

# INTERLINKAGES BETWEEN EQUITY MARKETS OF G-8 COUNTRIES

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## ABSTRACT

**This study attempts to investigate the inter linkages between equity market of G-8 countries. Daily data of stock market returns of G-8 equity markets for the period of 2000 to 2010 has been used. These markets include Canada, France, Germany, Italy, Japan, Russia, United Kingdom and United States. In order to explore the interlinkages among these markets, Granger causality test, Johansen and Juselius Multivariate test, Bi-variate co-integration test, Variance Decomposition and Vector error correction models have been used. The results reveal that co integration exists in equity markets of G-8 countries thus these markets do not offer an opportunity for portfolio diversification to the investors. Further, policy makers of these countries should be careful as the contagious problem may flow to these markets.**

## INTRODUCTION

The concept of portfolio diversification grabbed much attention in the early work of Harry Markowitz (1952, 59) contributing in the area of investment analysis, and providing bases for the development of famous Modern Portfolio theory. The portfolio return was weighted average of returns of single securities, whereas risk of a portfolio was dependent on the covariance among securities in the portfolio. Sharp (1964) expended the modern portfolio theory and offered famous Capital Asset Pricing Model. This study argued that systematic risk was relevant risk of any portfolio as unsystematic risk would be diversified through formulation of portfolio.

The late twentieth century had been marked by many significant occurrences. The advent of financial liberalization was one such phenomenon. This induced confidence among the investors and they started to invest internationally. A large number of countries also reduced regulations on the financial industry. This provided opportunities to investors to decrease the risks associated with any specific economy. Financial world was reshaped and the entire landscape of financial world was changed. Investors as well as the academicians were becoming more interested in exploring ways to minimize risks. They were indulged in understanding the interlinkages among the markets across the globe. Each market was marked by her distinctive features and characteristics. These characteristics affected the way these markets were interlinked. A large number of studies could be found addressing the linkages among international stock markets especially after the advent of financial liberalization. Technological advancements

both in terms of communication services and trading systems had created more opportunities for international portfolio investments. These opportunities provided the investors and policy makers with ways to earn more profits and optimize market interactions. All this was the result of globalization, as it had accelerated the process of integration of financial markets. The emerging markets were seen as the opportunity for portfolio diversification by a large number of international fund managers. The academicians thus extended immense importance to understand the relations amongst international stock markets. An analysis of co movement among different equity markets had been taken a focus with reference to international portfolio diversification. Sharp and Litner (1964) argued that if the co-movement of stock markets was comparable across stock markets, then the gain from the portfolio diversification was not possible. Engle and Granger (1987), Johansen (1988), Johansen and Juselius (1990) presented methods to study the co-movement of stock markets. The objective of this study was to understand the dynamic inter-linkages between equity markets of G8. These countries include Canada, UK, USA, Japan, France, Russia, Germany, and Italy. If the markets would be independent then investors can invest to diversify their portfolio and minimize the risks involved.

This study had been divided into four sections. Second section provided an overview of the literature on the topic. The third section reported the data and methodology used. The forth sections encompassed the empirical results. This section is followed by last section that reported the conclusion along with policy implication of the results.

## LITERATURE REVIEW

The stock market integration had solitary of being an extremely studied area. Kharka, Turan and Kaushik, (2012) found no long-term relationship among Bhutanese stock with Indian as well as other regional stock markets. Al-Zalabani, Sagar, Menon, and Subha (2012) investigated the co-integration among the foremost Saudi Stock market index (TASI) and other indices like of Hong Kong, India, USA, Japan, Singapore, Malaysia, UK and China. The objective was to study the interdependence among these indices. TASI reported a significant connection. Sakthivel and Kamaiah (2012) spent efforts toward studying the persuasive inter-linkages connecting European, Asian, and US stock markets for the period of 3rd January 1998 to 30th June 2010. The study examined the short as well as long run relationships by using Johansen-Juselius co-integration, Vector Error Correction models (VECM) and Impulse Response Function (IRF). The results of the co-integration test demonstrate strong co-integration relationship among global stock price indices. The results of Vector Error Correction model reported the linkages of US with some of European and Asian Stock markets.

Aktar (2011) investigated whether there exist any long run association or Granger Causality among Hungarian, Russian and Turkish stock indices or not. Johansen estimation method was used to examine the co-integration between the stock indices. This, acquainted by way of use, was a short run relationship as well as causality along with the stock indices. He located bidirectional causality intended for the Russian and Turkish stock indices. Furthermore, he located that Hungarian stock market did Granger cause Turkish stock market although did not associate and vice versa. Furthermore, Russian stock market did Granger cause Hungarian stock market other than not vice versa. Thus, Russian stock market involves mutually stock markets of Turkey along with Hungary.

Korkmar, Akman (2010) examined the Istanbul Stock Exchange (ISE) and found that it was weak form efficient by selecting two indices from Istanbul Stock Exchange. They analyzed the efficiency by using unit root and co-integration test. Co-integration results subsequently showed that there was no co-integration among indices in the long term. Foreign investors were concerned with emerging economies because of their two objectives i.e. to augment the portfolio expansion and to decrease portfolio risk throughout efficient global portfolio diversification. Modi, Paterek, Son, Vedral, and Williamson (2010) studied a range of different methods to understand the co-movement between some chosen developed stock markets and emerging stock markets of

the world. Daily data from July 1, 1997 to June 30, 2008 of Hong Kong (HANGSENG), India (SENSEX), Russia (RTS), Mexico (MXX), Brazil (BVSP), US (DJIA and NASDAQ) and UK (FTSE-100) had been employed and various co-integration method had been engaged to study the short term as well as long-term relationships connecting the markets under study. Harrison and Moore (2010) explored co-movement within five Caribbean stock markets (Jamaica and Barbados, Tobago as well as Trinidad, Bahamas along with Guyana) by means of common factor analysis. The common factors were obtained by principal component analysis along with explanation that was intended for the utmost segment of the variance in the stock exchanges analyzed. Both examined 10-year, 5-year and 3-year periods, and used a vector auto-regression model along with a simple test intended for co-movement among the five markets.

Aktan et al (2009) investigated the emerging markets of Russia, India, Brazil, Argentina (BRICA) and China, and explored the connections among the stock markets and their associations with the US market. The study employed the vector auto regression (VAR) methods to model the interdependencies along with VECM to verify a short-run relationship between these markets. Yalama (2009) examined the relation between Turkey and Brazil's Stock Exchange Markets for the period during 2002 to 2009. In order to establish causal show model, the study employed Johansen and Juselius (1990) co-integration framework and vector error-correction modeling, along with the Granger Causality Test. The study showed that there was a significant market interrelation between Turkey and Brazil. Time zone problem did not affect this relationship which creates an opportunity for investors to use international hedging strategies and asset allocation.

Mavrakis and Alexakis (2008) explored whether the Greek stock market was integrated with the equity markets of three foremost economies by applying the Johansen-Juselius methodology for the period 1991-2004. Empirical verifications specified the presence of two long-run relations among the Greek stock market and the equity markets of United Kingdom, Germany and United States. Impressive constraints, resting on the consequential co-integrating vectors, specify single frequent stochastic tendency intended for all co-integrating relations with a high degree of integration among the scrutinized European stock markets.

Coates and Wilson (2007) investigated and found out that there was no association between co-integration and market efficiency hypothesis. As a result, market was efficient in long-run and no arbitrage opportunities were present. However, arbitrage movement passing through the disequilibrium error correction allocated average risk-adjusted returns in the short run.

## RESEARCH METHODOLOGY

The foremost objective of this study is to test the inter-market relationship among the stock market in G-8 equity markets via (1) correlation matrix (2) co integration test (3) Granger causality (4) Vector error correction Model (5) Variance decomposition. Firstly, unit root tests offered by Phillips (1987); Phillips and Perron (1988) and Augmented Dickey-Fuller recommended by Dickey and Fuller (1979) are used to test the stationary of data. After that, co-integration in the price series of others markets are examined by using Johansen and Juselius Test. The maximum likelihood method is used to find the existence of co-integration vectors in a set of non-stationary time series by Johansen (1988) and Johansen and Juselius (1990). To examine multivariate co-integration, Vector Autoregressive (VAR) is applied. VAR model assumes all the variables in the model are endogenous. Johansen and Juselius approach verified if both the price series are co-integrated in the long run, subsequently the system of equation must be modified by including an Error Correction Term in relation to the short run deviation of prices. If two variables are co-integrated, then Granger causality must exist in at least one direction, which is a consequence of the relationships described by the error-correction model.

### Data Description

Stock index data are taken from daily, weekly, monthly closing prices of equity markets indices for G-8 countries i.e USA, UK, Russia, Japan, Italy, Germany, France, Canada, for the period Jan, 2000 to Dec, 2010. Data is collected through their respective stock exchange and Yahoo finance which is a well-known and reliable source of business information in Pakistan. The daily closing prices of G-8 equity markets indices are taken for the period Jan1, 2000 to Dec 31, 2010, which includes 4016 observations for each country.

**TABLE 1**  
**G-8 equity markets indices**

Country Name	Index
USA	S&P 500 Index
UK	FTSE 100
Russia	RTS index
Japan	NIKKEI 225
Italy	FTSEMIB
Germany	DAX
Canada	TSX Composite Index
France	CAC 40

The continuously compounded rate of return for

daily, weekly and monthly bases are used to measure the return for specific period as

$$R_t = \ln(P_t/P_{t-1})$$

So 'Rt' is the continuous compounded return for daily, weekly, monthly 't' and 'Pt', 'Pt-1' is representations of closing prices of the equity indices of the G8 used for the daily, weekly, monthly 't' and 't-1' correspondingly and natural log denoted by 'Ln'.

## RESEARCH ANALYSIS

Table 2 reports the results ADF, Phillip-Perron (PP) Test for daily, weekly and Monthly index series. It shows that index series is integrated of order 1. It shows that the hypothesis of non-stationary in the market returns is rejected. Similarly, the hypothesis of non-stationary in first differences is rejected for all returns.

**TABLE 2**  
**Unit root Analysis**

	ADF (Level)	ADF (1st Difference)	Phillips-Perron (level)	Phillips-Perron (1st Difference)
Canada	-1.7105	-66.0444	-1.61707	-66.2668
Italy	-1.0513	-64.6077	-1.02661	-64.6159
Germany	-1.5859	-65.6762	-1.51462	-65.7340
Russia	-1.0525	-57.5806	-1.04996	-57.5823
UK	-1.6054	-32.4253	-1.61778	-68.6137
USA	-1.5290	-49.8563	-1.52798	-69.1933
Japan	-0.9590	-65.6783	-0.80702	-65.8335
France	-1.2511	-66.7664	-1.09294	-67.4404
Critical Values				
1%	-3.435654	-3.435659	-3.435654	-3.435659
5%	-2.86377	-2.863772	-2.86377	-2.863772
10%	-2.568008	-2.568009	-2.568008	-2.568009

**TABLE 3**  
**VAR Lag Order Selection Criteria**

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-247480	NA	6.73E+43	123.6206	123.6331	123.6250
1	-173263	148100.5	5.52E+27	86.58105	86.69425	86.62117
2	-172166	2185.064	3.29E+27	86.06497	86.2787*	86.14076

The estimation of Johnson and Julius co-integration approach required that there should be appropriate lag length. Schwarz information criterion is used for this purpose. Since the index series are required to be integrated of order 1 so stationary of the data is tested. Johansen's (1991) procedure provides two different

test statistics that can be used to test the hypothesis of the existence of “r” co integration vectors. The study employs Johansen’s (1991) maximum likelihood ratio to examine that indices in question are co-integrated or not. The trace test results of G-8 countries are shown in Table. According to it, there is one co-integration vector between the underlying daily index series and hence long run relationship exists between these indices. The maximal Eigen-value test was used to test the null hypothesis. There are at most r co-integrating vectors against the alternative of r+1 co-integrating vectors. Table reports the result of Max-Eigen value test of G-8 countries stock markets. It shows that there is one co-integrating equation(s) at  $\alpha=.05$ , hence long runs relationship exists between these indices.

**TABLE 4**  
**Multi-Variate Co integration Analysis**  
**Trace Statistics**

Eigen value	Trace Statistic	5% C Value	P.value	Hypothesized Number of CEs
0.014546	183.463	175.1715	0.0171	None *
0.009571	124.7064	139.2753	0.2567	At most 1
0.007314	86.14146	107.3466	0.5194	At most 2
0.005102	56.70589	79.34145	0.6972	At most 3
0.004298	36.1927	55.24578	0.709	At most 4
0.002338	18.92176	35.0109	0.7725	At most 5
0.001832	9.534881	18.39771	0.526	At most 6
0.000544	2.182513	3.841466	0.1396	At most 7

**TABLE 5**  
**Multi-Variate Co integration Analysis**  
**Maximum Eigen Statistics**

Eigen value	Max-Eigen Statistic	Critical Value	Prob	Hypothesized Number of CEs
0.014546	58.75652	55.72819	0.0242	None *
0.009571	38.56498	49.58633	0.426	At most 1

**TABLE 7**  
**Granger Causality Test**

Null Hypothesis	Obs	F-Statistic	Prob.
FRANCE does not Granger Cause CANDIA	4013	38.5559	3.00E-17
CANDIA does not Granger Cause FRANCE		25.9044	7.00E-12
GERMANY does not Granger Cause CANDIA	4013	18.7378	8.00E-09
CANDIA does not Granger Cause GERMANY		32.1769	1.00E-14
ITALY does not Granger Cause CANDIA	4013	18.0797	2.00E-08
CANDIA does not Granger Cause ITALY		10.3505	3.00E-05

0.007314	29.43557	43.41977	0.6604	At most 2
0.005102	20.51318	37.16359	0.8781	At most 3
0.004298	17.27094	30.81507	0.7641	At most 4
0.002338	9.386878	24.25202	0.9339	At most 5
0.001832	7.352368	17.14769	0.6744	At most 6

Bivariate Cointegration analysis is used to explore the relationship between the markets. The trace test results of G-8 countries are shown in Table 6. There are two co-integration vectors between the underlying daily index series and hence long run relationships exist between these indices. Eigen-value test also confirms long runs relationship exists between these indices.

**TABLE 6**  
**Bi-Variate Co integration Analysis**

	Eigen value	Trace statistics	5% C Value	P.value	Hypothesized Number of CEs
CANADA & FRANCE	0.0983	473.3903	18.3977	0.0001	None *
	0.0144	58.3721	3.8414	0.0000	At most 1 *
GERMANY & ITALY	0.0666	280.1194	18.3977	0.0001	None *
	0.0008	3.35643	3.8414	0.0669	At most 1
JAPAN & RUSSIA	0.0056	32.9532	18.3977	0.0002	None *
	0.0025	10.2483	3.8414	0.0014	At most 1 *
UK & USA	0.0804	396.981	18.3977	0.0001	None *
	0.0150	60.7740	3.8414	0.0000	At most 1 *

Granger (1986, 1988) pointed out that if two variables are co-integrated, then Granger-causality must exist in at least one direction. The test results of Granger Causality between various markets are presented in Table 7. Lag of 2 days is taken to study the effects of one market to another under the assumption of substantial informational efficiency. Results of Granger Causality are reported in Table indicating that there exists unidirectional granger causality between daily G-8countries equity markets.

JAPAN does not Granger Cause CANDIA	4013	180.841	6.00E-76
CANDIA does not Granger Cause JAPAN		1.63056	0.196
RUSSIA does not Granger Cause CANDIA	4013	134.532	3.00E-57
CANDIA does not Granger Cause RUSSIA		3.33891	0.0356
UK does not Granger Cause CANDIA	4013	38.668	2.00E-17
CANDIA does not Granger Cause UK		35.6906	4.00E-16
USA does not Granger Cause CANDIA	4013	32.7456	8.00E-15
CANDIA does not Granger Cause USA		61.7507	4.00E-27
GERMANY does not Granger Cause FRANCE	4013	15.9201	1.00E-07
FRANCE does not Granger Cause GERMANY		23.5124	7.00E-11
ITALY does not Granger Cause FRANCE	4013	12.3321	5.00E-06
FRANCE does not Granger Cause ITALY		4.42437	0.012
JAPAN does not Granger Cause FRANCE	4013	291.947	4.00E-119
FRANCE does not Granger Cause JAPAN		2.82144	0.0596
RUSSIA does not Granger Cause FRANCE	4013	40.7349	3.00E-18
FRANCE does not Granger Cause RUSSIA		3.89389	0.0204
UK does not Granger Cause FRANCE	4013	32.964	6.00E-15
FRANCE does not Granger Cause UK		8.20798	0.0003
USA does not Granger Cause FRANCE	4013	35.2751	7.00E-16
FRANCE does not Granger Cause USA		188.398	6.00E-79
ITALY does not Granger Cause GERMANY	4013	13.1733	2.00E-06
GERMANY does not Granger Cause ITALY		0.85697	0.4245
JAPAN does not Granger Cause GERMANY	4013	307.168	8.00E-12
GERMANY does not Granger Cause JAPAN		0.46536	0.6279
RUSSIA does not Granger Cause GERMANY	4013	46.5057	1.00E-20
GERMANY does not Granger Cause RUSSIA		9.91387	5.00E-05
UK does not Granger Cause GERMANY	4013	53.801	9.00E-24
GERMANY does not Granger Cause UK		12.7426	3.00E-06
USA does not Granger Cause GERMANY	4013	42.2056	7.00E-19
GERMANY does not Granger Cause USA		95.6337	3.00E-41

JAPAN does not Granger Cause ITALY	4013	80.2921	6.00E-35
ITALY does not Granger Cause JAPAN		2.36053	0.0945
RUSSIA does not Granger Cause ITALY	4013	15.0536	3.00E-07
ITALY does not Granger Cause RUSSIA		0.97408	0.3776
UK does not Granger Cause ITALY	4013	3.32476	0.0361
ITALY does not Granger Cause UK		4.81095	0.0082
USA does not Granger Cause ITALY	4013	8.72929	0.0002
ITALY does not Granger Cause USA		46.8527	8.00E-21
RUSSIA does not Granger Cause JAPAN	4013	28.2281	7.00E-13
JAPAN does not Granger Cause RUSSIA		101.405	1.00E-43
UK does not Granger Cause JAPAN	4013	5.48201	0.0042
JAPAN does not Granger Cause UK		215.56	1.00E-89
USA does not Granger Cause JAPAN	4013	4.24381	0.0144
JAPAN does not Granger Cause USA		375.165	4.00E-15
UK does not Granger Cause RUSSIA	4013	0.56539	0.5682
RUSSIA does not Granger Cause UK		58.6576	8.00E-26
USA does not Granger Cause RUSSIA	4013	1.79435	0.1664
RUSSIA does not Granger Cause USA		90.029	6.00E-39
USA does not Granger Cause UK	4013	21.7063	4.00E-10
UK does not Granger Cause USA		7.00E-81	193.39

The result of VECM model shows that the short term disequilibrium is mostly adjusted in one period of time.

**TABLE 8**  
**Vector Error Correction Model**

	Canada	France	Germany	Italy	Japan	Russia	UK	USA
ECT	-0.10403	-0.21983	-0.99301	-0.84259	-0.694	-0.82189	-0.936	-0.509
S.E	-0.00484	-0.00317	-0.01563	-0.03526	0.0218	-0.03222	-0.017	-0.023
t Statistics	[-21.51]	[-69.31]	[-63.54]	[-23.89]	[-31.7]	[-25.50]	[-55.1]	[-21.3]

The variance decomposition indicates the amount of information each variable contributes to the other variables in the auto-regression. It determines how much of the forecast error variance of each of the variables can be explained by exogenous shocks to the other variables.

**TABLE 9**  
**Variance Decomposition**

Period	S.E.	CANADA	FRANCE	GERMANY	ITALY	JAPAN	RUSSIA	UK	USA
1	2.93E-17	100	0	0	0	0	0	0	0
2	2.93E-17	100	1.20E-28	1.03E-28	2.35E-29	9.73E-30	1.98E-29	3.72E-29	6.77E-30
3	2.93E-17	100	1.33E-28	1.27E-28	2.46E-29	1.29E-29	2.03E-29	4.28E-29	1.07E-29

4	2.93E-17	100	1.33E-28	1.27E-28	2.46E-29	1.29E-29	2.03E-29	4.28E-29	1.07E-29
5	2.93E-17	100	1.33E-28	1.27E-28	2.46E-29	1.29E-29	2.03E-29	4.28E-29	1.07E-29
6	2.93E-17	100	1.33E-28	1.27E-28	2.46E-29	1.29E-29	2.03E-29	4.28E-29	1.07E-29
7	2.93E-17	100	1.33E-28	1.27E-28	2.46E-29	1.29E-29	2.03E-29	4.28E-29	1.07E-29
8	2.93E-17	100	1.33E-28	1.27E-28	2.46E-29	1.29E-29	2.03E-29	4.28E-29	1.07E-29
9	2.93E-17	100	1.33E-28	1.27E-28	2.46E-29	1.29E-29	2.03E-29	4.28E-29	1.07E-29
10	2.93E-17	100	1.33E-28	1.27E-28	2.46E-29	1.29E-29	2.03E-29	4.28E-29	1.07E-29

## CONCLUSION

The augmented Dickey-Fuller and Phillips-Perron tests on the market index levels and their first differences showed that the hypothesis of non-stationary in the market indices cannot be rejected. However, the hypothesis of non-stationary in the first differences was rejected for all markets implying that the variables are integrated of order one. Since the index series are found to be non-stationary, the study examined Cointegration using Johansen's (1991) procedure. For this purpose Trace statistics is used. From results, it is evident that there is one co-integrating vector between underlying daily series and hence there is long run equilibrium. Pair-wise co-integration analysis also shows that co-integration exists between G-8 countries. Multivariate co-integration analysis also confirms the same results Granger causality test also confirms unidirectional bidirectional causality between G-8 markets.

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