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TESTING INTERNATIONAL TRANSMISSION OF STOCK RETURN VOLATILITY THROUGH COINTEGRATION

Dr. Tarika Singh[1], Ms Monika Gupta[2], Ms Rekha Yadav[3]

[1]Associate Professor, Prestige Institute of Management, Gwalior (M.P.) (India)

[2]Research Scholar, Jiwaji University, Gwalior (India)

[3]Alumni Prestige Institute of Management, Gwalior (India)

ABSTRACT

With the integration of national economies through international trade and finance, the exploration of financial market interdependency has become important among market participants and scholars. International transmission of stock return volatility has been an important driver for investors where they can earn the maximum out of the money investor, if they manage their funds well. Further this investment can be in foreign exchange also. This study aims to examine the nature of interaction between stock market returns and their volatility and will also try to explore the international transmission of stock price volatility to dynamic/causal price relationships in the market to investigate possible discriminating price behavior. A high degree of time-varying co-volatility among these markets indicates that investors will be highly unlikely to benefit from diversifying their financial portfolio by acquiring stocks within these countries.

Keywords: Integration, Volatility, Returns, Transmission

I. INTRODUCTION

Climent et al. (2006) interpreted volatility is an important phenomenon in markets in general and security markets in particular. Modeling stock market volatility has been the subject of empirical and theoretical investigation by both academicians and practitioners. As a concept, volatility is simple and intuitive. It measures the variability or dispersion about a central tendency. Aggarwal (1994) said that Information transmission between international equity markets has commonly focused on the short-run dynamic relations of return and volatility. Evidence of bi-directional transmission of return and volatility between developed equity markets (Lin et al., 1994; Wu, Li and Zang, 2005) and uni-directional transmission from developed to emerging equity markets (Wongswan, 2006) has been also documented. **Roy (2013)** propounded that the study of volatility becomes more important due to the growing linkages of national markets in currency, commodity and stock with rest of the world markets and existence of common players have given volatility a new property- that of its speedy transmissibility across markets. Bekaert and Harvey (1995), Peters (1996) said that stock prices and returns are cyclical, imperfectly predictable in the short run, and unpredictable in the long run and that they exhibit nonlinear, and possibly chaotic, behavior related to time- varying positive feedback.

Volatility studies are being carried out in number of markets like De Gennaro, (1990) examined volatility transmission for the Japanese stock, the Japanese foreign exchange, and the US stock markets. Miller (1991) conducted an analysis of volatility transmission between the Japanese and US stock and foreign exchange markets similar to studies by Soriano and Client (2006) and Jayasinghe and Tsui (2008), Baba, Engle, Kraft and Kroner who have used generalized autoregressive conditional heteroscedasticity (BEKK-GARCH) modeling.

In the present study the objectives were to study the transmission of volatility in the major stock indices of Asia, Europe and America and to find out co-integration between different stock indices. Further research methodology was set for and data was collected for variables. Cointegration tests were used to determine whether one index time series is related to another or not and whether it is a long term or short term integration. In the further part of study, Results & Discussion and Conclusion is presented.

III. CONCEPTUAL FRAMEWORK

Volatility is a measure for variation of price of a financial instrument over time. Historic volatility is derived from time series of past market prices. An implied volatility is derived from the market price of a market traded derivative. **Transmission:** the price volatility transmission does not attempt to empirically investigate the role of factors that potentially affect the transmission of price volatility (Assefa, 2013). **International Transmission**: As quoted by Mumtaz and Theodoridis (2000) focused on estimating the domestic impact of structural economic shocks originating from the rest of the world. Structural vector autoregressions ((S) VARs), originally proposed by Sims (1980), have featured prominently in this literature as they offer a flexible data-driven approach to modelling the international transmission mechanism. Prominent papers that adopt this approach include VAR studies by Cushman and Zha (1997), Kim (2001) and Scholl and Uhlig (2006) amongst many others.

IV. LITERATURE REVIEW

Aggarwal (1999), examined the events that caused large shifts in volatility in emerging markets. Both increases and decreases in the variance were identified first and then events around the period when volatility shifts occurred were identified. Similarly Pisedtasalasai and Gunasekarage (2007) examined the causal and dynamic relationships among stock returns, return volatility and trading volume for five emerging markets in South-East Asia—Indonesia, Malaysia, Philippines, Singapore and Thailand. They found strong evidence of asymmetry in the relationship between the stock returns and trading volume; returns are important in predicting their future dynamics as well as those of the trading volume, but trading volume had a very limited impact on the future dynamics of stock returns. However, the trading volume of some markets seems to contain information that was useful in predicting future dynamics of return volatility. Cunado et al. (2005), showed that emerging market volatility can increase, decrease or remain unchanged over the post-liberalization period, and all according to the market's specific characteristics and the quality of financial institutions.

Baele (2005) investigated volatility transmission from the aggregate European (EU) and U.S. market to 13 European equity markets and found high EU and U.S. Stock spillover intensity increased significantly over the 1980s and 1990s, and significant contagion effects from the U.S. to a number of local European markets in times of high equity market volatility. Jayasuriya (2005), found that in an effort of conciliating existing results, showed that emerging market volatility can increase, decrease or remain unchanged over the post-liberalization period, and all according to the market's specific characteristics and the quality of financial institutions. Bekaert and Harvey (1997), analyzed volatility in 20 emerging markets and found that increased market integration often increases the correlation between local market returns and the world market returns.

Bahmani-Oskooee and Sohrabian (1992) showed that there is bidirectional causality between stock prices measured by the S&P 500 index and effective exchange rates of the dollar. Ajayi and Mougoué (1996) found significant short-run and long-run feedback relations between the two variables for eight industrial economies. Soriano and Climent (2006) found that asymmetric volatility transmission from the foreign exchange market to the Japanese stock exchange occurs less frequently with the coefficient being statistically significant at the 1 per cent level in only three sectors.

Wongswan (2001) provided evidence of transmission of information from the U.S. and Japan to Korean and Thai equity markets during the period from 1995 through 2000. Hamao, Mmasulis, and Ng (1989), came up with the idea that there may be volatility spillovers across markets also has been examined .They used a GARCH-based model of volatility and found that higher lagged volatility in both own and other markets was associated with higher current volatility. Dombusch (1976), wrote that foreign exchange has a great impact on the financial markets; for example, overvaluing of exchange rates has a negative impact on foreign investors.

Nelson (1991), investigated the dynamic transmission of returns and volatility in the Asian REIT markets, the Exponential Generalized Autoregressive Conditional Heteroskedastic (EGARCH) model is utilized. King (2006) investigated why in October 1987, almost all stock markets fell together despite widely differing economic circumstances. They constructed a model in which "contagion" between markets occurs as a result of attempts by rational agents to infer information from price changes in other market.

Trangnhale (2010), examined the mean return and volatility spillover effects from the three influential stock markets of the US, Japan, and China to the two emerging stock markets of Indonesia and Malaysia over the sample period from 2005 to 2007. By analyzing GARCH models, we verify that there are significant mean spillover effects from the three major markets to the two emerging markets.

Dovi and Jondeau (1997) said that international transmission mechanisms were first identified between stock returns (Eun and Shim (1989)). Subsequently, interest has focused on volatility transmission between stock markets. Indeed, work on volatility spillovers on currency markets has recently been extended to stock markets. Lee(1980), research showed three findings: The first is that airline stock return affects airport stock return. But the same is not true in reverse. The second is that airline stock return affects travel stock return significantly. The same is not true in reverse here either. The third is that no meaningful relationship could be found between airport and travel companies.

Trivedi and Birău (1920), highlighted international transmission patterns in order to identify dynamic inter-linkages in terms of stock price volatility. The empirical analysis was based on the daily closing prices of the USA, UK, Japan, France, Hungary, Poland, Romania and Slovakia major stock indices in order to compute the stock returns and to reveal the impact of correlations between developed and emerging stock markets. Pieces and Hearn (1997), study results showed that the dominant markets of South Africa and Nigeria transmit their volatility to other local markets

Agarwal (2001), examined the international transmission patterns of stock market price volatility. The distinguishing characteristic is stability of developed capital market and in stability of emerging market. Park (2006,) attempted to assess the dynamics of volatility transmission between the equity market and the rand-dollar foreign exchange market.

Nurkse (1999), said that a central issue in open macroeconomic is the transmission of stocks from a country to its neighbors'. Nor, Cheong, and Isa (2007) studied the dynamic relationships between return- volatility-volume of the Malaysian stock exchange using a trivariate Vector Auto Regression (VAR) model. The Granger causality tests show only unidirectional causality from volume to volatility. Naka & Oral (2013) examined the volatility of Dow Jones Industrial Average stock returns and the trading volume by employing stable Pertain GARCH and Threshold GARCH (TGARCH) models. The results indicated that the trading volume significantly contributes to the volatility of stock returns. Berben,Paul and Woe (2005) examined the nature of transmission of stock returns and volatility between the U.S. and Japanese stock markets using and found that there are unidirectional contemporaneous return and volatility spillovers from the U.S. to Japan.

Mishra and Rahman (2010) said that in the extant literature are the causes of volatility and innovations in international stock markets and the results from the impact of new information in one market and its transmission to other markets.

Karolyi (1995) revealed that the transmission of volatility from one market to another market exhibits asymmetric behavior. That volatility spillover from the US to Japanese stock market is higher after a negative return innovation than after a positive return innovation. Gardebroek and Hernandez (2012) reviewed studies on the transmission of volatility in food supply chains (from farm to retail) and studies on the transmission of price volatility between energy and agricultural commodity markets.

Korsgaard (2009) examined the relationship between firm value and exchange rate volatility. Exchange rate volatility was then tested against stock returns, representing firm value. The findings suggested that stock returns were to a certain degree sensitive to exchange rate volatility and that being more selective in the sampling process gave more significant result than earlier research.

Veiga and Grané (2012) results suggested that the inclusion of realized volatility improves the GARCH forecast ability as well as its ability to calculate accurate minimum capital risk requirements and makes it quite competitive when compared with asymmetric conditional heteroscedastic models such as the GJR and the EGARCH.

V. OBJECTIVES

1. To study the transmission of volatility in the major stock indices of Asia, Europe and America.
2. To find out co-integration between different stock indices.

VI. RESEARCH METHODOLOGY

The study was exploratory in nature and secondary data was used to complete it. Population was of all the stock indices of world. Sampling frame was of all the stock indices of the world. Individual representative stock index (FIVE from each) of Asian nations, European nations & American nations acted as sampling element. Sample

Size was of 37 indices. 20 indices from Asia Pacific region, 12 indices from European region and 5 indices from America region were taken for study purpose. Non probability judgmental sampling was used for the selection of indices. For the purpose of data collection, secondary sources like yahoo finance and Bloomberg website were used.

Tools used for data analysis-

1. Access index return will be calculated using.

$$\text{Formula} = \log_{10} \frac{(\text{Today-previous})}{\text{Previous}} *100$$

2. Normality of the data was checked through Jarque-Bera Test.
3. Stationarity of the data was checked through ADF and PP test.
4. Cointegration tests were used to determine whether one index time series is related to another or not and whether it is a long term or short term integration.

VII. DESCRIPTIVE STATISTICS

Data employed in this study are daily closing stock market indices for the five representative indices of Asian nations, European nations & American nations. The sample period is from January 3, 1984, to December 30, 1991.Daily stock return is computed as the natural logarithm of the price index relative. For missing data due to holidays in one market while other markets are open, the previous day's closing price is used. The summary statistics of all the indices is given below in table.

US Indices: Summary statistics (Table 1)

	RENASDAQ	Redowjones	Renyse	Reother	resp
mean	0.024193	.034565	0.059110	0.070487	0.037077
median	0.063308	0.064086	0.110027	0.069423	0.073295
maximum	11.24342	11.58004	10.47558	17.51411	11.47475
minimum	-50.95363	-9.034980	-10.88697	-47.60134	-9.280987
Std.dev.	1.411228	1.211488	1.318945	2.631587	1.219959
skkewness	-9.241443	-0.057062	-0.235948	-0.869719	-0.115339
kuurtosis	339.9342	11.34900	9.480329	26.17909	11.03276
Jarque-bera	**24196588**	**14815.24**	**8971.188**	**114812.9**	**13722.93**
probability	**0.000000**	**0.000000**	**0.000000**	**0.000000**	**0.000000**

7.1 Interpretation

From about table we can see that the null hypothesis of normality of index return data is rejected for all the US indices this implies that we need to convert the data into log from before application of further test.

EUROPEAN INDICES: Summary statistics (Table 2)

	REEUROPE	REFTSE	REDAX	RECAC	REEURO STOXX
mean	0.022286	0.024837	0.020556	-0.01215	0.020141
median	0.036888	0.048572	0.037441	-0.057181	0.045927
maximum	11.17617	11.00183	9.783470	8.445542	9.838667
minimum	-9.036819	-7.880063	-7.98263	-10.22615	-8.848347
Std.dev.	1.454618	1.436227	1.216643	1.201374	1.175394
skkewness	0.131036	0.100761	0.164217	0.195164	-0.000839
kuurtosis	7.693741	7.985450	9.519701	8.310631	8.976132
Jarque-bera	4692.543	5256.108	9048.451	6020.745	7583.305
probability	0.000000	0.000000	0.000000	0.000000	0.000000

Interpretation:

From about table we can see that the null hypothesis of normality of data is rejected for all the Europe indices this implies that we need to convert the data into log from before application of further test.

ASIAN INDICES: Summary statistics (Table 3)

	RENIKKEI	RE HANG SENG INDEX	RESSE COMPOSITE	RESTRAITS TIME INDEX	RE ASX 200
mean	0.022591	0.029953	0.038235	0.013827	0.022420
median	0.048391	0.046962	0.0000000	0.011575	0.043246
maximum	14.15030	18.82361	33.45712	13.73919	6.254349
minimum	-11.40637	13.70044	-16.39366	-8.803639	-8.197982
Std.dev.	1.511888	1.692601	2.024038	1.303410	0.948697
skkewness	-0.139296	0.355371	2.120335	0.161077	-0.450015
kuurtosis	8.606147	13.24733	38.61221	11.27436	9.148338

Jarque-bera	6689.879	22403.92	273105.8	14559.45	8198.638
probability	0.000000	0.000000	0.000000	0.000000	0.000000

Interpretation:

From about table we can see that the null hypothesis of normality of data is rejected for all the Asia's indices. This implies that we need to convert the data into log from before application of further test.

All those the data was converted into log still we were not able to generate normality for the same further we applied unit root test for check in of stationary of the data .

VIII. UNIT ROOT TEST: ADF OF RESULT

It is a diagnostic test used for checking the stationary to a time series. A time series is stationary it the mean and auto co-variance do not depend on time. A series that achieve stationary after first differencing is said to have a unit root it the standard statistical inference procedures do not apply to regressions that contain a non stationary variables, therefore this test is recommended for all the series in this research 26 lagged specification were used for estimation.

The table given below shows the summary test result for ADF test for all American/US indices, Asian and European Indices. The null hypothesis is that of no unit in series. From the table below we can that the null hypothesis is rejected that means unit root is present and data is not stationary.

Table 4: Summarised Unit root testing table

Null Hypothesis:	t-Statistic	Prob.*	Ideal Value @5%	Null Hypothesis Rejected/ not rejected
NASDAQ DOWJONES NYSE OTHER SP has a unit root	-54.41234	0.0001	-2.861912	Rejected
RENIKKEI RE_HANG_SENG_INDEX RESSE_COMPOSITE RESTRAITS_TIME_INDEX RE_ASX_200 has a unit root	-74.14995	0.0001	-2.861912	Rejected
REEUROPE REFTSE REDAX RECAC REEURO_STOXX has a unit root	-35.16386	0.0000	-2.861912	Rejected

Further all the series were made stationary by differencing the series at level 1 and making them stationary for further analysis.

8.1 Co-integration Analysis

Further to fulfill the objective of finding out the co integration between difference time series, we carried out co integration analysis. Co integration was checked for US, Europe and Asian indices. The null hypothesis tested here is :no variables are co integrated" from the trace statistics at 0% probability we reject the null hypothesis and see that there are more than one variable which are co integration.

From the second block we can find out the maximum Eigen value statistics. The maximum Eigen value statistics test the null hypothesis "there are r co-integration relations" againt the alternative hypothesis "there are r+1 co integration relations".

The table results show that the null hypothesis is rejected and we have more than r co- integration relations.

The first part of the co integrating test output for the four-variable system used by Johansen and Juselius (1999) for the Asian Indices data is shown below.

(Table 5) Results for Asia's Indices

Date: 01/16/04 Time: 9:41

Sample (adjusted): 65096

Included observations: 5091 after adjustments

Trend assumption: Linear deterministic trend

Series: Nikkei Hang Seng SSE composite Straits time ASX

Lags interval (in first differences): 1 to 3

Unrestricted Co integrating Rank Test (Trace)

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.
None	0.179959	1010.041	3.841466	0.0000
At most	0. 182761	1027.485	3.841466	0.0000
At most	0.142605	783.2824	3.841466	0.0000
At most	0.158966	881.3681	3.841466	0.0000
At most	0.172895	966.3908	3.841466	0.0000

Denotes rejection of the hypothesis at the 0.05 level

Trace test indicates no co integration at the 0.05 level

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

Results for US's Indices: Table 6

Date: 05/01/14 Time: 09:57

978-81-931039-6-8

Sample (adjusted): 6 5100

Included observations: 5095 after adjustments

Trend assumption: Linear deterministic trend

Series: NASDAQ DOWJONES NYSE OTHER SP

Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.192259	1087.5851	3.841466	0.0000
None	0.193772	1097.406	3.841466	0.0000
None	0.183506	1032.940	3.841466	0.0000
None	0.176334	988.3789	3.841466	0.0000
None	0.191562	1083.459	3.841466	0.0000

Denotes rejection of the hypothesis at the 0.05 level

Trace test indicates no co integration at the 0.05 level

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

Results for Europe's Indices: Table 7

(Table 9) Date: 05/01/14 Time: 10:16

Sample (adjusted): 6 5096

Included observations: 5091 after adjustments

Trend assumption: Linear deterministic trend

Series: EUROPE FTSE DAX CAC EUROSTOXX

Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.195602	1108.113	3.841466	0.0000

None	0.193530	1095.014	3.841466	0.0000
None	0.183999	1035.202	3.841466	0.0000
None	0.185198	1042.687	3.841466	0.0000
None	0.191648	1083.148	3.841466	0.0000

Denotes rejection of the hypothesis at the 0.05 level

Trace test indicates no co integration at the 0.05 level

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

As indicated in the header of the output, the test assumes no trend in the series with a restricted intercept in the co integration relation (second trend specification in the dialog),

Includes three orthogonal zed seasonal dummy variables D1–D3, and uses one lag in differences

(Two lags in levels*)* which is specified as “1 1” in the edit field.

8.2 Number of Co-integrating Relations

The first part of the table reports results for testing the number of cointegrating relations. Two types of test statistics are reported. The first block reports the so-called trace statistics and the second block reports the maximum eigenvalue statistics. For each block, the first column is the number of cointegrating relations under the null hypothesis, the second column is the ordered eigenvalues of the matrix in (24.24), the third column is the test statistic, and the last two columns are the 5% and 1% critical values. The (nonstandard) critical values are taken from Osterwald-Lenum (1992), which differ slightly from those reported in Johansen and Juselius (1990). To determine the number of cointegrating relations conditional on the assumptions made about the trend, we can proceed sequentially from to until we fail to reject. The result of this sequential testing procedure is reported at the bottom of each table block.

8.3 VECM

The vector error correction model (VECM) is just a special case of the VAR for variables that are stationary in their differences (i.e.,I(1)). The VECM can also take into account any co-integrating relationships among the variables.

- Vector Error Correction Models (VECM) are the basic VAR, with an error correction term incorporated into the model and as with bivariate cointegration, multivariate cointegration implies an appropriate VECM can be formed.
- The reason for the error correction term is the same as with the standard error correction model, it measures any movement away from the long-run equilibrium.
- These are often used as part of a multivariate test for cointegration, such as the Johansen ML test, having found evidence of cointegration of some I(1) variables, we can then assess the short run and potential Granger causality with a VECM.

Here we have seen cointegration presence in the results, further we can run an Error Correction Model, so that we can estimate both the long run and the short run relationship between the relevant variables. The integration of the variables suggests that we should not use then in a regression, but rather only their differences.

By having already concluding that the variables are cointegrated, we have implicitly decided that there is a long-run causal relation between them. Then the causality being tested for in a VECM is sometimes called "short-run Granger causality". The ECM analysis can show that when values of the relevant variables move away from the equilibrium relationship implied by the contegrating vector, there was a strong tendency for the variable(s) to change so that the equilibrium would be restored. The ECM analysis under cointegration allows us not to throw away the information on the LR effect behind the relationship.

VECM **(Table 8)**

VECM system, **lag order 5**

Maximum likelihood estimates, observations 1950/01/11-1969/07/15 (T = 5090)

Cointegration rank = 1

Case 3: Unrestricted constant

beta (cointegrating vectors, standard errors in parentheses)

v2	1.0000	
		(0.00000)
v3	-144.04	
		(2.7225)
v4	2.3600	
		(2.2672)
v5	-1.9389	
		(1.1399)
v6	141.54	
		(2.6877)
v7	1.5105	
		(2.4327)
v8	3.3543	
		(2.1235)
v9	-3.4161	
		(2.5889)
v10	1.2452	
		(2.3914)
v11	-2.3311	
		(2.7337)
v12	3.8049	

		(2.0358)
v13	4.3510	
		(1.7467)
v14	-1.1433	
		(1.3831)
v15	-6.6439	
		(2.0846)
v16	-4.3884	
		(3.2178)

alpha (adjustment vectors) **(Table 9)**

v2	0.0073866
v3	0.0075165
v4	**-0.00036719**
v5	0.00093638
v6	**-0.0043300**
v7	**-0.00058999**
v8	**-0.00017000**
v9	8.7259e-005
v10	**-2.7779e-005**
v11	**-0.00034914**
v12	2.4113e-005
v13	**-0.00025917**
v14	0.00058485
v15	0.00020942
v16	8.2003e-005

Log-likelihood = -133394.83

Determinant of covariance matrix = 18888.649

AIC = 52.8624

BIC = 54.3261

HQC = 53.3749

Here V2 to v16 are respectively returns of NASDAQ, DOWJONES, NYSE, OTHER SP, EUROPE, FTSE, DAX, CAC, and EURO STOXX, HANG SENG INDEX, SSE COMPOSITE, STRAITS TIME INDEX, ASX 200, NIKKEI. The coefficients in bold indicates coefficient of error correction term. Opposite sign implies proper adjustment to equilibrium. The Durbin Watson statistics is nearly equal to two which means lag selection has been proper.

VECM here have more than one equation for each variable in the model, but each equation will be an error correction model.

The * indicates significance level of 1%, ** that of 5% and *** of 10%. The sign of coefficient indicates positive or negative relationship. The coefficient (ECT) itself indicates that in the event of a one unit deviation from one time series, there is a correction of approximately coefficient % in the subsequent time period. The speed with which the model converges to equilibrium is shown by the ECM coefficients. The coefficient of ECM is the error correction or disequilibrium correction coefficient. If the ECM coefficient is greater than zero, it means there is a "surplus" of the dependent variable; a reduction is therefore required to restore equilibrium. The further variables tests are summarized in below given table.

Summarised Result Table 10

INDEX RETURNS	**POSITIVE RELATIONSHIP**	**NEGATIVE RELATIONSHIP**
NASDAQ	NYSE, DAX, EURO STOXX, NIKKEI,ASX	OTHER US, EUROPE, FTSE, CAC
DOWJONES	SP, RENIKKI, ASX, RESSE, STRAITS	REEURO, FTSE , CAC, REHANG
NYSE	SP, REHANG SENG	OTHER US, RESSE
OTHER US	SP, REHANDSENG	OTHER US, RESSE
SP	NYSE, STRAITS	OTHER US, FTSE,RESSE, REASX
EUROPE,	NYSE, FTSE, STRAITS	SP, RENEKKEI, REASX
FTSE	FTSE, OTHER US	DAX, REASX
DAX	EUROPE	SP, OTHER US, ASX
CAC	NYSE	EUROPE, CAC, ASX
EURO STOXX	SP, EUROPE, STRAITS, HANG SENG, ASX	DAX, EURO, STOXX
NIKKEI	EUROPE, REEURO,STOXX, DAX	DAX, NEIKKEI
HANG SENG INDEX	NYSE, NEKKEI, STRAITS	DAX, CAC, REEURO,STOXX
SSE COMPOSITE	RESSE	NYSE,SP,OTHER US,NEKKEI,STRAITS
STRAITS TIME INDEX	RESSE	NYSE,SP,OTHER US,NEKKEI,STRAITS
ASX 200	SP, EUROPE, STRAITS, FTSE	DAX, CAC, RESSE

From the above table it can be seen that each representative indices has positive and negative relationship with one or other index. But majority US indices share a relationship with EUROSTOXX and HANG SENG, NIKKEI. Asian Indices are having relationship with NYSE, NIKKEI, SSE and STARITS. EUROPEAN indices have relationship mainly with NYSE , HANG SHENG and ASX.

IX. CONCLUSION

In this study the objective was to find international transmission stock return volatility among different Asian, European and US nation representative stock indices. For this the data of daily index returns was taken for the time period of twenty years (1994-2014). Initially diagnostic tests were applied on the data. The results of unit of root test showed that the data series for each country was stationary. Further to check for the transmission of Volatility, co integration between difference time series carried out johanson co integration analysis which showed more than one integrating relationship between the all the index series under study. The vector error correction model (VECM), a special case of the VAR and was applied to take into account any co-integrating relationships among the variables (index series). The results also showed strong co integration among nations. By having already concluding that the variables are co integrated, we have implicitly decided that there is a long-run causal relation between them.

The analysis clearly shows that there are long-run relationships between the Asian , Europe and US markets .Though the stock returns of the indices all are non-stationary (below 10%) they do interact with each other and have a stationary equilibrium relationship which assures that the stock indices never drift too far apart this result suggests that the cointegration structure is more complex than simple mutual relationships and that long-run equilibria are determined by more than two markets.

The estimation of the vector error correction model yields insight into short-term and long run linkages between the markets. The mature markets in Asia, Japan and Hong Kong, do not have great impact on the region which confirms the result of Yang et al. (2003).

Analysis of the cointegration vector found by the Johansen procedure confirms the leading position of the American market. This result is in line with the studies of Fernandez and Sosvilla (2001) and Wong et al. (2004). The implications are clear. With stock market cointegration present in the data, the efficient market hypothesis is violated. Both short-run and long-run linkages between the indices suggest that stock returns are not independent, but predictable using information of other markets. The results also suggest that investors who seek to diversify their portfolios internationally should be aware that the stock markets in the study follow a common stochastic trend. This means that these markets generate similar returns in the long-run. Therefore, diversification across the markets is limited and investors should include other markets with lower correlation to hedge their risk.

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