co-integration results (table 6a), the trace test, indicate that there exists four co-integrating vectors at 5% level. Second part of the co-integration results (table 6b), the Maximum Eigenvalue test, also indicates the same result. Therefore, both tests indicate

Table 5: Phillips-Perron Test

Symbol	Level			First Difference		
	Bandwidth	P-P Test Statistic	P-value	Bandwidth	P-P Test Statistic	P-value
SC	8	-1.4655	0.5511	7	-45.2130	0.0001
HS	7	-2.3062	0.1701	7	-46.3276	0.0001
BSE	20	-2.1727	0.2166	24	-41.4717	0.0000
JC	20	-1.9224	0.3221	21	-42.3747	0.0000
KLSE	9	-1.7599	0.4008	5	-39.4079	0.0000
NIKKEI	4	-0.9001	0.7887	5	-46.0569	0.0001
ST	4	-1.6329	0.4655	3	-46.6939	0.0001
SEOUL	8	-2.0769	0.2543	9	-44.4027	0.0001
TAIWAN	5	-1.9922	0.2905	7	-44.6196	0.0001
TA	6	-1.1487	0.6983	8	-49.1305	0.0001
DJIA	14	-2.0455	0.2674	12	-47.7949	0.0001
S&P	20	-1.3527	0.6067	21	-48.5712	0.0001

Exogenous: Constant

Bandwidth: Newey-West using Bartlett kernel

MacKinnon (1996) one-sided p-values

Deterministic terms: Intercept

The critical values from MacKinnon (1996) for rejection of H0 : intercept	1% level	-3.43329
	5% level	**-2.86273**
	10% level	-2.56745

Table 6: Co-integration Tests

A: Unrestricted Co-integration Rank Test (Trace)

Hypothesised No. of CE(s)	Eigen Value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.049543	471.4298	334.9837	0.0000
At most 1 *	0.040735	365.7900	285.1425	0.0000
At most 2 *	0.031280	279.3291	239.2354	0.0002
At most 3 *	0.027998	213.2600	197.3709	0.0063
At most 4	0.021328	154.2223	159.5297	0.0937
At most 5	0.016582	109.4024	125.6154	0.3150
At most 6	0.013095	74.64015	95.75366	0.5568
At most 7	0.010134	47.23487	69.81889	0.7520
At most 8	0.005415	26.05782	47.85613	0.8874
At most 9	0.004655	14.77022	29.79707	0.7948
At most 10	0.002101	5.070911	15.49471	0.8012
At most 11	0.000336	0.698824	3.841466	0.4032

Trace test indicates 4 co-integrating eqn(s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Trend assumption: Linear deterministic trend

Lags interval (in first differences): 1 to 4

B: Unrestricted Co-integration Rank Test (Maximum Eigenvalue)

Hypothesised No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.049543	105.6398	76.57843	0.0000
At most 1 *	0.040735	86.46088	70.53513	0.0009
At most 2 *	0.031280	66.06911	64.50472	0.0352
At most 3 *	0.027998	59.03773	58.43354	0.0435
At most 4	0.021328	44.81995	52.36261	0.2396
At most 5	0.016582	34.76221	46.23142	0.4751
At most 6	0.013095	27.40528	40.07757	0.6044
At most 7	0.010134	21.17705	33.87687	0.6708
At most 8	0.005415	11.28761	27.58434	0.9575
At most 9	0.004655	9.699307	21.13162	0.7723
At most 10	0.002101	4.372086	14.26460	0.8181
At most 11	0.000336	0.698824	3.841466	0.4032

Max-eigenvalue test indicates 4 co-integrating eqn (s) at the 0.05 level

* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

that stock markets across the world are company-integrating, that is, they are trending together which may indicate the fact that assets allocation across the markets may not provide enough opportunities of diversification gains. Further, the evidence that the co-integrating results are significant at most 3 level at the 5% level which could hint at that there may exist three types of a long-term or co-integrating relationship between prices of stock markets across the world.

It is important to note that co-integration reflects only co-movements between two time series over a period of time among variable under study but does not represent the correlation among them. Hence, through the co-integration tests, one can conclude that by and large stock price indices across the world move together.

Table 7: Summary of Pair-wise Granger Causality Tests

Symbol	SC	HS	BSE	JC	KLSE	NIKKEI	ST	SEOUL	TAIWAN	TA	DJIA	S&P
SC	–											
HS	↔	–										
BSE	↔	↑	–									
JC	↵	↵	↔	–								
KLSE	↵	↑	↔	↵	–							
NIKKEI	↔	↔	↑	↵	↑	–						
ST	↵	↵	↵	↔	↵	↑	–					
SEOUL	↵	↑	↔	↔	↑	↑	↵	–				
TAIWAN	*0*	↑	↔	↔	↔	↔	↑	↑	–			
TA	↑	↔	↑	↔	↔	↔	↑	↑	*0*	–		
DJIA	↵	↵	↵	↵	↵	↔	↵	↵	↑	↵	–	
S&P	*0*	↵	↔	*0*	↵	↔	↵	↵	↑	*0*	↔	–

Note. 1: ↑ denotes Granger Causality, running from one side to another, whereas ↔ means Causality from both side and *0* is put for no causality.

2: The precise table is formed from the analysis of Granger Causality between the markets. Complete analysis is available, if required by the reader.

Pair-wise Granger Causality Tests

Having done the co-integration test, there is a need to capture the degree and the direction of correlation among the stock price indices under study pair-wise Granger Causality Tests are conducted. These tests involve examining whether lagged values of one series have significant explanatory power for another series. They have null hypotheses of no granger causality. The results of these tests summarised in table 7 and it indicates whether there exists significant Granger Causality and if it exists, then in which direction such causality exists among various stock markets.

It can be inferred from the observation of table 7 that no stock market is playing a very dominant role, as the direction of the Granger Causality is not following only from few markets to others. At times, pair-wise causality is running both the ways. It is interesting to note here that both the US markets are not dominant and unable to cause any impact on the markets like SC, HC, BSE, and TA. It is also noticed that BSE, Heng Seng and NIKKEI Granger cause Shanghai composite and get caused in return. JC, KLSE, ST, SEOUL do not cause SC, but SC causes all except TAIWAN and S&P. For HS, it is noted that it does not granger cause SEOUL, TAIWAN, BSE and KLSE but gets caused by other markets. This fact is also verified on the basis of the data analysed that HS causes DJIA and SP, but not caused. It is further noticed that KLSE, NIKKEI, DJIA does not cause JC but get caused from them. All other markets, but S&P, show two-way causality with JC. ST, JC and SEOUL causes NIKKEI, but not get caused. BSE, S&P and JC do not cause each other at all. Some unknown facts about TA are revealed as, TA and S&P does not cause each other. TA causes ST, ST does not cause TA. BSE does not cause TA, but get caused. BSE causes ST, but not get caused. TAIWAN does not cause DJIA, DJIA causes Taiwan, DJIA and S&P causes each other. Some other facts about BSE are that NIKKEI causes BSE, but not get caused. DJIA does not cause BSE but get caused and S&P and BSE do not cause each other. It is obvious that DJIA and S&P causes each other but amazing to not that KLSE causes DJIA, DJIA does not cause KLSE but further identified that NKKEI and SEOUL causes KLSE, KLSE does not cause NIKKEI and SEOUL, But DJIA and S&P.

It is observed that BSE has two-way causality with SC, JC, SEOUL, TAIWAN, S&P and KLSE. NIKKEI and BSE have highest two-way causality with six other markets, whereas ST has the least, i.e. just one two-way causality with the market. Out of the markets under study, S&P has no causality with three other markets followed by SC with two (including S&P) no causality relations with others. It is remarkable to note that the influence of the US markets is not noticeable as in the previous studies.

CONCLUSION

The study is a continuation of research on the issue of growing interdependency among the stock markets. Interdependency among global stock markets is studied primarily through Co-integration and the Granger Causality. It is observed that stock prices across the world markets are trending together. It is also seen that the degree of correlation between the markets varies. Results provide evidences that correlation of NIKKEI with other markets is found to be relatively lesser than the other markets, which is in line with the previous researches. Furthermore, it provided that no stock market is playing a dominant role in influencing other markets. The US influence is not noticeable as in the earlier researches. Both the US markets are unable to cause impacts in various Asian markets like SC, HC, BSE, and TA. If the results of this study, regarding the influence of the US markets on other markets, are extended and contrasted with the previous studies included in the literature, it can be concluded that stock market integration and causation between different markets have changed over the time. In brief, it can be concluded that the interdependencies among the stock markets in the world has increased and no clear direction of relationships exists in the sense of Granger Causality indicating the fact that influence of few markets, especially that of the US, has eroded over a period of time. These developments in the international stock markets will pose great challenges before the investors to look for the markets with low correlation with that of the domestic markets so as to exploit the gains of diversification as well as before policy makers because these growing interdependencies will infuse crisis in the domestic economy from other economies. Therefore, it is hoped that the results of the present paper would be useful for individual and institutional investors for the management of their assets portfolios and policy makers.

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