Investigating co-movements between emerging and developed stock markets and forecasting transmission pattern dimensions

Ramona Birău, Jatin Trivedi

Abstract — The aim of this paper is to examine co-movements between emerging and developed stock markets and forecasting transmission pattern dimensions. In recent past, the significant investors' interest in international portofolio diversification was based on the phenomenon of increasing co-movement between developed and emerging stock markets, liberalization of stock markets, integration and financial globalization. The study sample period is relevant to investment decision making process since it covers pre-financial crisis, crisis-period and post-crisis period. The benefits of international portofolio diversification involve a complex investment strategy in order to avoid the inherent risks. ARIMA model is used to follow transmission patterns of time series trend in order to facilitate financial decision process and risk management strategy. The empirical analysis has founded significant relationship between emerging and developed stock markets.

Keywords—index returns, transmission pattern, co-movements, ARIMA models, interdependence, financial inter-linkages,

I. INTRODUCTION

As financial approach, international market are truly integrated. Consequently, the global financial crisis had a significant impact on stock markets all over the world. The aim of this article is to highlight the influence of co movements which generate dynamic financial contractions in order to understand the positive linkages among the international stock markets. Co-movement is perceived as a positive pattern of correlations. It is characterized by explicit profound meaning when it connects with international stock market, such as an asset price movement phenomenon. Financial crisis has not only generated large interest of researcher and investors in it but also delivered variety of new innovations in the area of international stock market. The international financial architecture is regarded as a continuous process of adjustment. Nevertheless, is strictly required to maintain a separation between common interdependencies, spillovers across financial assets and other random fundamentals. Present structure of trading and economic links between international countries has linked them strongly in a way of finance, trade, innovations, IT and telecommunications. Impact of globalization and liberalized policy has added additional value to international integrations of the countries. Now it seems like a joint chain of regularly operated activity. It is investigated from previous studies that not only developed countries but also financial markets of developed and developing countries become interrelated (Aktar, I., 2009). The intensity of interdependence among international equity markets varies with different degree in developed and developing economies. This identified change has interested researchers to develop and use highly advanced econometric methods for a variety of technical analysis. Integrated interlinked process has also spread out the equal degree of risk along with profit gain and economic development. This process gives large opportunity and a large area for research study to understand the relativity impact of comovements of stock markets in interdependence situation, internationally. Our objective is to investigate the degree of interdependency in comovements, linkages, and risk-security criteria among the developed stock markets like UK, USA, Japan, and France and emerging stock markets includes Hungary, Poland, Romania and Slovakia. We are considering our study area which consists of three stages, pre-financial crisis, crisis stage, and post-financial crisis, from Jan 2003 to Jan 2013. The stock indices are daily close index of each stock market. The daily indices observations will give more accurate understanding on comovements and its interdependency. To study comovement between emerging and developed market would be useful for policy maker and investors and provide a sense of stock market linkages, interdependency, risk and danger shocks, and how this will impact to other market and at which degree. And it requires closer look on comovements and interdependency of emerging and developed stock markets. It is considering an advanced methodological econometric tool to analyze the comovements between emerging and developed international stock markets. This data filtered from various econometric methods and results justify the transmitting pattern, trend forecast dimensions, interlinkages and interdependency for each exchange. The study is also analyzing the role structure

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of interdependency, co movements and degree of profit & risk. Finally, this study aims to test co movements, interdependency and highlights development stages of stock market movement by using variety of techniques.

II. LITERATURE REVIEW

The major financial crisis has ringed alarm bells among investors, researchers and practitioner professionals; it has generated large degree of alertness. Researcher and investors are among leading interest takers. A series of research investigations has made after solid crisis. The co movements and interdependency area also covers to deliver contribution in relation to specified countries but it still lacking closer look and requires great number of further advanced research, which can be stand out for policy makers, investors and may be even for economy as well. Previous empirical studies on co movements, interrelationship and interdependency of world's major stock indices has not revealed satisfied and consistent result from decision maker's point of view. It combines series of reasons , results vary depending on sample period, choice of market, frequency of observations (i.e. daily, weekly, monthly) (Chen, G.M, 2002) and of course econometric methods. Our research and findings also would not be out of limitation, but we focus on basic inter-linkages impact which can be considered as common and acceptable among researchers and policy makers. Generally, emerging capital markets are considered to be extremely attractive for both institutional and individual financial investors. Nevertheless, extreme financial events such as the current global financial crisis provide an intriguing perspective regarding emerging capital markets behavior. Empirical studies revealed a wide range of stylized facts, such as : volatility clustering, non-stationarity of financial asset price levels, leverage effect, heteroskedastic log returns, deviations from normal distribution, fat-tailed distributions, deterministic chaos. In recent past, financial integration and liberalization processes have generated higher volatility and lead to a more dramatic reaction to financial shocks. In this particular context, international contagion present a special resonance for international financial investors in order to use informations about one or more capital markets basically to forecast the performance of another. The debated issues raise the question of short-run and long-run equilibrium based on financial linkages among capital markets. Eun and Shim (1989) have provided interesting results regarding the international transmission of stock market movements among several mature markets, such as : Australia, Japan, Hong Kong, U.K, Switzerland, France, Germany, Canada and U.S.A., considering the fact that a series of multilateral interconnections were identified. Empirical analysis results highlighted that the correlations of U.S.A with Asian-Pacific and European stock markets, with the exception of U.K, are rather inconclusive and low, particularly because of the different trading hours of these particular stock markets. Forbes and Rigobon analyzed a sensitive issue, based on a relatively categorical premise, namely total exclusion of

contagion and obvious preference for interdependence, conclusions generated strictly by the perception of stock market co-movements. According to Singh (2010) who investigated the Chinese and Indian stock market linkages with several developed stock markets, namely U.S., U.K., Japan and Hong Kong, both Chinese and Indian market are correlated with all the selected developed markets based on the analysis of Granger causality. Rodriguez (2007) highlighted in his article "Measuring financial contagion: A Copula approach" a particular approach of financial contagion based on models dependence with switching-parameter copulas. Technically, the empirical analysis is based on daily returns from five East Asian stock indices during the Asian crisis and from four Latin American stock indices during the Mexican crisis. The results demonstrated the existence of changing dependence during periods of financial turmoil. A investigation also made on BRICA countries (Brazin, China, Russia, India and Argentina) and their relations with the US market on the basis of daily indices from Jan 2002 to Feb 2009, by (Aktan, B., P.E. Mandaci, B.S. Kopurlu and B. Ersener in 2009).

III. METHODOLOGICAL APPROACH

In The study consists daily closing prices of stock market indices for the period of Jan 2003 to Jan 2013 and includes 2303 observations for each selected stock market. The empirical analysis includes developed and emerging stock markets i.e. USA, UK, JAPAN, FRANCE, HUNGARY, POLAND, ROMANIA and SLOVAKIA. The analysis is based on the following stock indices, i.e DIJA, FTSE100, Nikkey225, CAC40, BUX, WIG20, BET, and SAX. Each approach provides different variety of results, when brought together we hope for expected outcome that reveals some of the many facts of comovements between emerging and developed stock markets and become helpful to investors for investment decision making. It is employed below the variety of technique used in oeder to measure the factor from different angle.

The study consists of variety of statistical analysis to judge the co movements of emerging and developed stock indices. First we used Index Conditional Value (ICV) model to calculate general statistics and ranking the profitability and risk level. To describe scatterplot matrix, we use Parallel Coordinates Plots (PCP) by Matlab. There are other alternatives that display all the variables together, allowing you to investigate higher-dimensional relationships among variables but the most straight-forward multivariate plot is the parallel coordinates plot. In this plot, the coordinate axes are all laid out horizontally, instead of using orthogonal axes as in the usual Cartesian graph. Each observation is represented in the plot as a series of connected line segments. Parallel coords(X) creates a parallel coordinates plot of the multivariate data in the n-by-p matrix X. Rows of X correspond to observations, columns to variables. A parallel

coordinates plot is a tool for visualizing high dimensional data, where each observation is represented by the sequence of its coordinate values plotted against their coordinate indices. parallelcoords treats NaNs in X as missing values and does not plot those coordinate values. Empirical cumulative distribution function – Matlab. In survival and reliability analysis, this empirical cdf is called the Kaplan-Meier estimate. And the data might correspond to survival or failure times.

   [f,x] = ecdf(y)

Description - returns the empirical cumulative distribution function (cdf), f, evaluated at the points in x, using the data in the vector 'y'.

Correlated Component Regression (CCR) model used to set the proper degree of regularization specifically to reduce confounding effects of high predictor-correlation. It allows obtaining more interpretable regression coefficients with better predictions, significant predictors compare to traditional regression model.

Moreover, The data first will filter from its stationary criteria based on Dickey-Fuller test (DF) (1979) applied. For the selection of the best ARIMA (p,d,q) type of models fitted for the indices. The statistics been compared from following criteria.

- *The Akaike Information Criteria (AIC)*
- *The Corrected Akaike Information Criteria (AICc)*
- *Mean Absolute Percent Error (MAPE)*
- *Root Mean Square Error (RMSE) and*
   Iterations
- *Karl Pearson's Correlation*

Below is brief description about the criteria for the selection of best ARIMA model;

The Akaike Information Criteria (AIC): The proper application of AIC will give judgmental forecasting trend and will help to decision makers. The Akaike Information Criterion is applied by the following formula;

$$AIC = n \ln \left(\sum_i w_i \left[y(t_i) - \hat{y}(t_i) \right]^2 / n \right) + 2p$$

If applicable, (in absence case) PKIN uses an adjusted procedure with a second order correction for missing sample size. **Corrected Akaike Information Criteria (AICc):**

$$AIC = n \ln \left(\sum_i w_i \left[y(t_i) - \hat{y}(t_i) \right]^2 / n \right) + 2p + \frac{2p(p+1)}{n-p-1}$$

At the time of corrective application and final selection of statistics, the smaller AIC is considered for accurate filter process. **Mean Absolute Percent Error**: We have used MAPE for the estimation of the future valuation and estimation of future pattern. It filters from following degree;

$$E = \frac{1}{n} \sum_1^n | \frac{a0 - ft}{a0} |$$

a0–actual value
ft–future value

The filtered data from MAPE process represents accurate future patterns and a perfect estimation. Moreover we have summed up actual value for every estimated point and divide by the total number of points for each index. **Root Mean Square Error (RMSE):** All data will be filtered from RMSE

to finding out the degree of variance between the values predicted by a model and valued actually observed. All variances from this is identified as (*r*) residuals here. **Iterations:** We used iterations for creating timelines in a way to finding out the repetition of a sequence of specified number of indices. **Karl Pearson's Correlation:** The purpose of using correlation method is to finding out one measure based on another. It will reflect the interrelationship of one stock index with another and in the degree of correlations. The following formula used;

$$r_{xy} = \frac{\sum x_i y_i - n \bar{x} \bar{y}}{(n-1) s_x s_y} = \frac{n \sum x_i y_i - \sum x_i \sum y_i}{\sqrt{n \sum x_i^2 - (\sum x_i)^2} \sqrt{n \sum y_i^2 - (\sum y_i)^2}}.$$

The absolute value of all the indices represents Pearson correlation coefficients are less than or equal to 1. Correlations equal to 1 or -1 correspond to data points lying exactly on a line (in the case of the sample correlation), or to a bivariate distribution entirely supported on a line (in the case of the population correlation). The Pearson correlation coefficient is symmetric: *corr(X,Y) = corr(Y,X)*.

ARIMA models are identifies one of the best in forecasting or estimation of time series which can be stationeries by transformations such as differencing and logging. We have separated data in to three phase time series and independently residuals processed for each. The filtered outcome clearly defines the time serried trend with 3(RMSE) for accurate decisions and predictions for policy makers, investors, decision makers and may be even for respected economy. We applied the first model of ARIMA for the positive autocorrections. ARIMA (1,1,0) which we used as a differenced first-order autoregressive model; we define by X_t a series with mean μ, then if the series is supposed to follow an ARIMA(p,d,q)(P,D,Q)s model, it can be write as following :

$$Y_t = (1 - B)^d (1 - B^s)^D X_t - \mu \; ; \; \Phi(B)\emptyset(B^s))Y_t = \theta(B) \, \Theta(B^s)$$
$$Z_t, Z_t \infty N(0,\sigma^2) \dots (1)$$
$$\Phi(z) = 1 - \Sigma^p_{i=1} \Phi_i z^i, \emptyset(z) = 1 - \Sigma^p_{i=1} \emptyset_i z^i \; ; \; \theta(z) = 1 + \Sigma^q_{i=1}$$
$$\theta_i z^i, \Theta(z) = 1 + \Sigma^q_{i=1} \Theta_i z^i \dots (2)$$

Here p is the order of the autoregressive part of the model. q is the order of the moving average part of the model. d is the differencing order of the model. D is the differencing order of the seasonal part of the model. s is the period of the model. P is the order of the autoregressive seasonal part of the model. Q is the order of the moving average seasonal part of the model.

Where, 4.1 Y_t process is causal if and only if for any z such that $|z| \leq 1$, f(z)≠0 and q(z)≠0, 4.2: if D=0, the model is an ARIMA(p,d,q) model. In that case, P, Q and s are considered as null. 4.3: if d=0 and D=0, the model simplifies to an ARMA(p,q) model. 4.4: if d=0, D=0 and q=0, the model simplifies to an AR(p) model. 4.5: if d=0, D=0 and p=0, the model simplifies to an MA(q) model.

Further we consider that when forecasting estimated or future value of time series variables, it is equally important to

prove benchmark of applied models and proper econometric methodology specifically when random walk to compare the forecasts of the model with designed random walk it must not beat random walk or else can be argued for relatively poor forecaster. And at last we residuals for stationary of statistics at the time of application of ARIMA model.

IV. EMPIRICAL RESULTS AND APPLIED DEBATE

In this paper was described the entire empirical analysis in three particular sections. Section 01 represents the general statistics outcomes from the data which is described in Table-1. Section 02, deals with all figured analysis by Parallellcoords – Matlab. At last, section 03 covers Correlated Component Regression (CCR) analysis and integrated outcomes of entire result. Section 01-General statistics of entire data (2003-2013) covering all daily indices presented in Table-1. It is clear that Hungary, contains the highest degree of Sd, 4943.68, the highest risk and highest profitability among the study indices. Hungary capital market can be attractive for investors those who deal with high profitability and ready to take equally risk. But from the safe side, Slovakia attracts stable and lowest risk takers as it is maped in Table-1 and figured in Fig.1.

Section 01

Table 1: Descriptive Statistic Log Indices

Variable	Min**	Max**	Mean**
USA	6547.05	14164.53	11263.73
UK	3512.09	6732.40	5433.24
JAPAN	7054.98	18842.40	11918.71
FRANCE	2519.29	6168.15	4128.59
HUNGARY	7732.35	28511.38	18445.19
POLAND	1327.64	3917.87	2481.38
ROMANIA	1887.14	10813.59	5625.57
SLOVAKIA	160.15	507.98	312.93

Variable	Std. dev**	Profit & Risk***	Safety rank***
USA	1484.31	4.00	5.00
UK	678.91	6.00	3.00
JAPAN	2979.55	2.00	7.00
FRANCE	846.05	5.00	4.00
HUNGARY	**4943.68**	**1.00**	**8.00**
POLAND	575.16	7.00	2.00
ROMANIA	1921.14	3.00	6.00
SLOVAKIA	103.80	8.00	1.00

*Descriptive Statistics-Original Indices (daily basis from year 2003-2013)
**OBS-2303, Sd-0.05%, 0.01%, Sr-0,R=r
***Filtered by ICV

Source: Own computations based on selected financial data series

This article provides additional empirical evidence of developed and emerging capital markets behavior in the context of the global financial crisis. The topics discussed in this article covers an area of current interest both for practitioners and academics. Moreover, in terms of financial econometrics, emerging capital market behavior is encumbered by certain features such as : volatility clustering, non-stationarity of price levels, leverage effect, heteroskedastic log returns, deviations from normal distribution, time variation, unpredictability, fat-tailed distributions, chaos.

The stock market of Hungary can be attractive for investors those who deal with high profitability and ready to take equally risk. But from the safe side, it stands at last in entire study country. Slovakia attracts stable and lowest risk takers as it can map in Table-1 and figured in Fig.1. Japan, Romania, and USA follow the movements. The risk factor for Hungary moves with high degree of movements as it is clearly indicated by Minimum 7732.35 against Maximum high at 28511.38 it covers about more than 3.5 times fluctuations which generally never seen in developed and matured market like UK and US where Min and Max movements covers in 2-2.5 times. We can consider Japan and France as intermediate stage developed market but intermediate stage of maturity. As emerging market, Hungary, Romania leads among other country, while Japan and US as develop market leads. Fig-1 can be important to follow the Table-1.

Section 02 – Parallel Coordinates

Fig .1 Statistics of Parallel Profile Plots
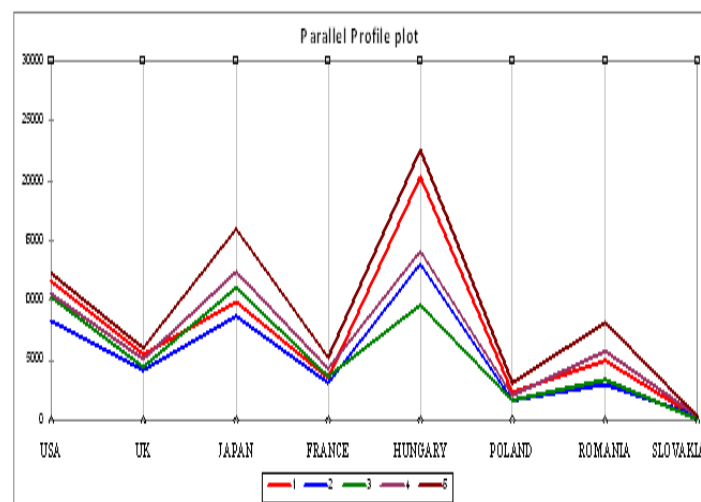
Source: Own computations based on selected financial data series

Fig-1, consist of (f) Factor-5 regression statistics includes daily indices from year 2003 to 2013. With reference to leading comovements of capital markets, Hungary not only leads but it has recovered crisis period with good jump offs. It

has high ratio of inter lined comovement among the others. As developed market Japan stands in stable investment and good profitable option. While US and UK represents strong and stable markets from developed and matured market, it indices the strong stability against heavy downfall. Investors who opt to invest in such market may suffer lowest asset loss if there is down trend. But equally immediate asset gaining also runs slowly. Romania can be considered as second profitable emerging capital market. Slovakia and Poland are stable and strong emerging markets with lowest degree of risk which is followed by US, UK and France as developed and matured market. The following figure highlights in a very suggestive manner the of co-movements of selected stock markets.

Fig .2 Statistics of Parallel Coordinates Plots
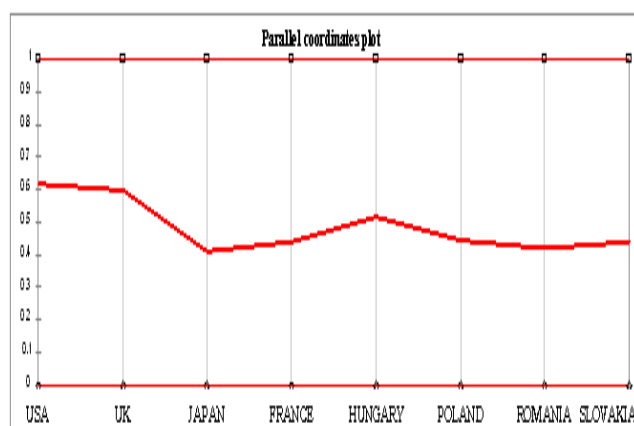
(*Std.dev=0.05, Sw=2302, OBS=2302, statistical data from 2003-2013)
Source: Own computations based on selected financial data series

The figure above integrates entire study outline with daily basis indices. The filtered regression coefficient statistics highlights and supports comovements of covered stock markets which consists of developed and emerging covers periods of before crisis, crisis and after crisis. The strong recovery indices in emerging market clearly visible in Hungary, followed by Romania as emerging markets. The above statistics considers entire data analysis with Std.Dev 0.05. The outcomes are clear and visible for the decision making. As developed country Japan market is leading and attracting investors for who can decides to invest in developed economy. The overall performance of Hungary and Romania all these years has generated greater fluctuations with high degree of risk and profitability as well. Investors can opt for this option if they equally believe in risk theory. Regression matrix model would be more supportive to be helpful to highlighting the interlinkages and integrated regression degree of stock indices.

Section 03- Correlation Matrix

Moreover it can be filter the data statistics from Correlated Component Regression (CCR) model for final analysis.

Table 2. Descriptive statistics - Correlation matrix

Variables	USA	UK	JAPAN	FRANCE	HUNGARY	POLAND	ROMANIA	SLOVAKIA
USA	1.000	0.864	0.390	0.456	0.576	0.700	0.642	0.005
UK	0.864	1.000	0.576	0.638	0.810	0.896	0.818	0.272
JAPAN	0.390	0.576	1.000	0.931	0.416	0.742	0.836	0.699
FRANCE	0.456	0.638	0.931	1.000	0.505	0.792	0.906	0.676
HUNGARY	0.576	0.810	0.416	0.505	1.000	0.849	0.706	0.293
POLAND	0.700	0.896	0.742	0.792	0.849	1.000	0.903	0.475
ROMANIA	0.642	0.818	0.836	0.906	0.706	0.903	1.000	0.567
SLOVAKIA	0.005	0.272	0.699	0.676	0.293	0.475	0.567	1.000

*CCV-Linear regression, Confidence Interval=95%, OBS=2303, R²=1.000, Sw=2303
Source: Own computations based on selected financial data series

Statistical data were filtered based on Correlated Component Regression (CCR) analysis in a manner that all statistic can be able to present the co-movements of selected stock indices. The degree of regression on interdependency is clear on the above table with considering confidence interval of 95%. CCR clearly highlights that UK and USA are strong developed market which influence emerging markets. Moreover, the results of empirical analysis emphasized that percentages of co-movements represents the amount of impact on co-movements and relativity impact from developed to developed, developed to emerging, emerging to developed and emerging to emerging markets.

On the other hand, The selected international developed and developing market represents very strong dependency relationship with specific markets. The two most developed and stable markets (US & UK) are found strongly interdependent and interlinked with developed markets and reflect changes according to changes in one. We have been observing the data since 2003 for the changes, dependency and interlinkages among developed and emerging markets for the selected countries. We have found the following analytical results at the end. We start with developed market transmitting pattern and interdependency within developed market and interlinkages with emerging capital markets.

It is possible to categorize results in two category viz. transmitting pattern and interlinkages of developed market, and emerging markets. US (DIJA) and UK (FTSE100) are found strongly interlinked developed markets where variables are highly independent and the transmitting patterns reflects mutual positivism. There is 87.3% correlation between both the markets as second strong developed interlinkages. However, first developed market interdependency found in Japan (NIKKEY225) and France (CAC40) markets which consist 93.4% correlations. This interlinkage and correlations is also recognized as strongest amongst developed capital markets.

Table 3. Correlation matrix

Variables	USA-DIJA	UK-FTSE100	JAPAN-NIKKY225	FRANCE-CAC40	HUNGARY-BUX	ROMANIA-BET	POLONIA-WIG20	SLOVAKIA-SAX
USA-DIJA	1	0.873	0.510	0.603	0.549	0.751	0.782	0.272
UK-FTSE100	0.873	1	0.632	0.765	0.754	0.908	0.933	0.479
JAPAN-NIKKY225	0.510	0.632	1	0.934	0.480	0.808	0.742	0.734
FRANCE-CAC40	0.603	0.765	0.934	1	0.567	0.903	0.855	0.761
HUNGARY-BUX	0.549	0.754	0.480	0.567	1	0.754	0.804	0.435
ROMANIA-BET	0.751	0.908	0.808	0.903	0.754	1	0.951	0.710
POLONIA-WIG20	0.782	0.933	0.742	0.855	0.804	0.951	1	0.586
SLOVAKIA-SAX	0.272	0.479	0.734	0.761	0.435	0.710	0.586	1

Source: Own computations based on selected financial data series

Transmission pattern developes variety of changes in emerging markets as well unstable developed markets i.e. Japan and France. Hence, the transmission pattern of stable and developed capital market reflects internationally with specific kind of inter-linkages and with systematic pattern, starts from developed but not stable capital markets, emerging with stable capital flow and emerging capital markets. High degree of correlationship among specific countries can be considered as most important part for the decision makers and investors. The interlinkages between developed and developed, developed and developing and developing and developing stock markets represents specific and strong dependency of transmitting pattern. We can notice the best correlation and interlinkages between Japan-NIKKEY225 and France-CAC40 93.4% which is highest among developed countries, followed by US-DIJA and UK-FTSE100 87.3% (see table-3).

The strong correlation and interlinkages also noticed within developed to developing where UK-FTSE100 and Polonnia-WIG20 have 93.3% linkages, followed by Romania-BET which consist of two parelal linkages UK-FTSE100 90.8% and France CAC-40 90.3% (see table-3). Developing countries have found interlinked more than 75% (avg) except Slovakia-SAX index. The highest correlationship found between Romania-BET and Polonia-WIG20 95.1% which is highest relationship among entire study area. Now decisionmakers and investors may take better decisions when they follow interlinkages-relationship from developed to developing i.e for decisions about Romania-BET which linked with two developed markets FTSE100 and CAC40 (see table-3). The following Figures represents interlinkages among developed and developing countries which supports above explainations.

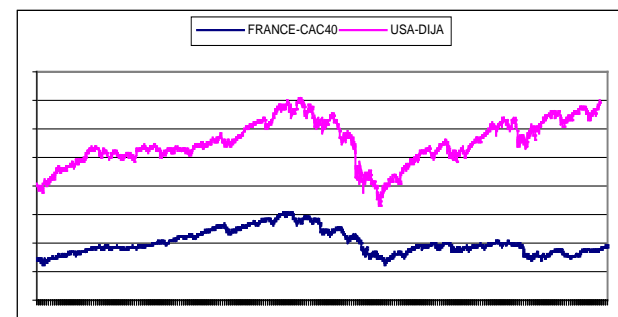Fig .3 Developed stock market pattern (UK-FTSE100 and FRANCE-CAC40) Jan-2003 to Jan-2013
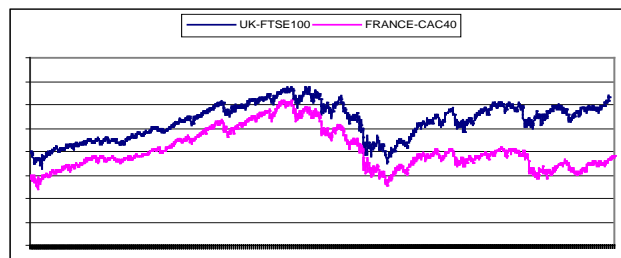
Source: Own computations based on selected financial data series

Fig .4 Developed stock market pattern (US-DIJA and JAPAN-NIKKEY225) Jan-2003 to Jan-2013
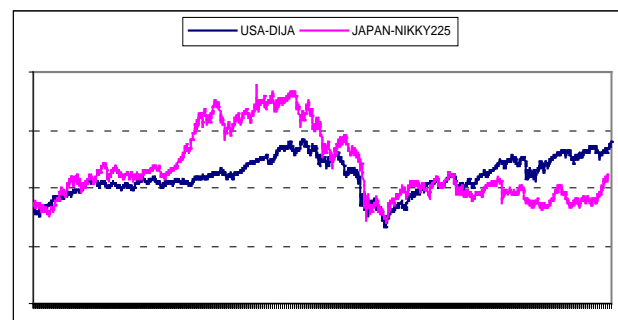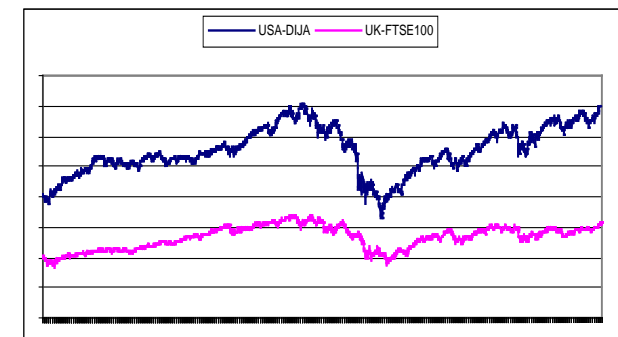

Source: Own computations based on selected financial data series

Fig .5 Developed stock market pattern (FRANCE-CAC40 and US-DIJA) Jan-2003 to Jan-2013
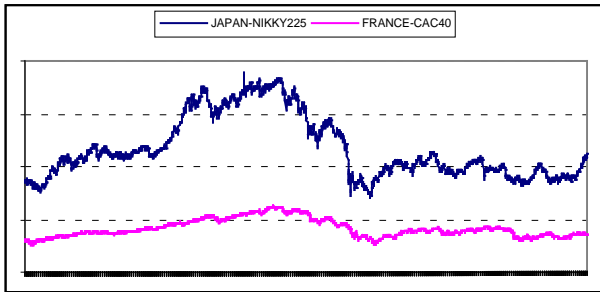

Source: Own computations based on selected financial data series

Fig .6 Developed stock market pattern (US-DIJA and UK-FTSE100) Jan-2003 to Jan-2013
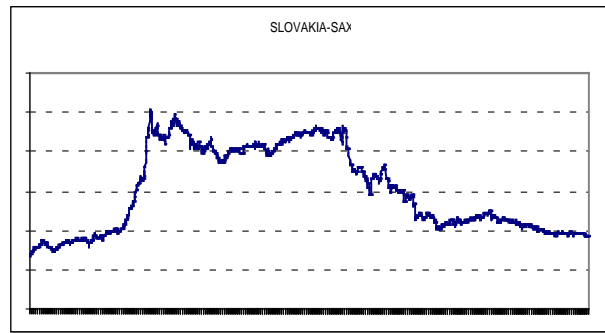

Source: Own computations based on selected financial data series

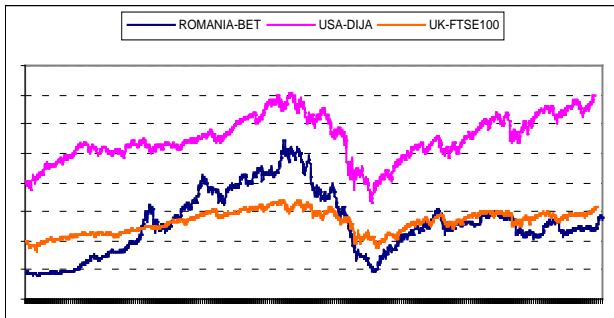Fig .7 Developed stock market pattern (Japan-NIKKEY225 and France-CAC40) Jan-2003 to Jan-13
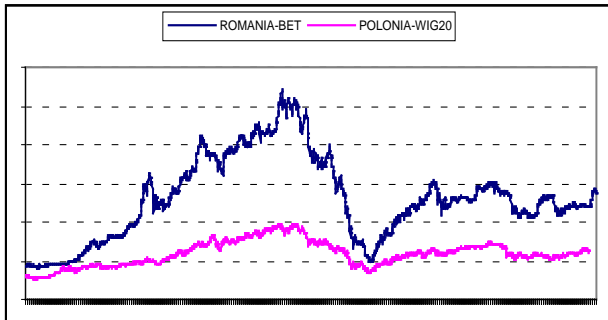

Source: Own computations based on selected financial data series

Fig .8 Mixed market pattern (Romania, US and UK) Jan-2003 to Jan 2013
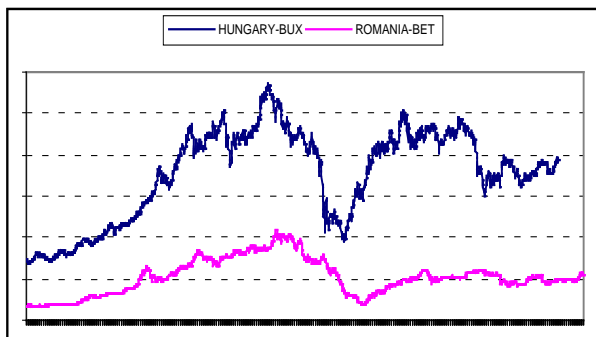

Source: Own computations based on selected financial data series

Fig . 9 Developing market pattern (Romania-BET and Polonia-WIG20) Jan-2003 to Jan-2013

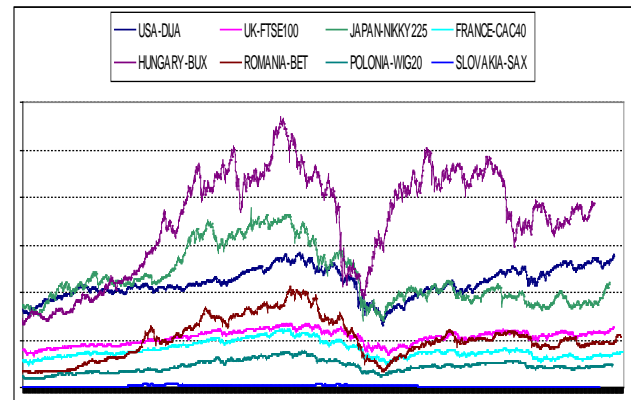Source: Own computations based on selected financial data series

Fig 10. Developing market pattern (Hungary-BUX and Romania-BET) Jan-2003 to Jan-2013

Source: Own computations based on selected financial data series

Fig .11 Independent market pattern (Slovakia-SAX) Jan-2003 to Jan-2013

Source: Own computations based on selected financial data series

Above figures represents three interlinked dependency movement of stock indices. Fig.3 to Fig.7 represents developed market linkages, Fig.8 suggests mixed market pattern, Fig.9 represents developing market pattern and Fig.10 stands for only independent market pattern Slovakia-SAX index. Japan-NIKKEY225 and France-CAC40 (see fig.7) identified as most correlated developed market followed by US-DIJA and UK-FTSE100 (see fig.6). Romania-BET index is found most relavent, correlated and interlinked with developed market like UK-FTSE100 and France-CAC40 and with Polonia-WIG20 as developing market linkages. Slovakia-SAX index found as highly independended market which has below average linkages and correlations with developed and developing study indices (see fig.11).

Fig. 12 Entire study regarding stock market pattern (developed and developing) Jan-2003 to Jan-2013

Source: Own computations based on selected financial data series

The figure above (fig.10) represent all stock indices from year Jan-2003 to Jan-2013 where entire market is interlinked with international transmitting pattern of stock market movement and highly linked with specific market (developed and developing). The most independent market among study period is Slovakia-SAX market which practically not strongly linked with any developed market or with developing market. The following canonical variable provides four factor (f) analysis of all stock indices.

Table 4. Descriptive canonical variables
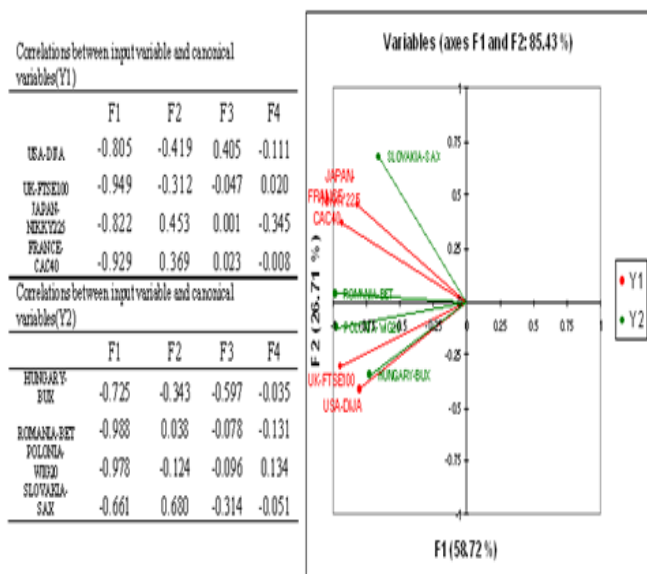
Source: Own computations based on selected financial data series

The above canonical variable comparision with correlations represents the dimensionality of the independent variables and shows the similarity to the principal components. F1 consist set of developed countries which has interrelated among all at 58.72% (see table-4) where as the overall variable relationship and interlinkages (F1+F2) (F2 consist of developing countries) 85.43% which also practically proves strong movement of transmitting pattern.

Table 5. Goodness of fit statistics

Vari	USA-DJIA	UK-FTSE100	JAPAN-NIKKEY225	FRANCE-CAC40
Observations	2451.00	2451.00	2451.00	2451.00
DF	2449.00	2449.00	2449.00	2449.00
MSE	15121.41	3927.56	32644.03	3083.20
RMSE	122.97	62.67	180.68	55.53
MAPE	145.23	110.65	166.70	118.77
-2Log(Like.)	30543.75	27239.56	32429.91	26646.30
FPE	15133.76	3930.77	32670.67	3085.72
AIC	30547.75	27243.56	32433.91	26650.30
AICC	30547.75	27243.57	32433.92	26650.30
SBC	30559.36	27255.17	32445.52	26661.90
Iterations	6.00	21.00	1.00	4.00

Vari	HUNGARY-BUX	ROMANIA-BET	POLONIA-WIG20	SLOVAKIA-SAX
Observations	2451.00	2451.00	2451.00	2451.00
DF	2449.00	2449.00	2449.00	2449.00
MSE	94419.76	8752.17	1412.10	12.76
RMSE	307.28	93.55	37.58	3.57
MAPE	108.09	122.45	109.75	99.92
-2Log(Like.)	35033.08	29203.51	24732.34	13196.39
FPE	94496.84	8759.32	1413.26	12.77
AIC	35037.08	29207.51	24736.34	13200.39

Source: Own computations based on selected financial data series

Based on the informations presented in table 4, it is very

easy to understand the trend series of each stock indices. It represents 0.1 difference between AIC and AICC for UK-FTSE100, JAPAN-NIKKEY225, HUNGARY-WIG20 and ROMANIA-BET for the rest it equals. Interations represents repeted indeces for each country. UK-FTSE100 found as highest interation which means a predictable forecast can be possible from series.

V. CONCLUSIONS

The global financial crisis emphasized in a dramatic manner the importance of research in the field of theoretical and applied finance. In this respect, stock market is an area of highly fertile applied research with significant practical implications. Academics, financial investors and policy makers analyzed this issue from different perspectives and have provided a variety of outcomes generated by an heterogeneous research methodology. This research study investigates the co-movements of emerging and developed stock markets particularly in the context of the global financial crisis by using series of integration test based on daily closing price stock indices during the period of January 2003 to January 2013. The empirical results reveal the presence of co-movement relationship, interdependency and inter-linkages among developed and emerging stock market. Hungary has been identified as the highest return payer country and Romania as an emerging stock market with high risk ratio. Japan and France indicate highest return payer with average risk ratio among the developed stock markets The study outcomes are based on advanced econometric models and techniques. Moreover, integrated results would be useful for international investors and decision makers in order to understand the co-movement, interdependency and inter-linkages among the selected international stock markets.

The article empirically investigates the co-movement of emerging and developed international stock markets (i.e. USA, UK, Japan, France, Hungary, Poland, Romania and Slovakia). The outcome is based on daily stock indices covering 2303 observations of each country market. Our integrated result clears highly risk oriented, profit oriented markets (i.e. Hungary, Romania as emerging stock market, and Japan, UK as developed stock market). It is observed that investors those who consider high risk margin to earn higher profitability, their decisions to invest in Hungary market, is proved to be highest return with highest risk ratio. This market has delivered more than 3.5 times movements during the study period which is comparatively 1-1.5 times higher than any covered developed or/and emerging market. The situation implies that Hungary stock market provides an attractive diversification opportunity for international investor managers, institutional investor's delegates and independent risk takers. However, compound regression investigates that all markets are spreading different degree of impact on other market either it is developed or emerging. It is observed that short run relationship between stock market of Hungary, Romania and

Japan. The UK market movements is perceived as highly strong and stable, followed by US and France stock market. Slovakia is identified as highly safe market for investors with low degree of returns. This also helps investors who believe in safe and secure investment. Slovakia is an attractive additional investment option. The overall co-movement of emerging and developed stock market investigates that particularly in terms of global financial crisis. Among emerging stock markets, Hungary is suitable for high risk taker and Romania stands for average return expectation. The study sample period can be important to investment decision making process since it covers pre-financial crisis, crisis-period and post-crisis period. This study also investigates four category of movement behavior (i.e. developed and stable, developed but yet to stable, emerging and stable and emerging but yet to stable). So the potential area for further research can be focus on co-movements in respect to equality of capital markets. Moreover, in this paper it is used ARIMA model to follow transmission patterns of time series trend.

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