Testing The Random Walk Hypothesis: An Application in the BRIC Countries and Turkey

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This paper investigates the weak form efficiency in the BRIC countries and Turkey with use of autocorrelation analysis, unit root tests, Johansen cointegration and Granger causality test. Monthly data covers the period from July 1997 to December 2013. Our findings indicate the efficiency among the stock markets in the weak form. The empirical findings indicate monthly closing prices of indices follow the random walk procedure. According to Granger causality and Johansen cointegration tests we found the long-run relationship between China and India, also China and Turkey.

Key Words: Random Walk Theory, BRIC-T Countries, Weak Form Efficiency, Unit Root, Johansen Cointegration, Causality.
Jel Classifications: C5,G14, G15.

1. Introduction

Brazil, Russia, India, China (BRIC) and Turkey are leading emerging economies and political powers at the regional and international level. The BRIC and Turkey economies continue to grow and domestic demand has reached unprecedented levels. They all show high economic growth rates. They slowed down only shortly

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under the turbulences of the global financial crisis in 2008/2009 and were able to recover quickly.

Many researchers have been interested in developing and testing models of stock price behavior. The efficient market hypothesis is based on the assumption that prices of securities in financial markets fully reflect all available information and these prices adjust rapidly to the arrival of new information. This hypothesis has effects both on companies and investors (Đurić, 2006).

Fama (1965) defined an "efficient" market for the first time, in his empirical analysis of stock market prices. Fama (1970) classified the market efficiency into three levels, depending on the information reflected in security prices; weak form market efficiency, semi strong form market efficiency and strong form market efficiency. First of all, weak-form efficiency exists when security prices reflect all the information contained in the history of past prices and returns. If stock markets are in weak-form efficient, then investors cannot earn excess profits from trading strategies based on past prices or returns. Second, semi-strong form markets, in which the concern is whether prices efficiently adjust to other information that is obviously publicy available (e.g., announcements of annual earnings, stock splits, etc.) are considered. Thirdly, strong form markets concern with whether given investors or groups have monopolistic access to any information relavant for price formation are reviewed. Share prices here reflect all information, public and private, and no one can earn excess returns in strong form markets.

Weak-form efficiency is often associated with the random-walk hypothesis, where future price changes are independent of price changes in the past. The term random walk describes the movements of a variable whose future changes cannot be predicted (are random) because, given today's value, the variable is just as likely to fall as to rise. An important implication of the efficient market hypothesis is that stock prices should approximately follow a random walk; that is, future changes in stock prices should, for all practical purposes, be unpredictable (Mishkin, 2012). If the random-walk theory is valid and if security exchanges are "efficient" markets, then stock prices at any point in time will represent good estimates of intrinsic or fundamental values (Fama, 1995).

This paper is an attempt to test the market efficiency of Brazil, Russia, India, China (BRIC) and Turkey capital markets. The remainder of this paper is organized as follows. Section 2 provides a thorough review of the literature on random walk theory. Section 3 describes the data and their properties. Section 4 discusses the empirical methodology and results. Last section presents our conclusion.

2. Review of Scientific Literature

Market efficiency and the random walk hypothesis have been widely discussed in financial literature. The emerging stock markets and developed markets have been highly focused by researchers about random walk theory. There have been various studies about market efficiency and random walk in finance (Fama, 1965; Samuelson,1965; Fama 1970; Fischer, 1971; Shiller, 1981; Shiller and Perron, 1985; Summers, 1986; Narayan and Smith, 2004; Malkiel, B.G. 2005; Borges, 2011 etc.). The results of these studies are inconclusive. Some studies have found a weak form or semi strong form efficiency in markets (Butler and Malaikah; Hall et al, 1998; Appiah and Menyah, 2003). Some authors have reported market ineficiency in their studies (Lo and MacKinlay, 1988; Balaban and Kunter, 1996; Jarrett and Kyper, 2006 etc.).

Butler and Malaikah (1992) used traditional autocorrelation and runs tests to evaluate the weak form efficiency of Kuwait and Saudi stock markets over the period 1985–1989. They reported that the Saudi stock market is inefficient while the Kuwaiti Stock Market is efficient. Their study showed that the Saudi stock market does not follow a random walk.

Hall et al. (1998) tested changing market efficiency based on a time varying parameter model with GARCH in mean effect in Russia stock market. They demonstrated that the market was initially inefficient and that it took something of the order of two and a half years to become efficient.

Moreover, Appiah and Menyah (2003) focused on testing the weak-form efficiency of 11 African stock markets (Botswana, Egypt, Ghana, Ivory Coast, Kenya, Mauritius, Morocco, Nigeria, South Africa, Swaziland and Zimbabwe) applying EGARCH-M model with weekly data in different time periods (1989-1995). They found that the markets in Mauritius, Morocco, Egypt, Kenya and Zimbabwe are weak-form efficient while those in Botswana, Ghana, Ivory Coast, and Swaziland are inefficient.

Furthermore, Narayan and Smith (2004) tested the efficient market hypothesis using monthly South Korean stock price data for the period 1981–2003. ADF unit root test, the Zivot and Andrews (1992) one break and the Lumsdaine and Papell (1997) two break unit root tests were used in their study. Their results defined that stock prices in South Korea have unit root, which is consistent with the random walk hypothesis.

In 2007, Cooray and Wickremasinghe examined the efficiency of stock markets of India, Sri Lanka, Pakistan, Bangladesh and the linkages between these four markets for the period of 1996 to 2005. The Augmented Dicky Fuller (ADF-1979), the Phillip-Perron (PP-1988), the Dicky-Fuller Generalized Least Square

(DF-GLS 1996) and Elliot-Rothenberg-Stock (ERS – 1996) were used. The unit root tests supported weak form efficiency for all four countries while the DF-GLS and ERS tests did not support weak form efficiency for Bangladesh.

Lim et al. (2009) examined the weak-form efficiency of Shanghai and Shenzhen Stock Exchanges. Their results showed that the two Chinese markets were found to be efficient most but not all the time. Specifically, the adjusted returns series from both markets follow a random walk for long periods of time, only to be interspersed with brief periods of strong linear and/or nonlinear dependency structures. This suggests that there are certain time periods when new information is not fully reflected into stock prices.

Besides, Okpara (2010) investigated whether the Nigerian stock market follows a random walk using the Generalized Autoregressive Conditional Hetrosecedasticity (GARCH) for the period 1984 to 2006. The result showed that the Nigerian stock market followed a random walk and was therefore weak form efficient.

In addition, Borges (2011) examined the weak form of market efficiency of five stock markets (France, Germany, UK, Greece, Portugal and Spain) and applied a serial correlation test, a runs test, an Augmented Dickey-Fuller test and the multiple variance ratio test using daily and monthly data from January 1993 to December 2007. This hypothesis is rejected in Portugal, Greece, France and UK, however it is not rejected in Germany and Spain. The most efficient stock markets are those in Turkey, the UK and Hungary; the least efficient are those located in Malta and the Ukraine in their studies.

A comparative study's Smith (2012) tested for random walk behavior of 15 European emerging stock markets in Croatia, the Czech Republic, Estonia, Hungary, Iceland, Latvia, Lithuania, Malta, Poland, Romania, Russia, the Slovak Republic, Slovenia, Turkey and the Ukraine and using rolling window VR tests over the period beginning in February 2000 and ending in December 2009. Furthermore, the 2008 financial crisis coincides with return predictability in the Croatian, Hungarian, Polish, Portuguese, Slovakian and UK stock markets. However, the crisis had little effect on weak form efficiency in stock markets of Greece, Latvia, Romania, Russia and Turkey.

A recent study in BRIC countries, Mobarek and Angelo (2014) studied to determine whether the equity markets of Brazil, Russia, India and China (BRIC) may be considered weak-form efficient using daily data and a bias-free statistical technique with a sample spanning from September 1995 to March 2010. The study indicated that the results from the last sub-periods, including the subprime crisis, support the belief that these markets may have been approaching a state of being fairly weak-form efficient.

On the other hand, there are some studies have found a market inefficiency. For instance, Lo and MacKinlay (1988) tested the random walk hypothesis for weekly stock market returns by comparing variance estimators derived from data sampled at different frequencies. They rejected the random walk hypothesis for weekly stock market returns using a simple volatility-based specification test for the entire sample period from September 6, 1962 to December 26, 1985. These rejections cannot be ascribed to infrequent trading or to time varying volatilities.

Furthermore, various studies in Turkey; Balaban and Kunter (1996) tested semi strong form efficiency in Foreign Exchange Market, Interbank Money Market and Istanbul Stock Exchange Market with respect to changes in currency in circulation for the period January 1989 to July 1995 using Granger Causality test. They implied that Turkish financial markets were not semi strong form efficient. Also, Buguk and Brorsen (2003) tested the random-walk hypothesis for ISE's composite, industrial, and financial index weekly prices using ADF unit root, GPH fractional integration, LOMAC variance ratio, and a modified variance ratio tests for the period 1992-1999. They reported that Turkish stock market was not weak-form efficient.

Jarrett and Kyper (2006) tested NYSE and NASDAQ stock exchanges over a ten-year period from 1992 to 2002. They performed the predictability of daily returns on more than 62 firms listed on American Stock Exchanges and concluded that daily variation exists and is predictable.

Raja and Sudhahar (2010) empirically examined the informational efficiency of capital market with regard to bonus issue announcement released by the IT companies listed in Bombay Stock Exchange (BSE). They stressed that the security prices reacted to the announcement of bonus issue. Indian capital market for the IT sector, in general, are efficient, but not perfectly efficient, to the announcement of bonus issue.

The correlation between financial markets which open up their financial markets to foreign investors and developed markets tends to increase over time. Poterba and Summers (1988) indicated that stock returns show positive autocorrelation over short periods and negative autocorrelation over longer horizons. Gupta and Donleavy (2009) studied the correlations among international markets are changing and increasing over time. They agreed that potential diversification benefits for the Australian investors, if they combines international emerging markets investments in their portfolios. They found correlations within emerging market pairs. Consistent with this opinion, Harrison and Moore (2009) attempted to investigate the degree of comovement between stock exchanges in CEE countries using realized correlations, time-varying unit root tests and recursive cointegration statistics (1990-2006.) Their results showed that there were a relatively weak correlation between stock markets in CEE countries and those in Europe before 2002. Horobet and Lupu also (2009) analyzed the stock markets of five emerging countries from the CEE region Czech Republic, Hungary, Poland, Romania and Russia and contrasted them against four major EU markets – Austria, France, Germany and United Kingdom over the 2003-2007 period, by employing co-integration and Granger causality tests with different data frequencies. They indicated that the markets reacted quite quickly to the information included in the returns on the other markets, and that this flow of information taked place in both directions, from the developed markets to the emerging ones, and vice versa.

In addition to this studies, Savva and Aslanidis (2010) measured time-varying correlations in the stock markets of five CEEC's (Hungary, Czech Republic, Slovakia, Slovenia and Poland) and the euro zone using smooth transition conditional correlation GARCH model during the period 2001-2007. They implied that the correlation between stock markets increased from 2001 to 2007. In particular, the Czech and Polish markets showed a higher correlation to the Euro-zone.

3. Data

Data set consists of stock market indices for BRIC-T countries (Brazil, Russia, India, China and Turkey). The indices are *Bovespa* for Brazil, *Russian Trading System Cash Index (RTSI)* for Russia*, Bombai Stock Exchange Sensex* for India, *Shangai Stock Exchange* (SSE) for China and *Borsa Istanbul National 100 Index* for Turkey. The monthly sample for five countries spans from July 1997 to December 2013 including totaly 198 observations for each countries. All data are being obtained from yahoo.finance data base. Table 1 summarizes the stock markets and their starting date.

Table 1

BRIC-T Stock Exhanges

Country	Stock Exchange	Starting Date
Brazil	Bovespa	27.April.1993
Russia	RTSI Index	01.September.1995
India	Bombai Stock Exchange Sensex	01.July.1997
China	SSEC-Shangai	19.December.1990
Turkey	BIST 100	04.January.1988

Monthly equity index returns were calculated as a log difference between current price and previous period price. Summary statistics for the monthly closing prices are presented in Table 2. The average monthly returns for Brazil, Russia, India. China and Turkey are 0.0070, 0.0053, 0.0080 and 0.0029 and 0.0180 and the standard deviations are 0.0912, 0.1424, 0.0745, 0.0799 and 0.1292 respectively. The lowest mean return is observed in Russia with a value of -0.8245 and highest return is observed in Turkey with a value of 0.5865. Also positive mean return is observed in all stock markets. Standard deviation customarily measures the market risk and is significantly higher in Russia and the lowest in India. All indices are negatively skewed indicating negative shocks are more common than positive for Brazil, Russia, India and China while positive shocks are more common for Turkey. Kurtosis is greater than 3 for all countries expressing a fatter-tailed distribution. According to Jargue-Bera (1987) normality test statistics all returns are not normally distributed.

Table 2

Descriptive Statistics of Logarithms on First Differences for The Stock Market Indices

	Brazil	Russia	India	China	Turkey
Maximum	0.2154	0.4445	0.2488	0.2780	**0.5865**
Minimum	-0.5034	**-0.8245**	-0.2729	-0.2827	-0.4948
Mean	0.0070	0.0053	0.0080	0.0029	0.0180
St. Deviation	0.0912	**0.1424**	**0.0745**	0.0799	0.1292
Skewness	-1.2199	-1.4219	-0.3702	-0.2669	0.1475
Kurtosis	7.7904	9.3018	3.7705	4.6891	6.3183
Jarque-Bera	237.2327	392.36	9.3756	25.7599	91.0995
Probability	0.0000	0.0000	0.0092	0.0000	0.0000

Table 3 presents the correlation matrix of stock returns. All correlation coefficients are positive indicate that all indices move in same direction. The results present that all pair wise correlation coefficients are significant at 1% and 5% level. Correlation coefficients vary from 0.1420 to 0.6557. The highest correlation is between Brazil and Russia (0.6557), while the lowest is between China and Turkey (0.1420). According to results also it can be seen that Turkey, Russia and Brazil are linked among themselves (Brazil-Russia 0.6557; Turkey-Russia 0.5222; Brazil-Turkey 0.4908).

Table 3

Correlation Matrix of Stock Returns

	Brazil	Russia	India	China	Turkey
Brazil	1.0000				
Russia	**0.6557*****	1.0000			
India	0.5187***	0.3877***	1.0000		
China	0.2883***	0.2609***	0.3339***	1.0000	
Turkey	0.4908***	0.5222***	0.3396***	**0.1420****	1.0000

Note: ***, ** mean significance at 1%, and 5%.

4. Research Methodology

According to Fama (1970)'s efficient market theory, weak form of efficiency based on the hypothesis that current stock prices reflect al the information that contained in the historical sequence of prices. This efficiency known as Random Walk Theory rely on the model that continuous stock prices changes are independent and distributed identically. Hence, past activities cannot be used for prediction. In literature, serial correlation and stationarity of time series analysis generally applied to test the presence of random walk theory.

4.1. Autocorrelation Test

Autocorrelation test is a reliable measure for testing of independence of random variables in return series. This test statistic is widely used to notice any perceptible trend in stock prices. Autocorrelation test measures the correlation between series of returns and lagged series and tested whether the correlation coefficients are significantly different from zero. This means the returns of both stock markets are tested whether returns can be characterized by serial dependence.

It measures the correlation between the current (t) and lagged observations (k) of the time series of stock returns, which is defined as:

$$p_k = \frac{\sum_{t=1}^{n-k}(R_t - \bar{R})(R_{t+k} - \bar{R})}{\sum_{t=1}^{n}(R_t - \bar{R})^2} \qquad (1)$$

where p_k is the serial correlation coefficient of stock returns R_t represents the real rate of return.

The Ljung-Box test was proposed by Ljung and Box (1978) and is based on the statistic autocorrelation coefficients. Autocorrelation coefficients define the linear correlation which are between two observations of the returns time series. The Ljung-Box test is identified as:

$$Q_{Ljung-Box} = n(n+2)\sum_{k=1}^{m}\frac{r_k^2}{n-k} \tag{2}$$

where n is the length of the time series, r_k is the kth autocorrelation coefficient of the residuals, m is the number of lags to test and k is the number of parameters estimated in the model. Large values of $Q_{Ljung-Box}$ indicate that there are significant autocorrelations in the residual series.

4.2. Unit Root Test

The market efficiency is also tested, using unit root tests for testing the order of integration. We use the Augmented Dickey Fuller (ADF-1979), Dickey-Fuller Generalised Least Squares (DF-GLS-1996) and Kwiatkowski, Philips, Schmidy and Shin (KPSS-1992) tests. The most commonly used test to examine the existence of a unit root is the Dickey-Fuller test. ADF unit root test of the null hypothesis of nonstationarity is conducted in the form of the following regression equation:

$$\Delta p_{it} = \alpha_0 + \alpha_1 t + \rho_0 p_{it-1} + \sum_{i=1}^{q}\rho_i \Delta p_{it-1} + \varepsilon_{it} \tag{3}$$

where p_{it} denotes the price for the $i-th$ market at time t, $\Delta p_{it} = p_{it} - p_{it-1}$, ρ_0 are coefficients to be estimated, q is the number of lagged terms, t is the trend term, α_1 is the estimated coefficient for the trend, α_0 is the constant, and ε is white noise. MacKinnon's critical values are used in order to determine the significance of the test statistic associated with ρ_0. Using equation (1), the null hypothesis of a unit root is $\alpha_1 = 0$ which is tested against the alternative hypothesis that $\alpha_1 < 0$.

The DF-GLS test is a more powerful test than the Dickey-Fuller test. Because it has the best overall performance in terms of smallsample size and power, dominating the ordinary Dickey–Fuller test. This test proposes a modification to the ADF regression in which data are detrended before the unit root test is conducted. The KPSS test differs from these other unit root tests in that the series is assumed to be (trend) stationary under the null.

4.3. Johansen Cointegration Test

The Johansen (1988) procedure is employed to test for a long-run relationship between the variables. The Johansen procedure allows testing for the cointegration rank for the whole system and therefore can detect indirect channels of stock market linkages.

Johansen and Juselius (1990) consider the following model in the vector autoregression (VAR) of order p given by :

$$\Delta Y_t = \mu + \Gamma_1 \Delta Y_{t-1} + ... + \Gamma_{p-1} \Delta Y_{t-p+1} + \Pi Y_{t-p} + \mu_t \qquad (4)$$

Where Y_t is $px1$ vector containing the variables that are integrated of order one- commonly denoted $I(1)$.

μ_t is the $px1$ vector of constant terms

$\Gamma_i = -I + A_1 + A_2 + ... + A_i (i = 1, 2...p-1)$ is the pxp matrix of coefficients.

$\Pi = \mathrm{I} - \mathrm{A}_1 - A_2 - ... - A_p$ is the pxp matrix of coefficients and μ_t is the $px1$ vector of the distubance terms coefficients (Dritsaki, 2011).

Johansen and Juselius propose two likelihood ratio tests for the determination of the number of cointegrated vectors. One is the maximal eigenvalue test which evaluates the null hypothesis that there are at most r cointegration vectors against the alternative of $r+1$ cointegrating vectors. The maximum eigenvalue ($L-\max$) statistic is given by,

$$\lambda_{\max} = -T \ln(1 - \lambda r + 1) \qquad (5)$$

Where $\lambda\ r+1, ...\lambda n$ are the $n-r$ smallest squared canonical correlations and T = the number of observations.

the trace (Tr) test shown in equations (6) ;

$$\lambda_{trace} = -T \Sigma \ln(1 - \lambda i) \qquad (6)$$

In order to apply the Johansen procedure, a lag length must be selected for the VAR. A lag length of one is selected on the basis of the Akaike Information Criterion (AIC)

4.4. Granger Causality Test

Granger (1969) proposed a time-series data based approach in order to determine causality. The Granger causality test estimates the pair regressions as below.

$$y_t = \beta_{1,0} + \sum_{i=1}^{p} \beta_{1,i} y_{t-i} + \sum_{j=1}^{p} \beta_{1,p+j} x_{t-j} + \varepsilon_{1t} \qquad (7)$$

$$x_t = \beta_{2,0} + \sum_{i=1}^{p} \beta_{2,i} y_{t-i} + \sum_{j=1}^{p} \beta_{2,p+j} x_{t-j} + \varepsilon_{1t} \qquad (8)$$

where p is the number of lags that adequately models the dynamic structure so that the coefficients of further lags of variables are not statistically significant and the error terms ε are white noise. If the p parameters $\beta_{1,p+j}$ are jointly significant then the null that x does not Granger cause y can be rejected. If the p parameters $\beta_{2,i}$ are jointly significant then the null that y does not Granger cause x can be rejected. Engle and Granger (1987) introduced the notion of cointegration and tied it closely to the VAR model.

4.5. Empirical Findings

Table 4 exhibits the autocorrelation coefficients, in other words serial independence of stock returns for 32 lags. P-values are shown in parentheses. The results indicate autocorrelation coefficients are statistically significant for Russia and China but not for all lags. The the null hypothesis of no autocorrelation is accepted for Brazil, India and Turkey, while rejected for Russia and China. Therefore stock returns of Brazil, India and Turkey follow in weak efficiency form and satisfy random walk theory.

Table 4

Autocorrelation Coefficients and Ljung-Box Q Statistics for Stock Returns

Lags	**Brazil**		**Russia**		**India**		**China**		**Turkey**	
	AC	Q	AC	Q	AC	Q	AC	Q	AC	Q
1	-0.003	0.0013 [0.971]	0.215	9.2237 **[0.002]**	0.050	0.4945 [0.482]	0.056	0.6302 [0.427]	-0.024	0.1167 [0.733]
2	0.017	0.0605 [0.970]	-0.011	9.2487 **[0.010]**	0.059	1.1831 [0.553]	0.177	6.9038 **[0.032]**	0.002	0.1177 [0.943]
4	0.084	1.5670 [0.815]	0.137	16.481 **[0.002]**	0.059	2.2416 [0.691]	0.181	13.766 **[0.008]**	-0.005	2.2610 [0.688]
8	-	7.526	-	22.05	-	4.514	0.01	18.24	-	5.492

	0.053	1 [0.481]	0.012	5 **[0.005]**	0.092	0 [0.808]	5	8 [0.019]	0.065	9 [0.704]
16	-0.005	18.220 [0.311]	-0.069	25.171 **[0.067]**	-0.057	10.228 [0.854]	-0.060	33.115 **[0.007]**	-0.116	17.007 [0.385]
32	-0.054	28.387 [0.650]	-0.028	36.046 [0.285]	0.045	18.539 [0.972]	-0.098	52.916 **[0.011]**	-0.056	37.211 [0.242]

Notes: AC:Autocorrelation Coefficients
Q : Ljung-Box Q Statistics

The unit root tests should be applied to determine whether the time series are stationary in levels or in their first difference. Augmented Dickey Fuller (ADF-1979), Kwiatkowski, Philips, Schmidt and Shin (KPSS-1992) and Dickey-Fuller Generalized Least Squares (DF-GLS-1996) tests are employed to estimate the presence of unit root in stock prices. Table 5 shows the results of ADF, DF-GLS and KPSS tests at logarithmic level and first differences for intercept and intercept and trend. All null hypothesis of ADF and DF-GLS (H_0: There is unit root in time series) and KPSS (H_0: Time series is stationary) are cannot be accepted. According to results, all stock indices (except China) are integrated I(1). In other words all stock prices are non-stationary in levels and become stationary at first differences. This finding supports the random walk process and gives evidence of stochastic process.

Table 5

Unit Root Tests of Stock Price Indices

Levels						
	Intercept			**Intercept and Trend**		
	ADF	**DF-GLS**	**KPSS**	**ADF**	**DF-GLS**	**KPSS**
Brazil	-1.1982 (1)	-0.3862 (1)	1.5633 (11)	-2.1400 (1)	-1.9999 (1)	0.1802 (10)
Russia	-1.4083 (1)	-1.0499 (1)	1.3232 (11)	-2.4693 (1)	-2.1424 (1)	0.1597 (10)

India	-0.2724 (0)	0.5791 (0)	1.5991 (11)	-2.5961 (0)	-1.8264 (0)	0.1979 (10)
China	-2.6445 (6)*	-1.8798 (6)*	0.6762(11)***	-2.9804 (6)	-3.0039 (6)**	0.1064 (10)*
Turkey	-0.8041 (0)	0.4211 (0)	1.6207 (11)	-2.9775 (0)	-2.6980 (0)**	0.1418(10)***
First Differences						
	Intercept			**Intercept and Trend**		
	ADF	**DF-GLS**	**KPSS**	**ADF**	**DF-GLS**	**KPSS**
Brazil	-11.7617 (0)***	-4.3084 (2)***	0.0845 (5)***	-11.7384 (0)***	-10.4872 (0)***	0.0816 (5)***
Russia	-11.2883 (0)***	-10.7808 (0)***	0.0628 (5)***	-11.2592 (0)***	-11.1511 (0)***	0.0633 (5)***
India	-13.8353 (0)***	-3.9542 (3)***	0.0959 (6)***	-13.8375 (0)***	-13.2788 (0)***	0.0441 (6)***
China	-7.5275 (1)***	-7.4899 (1)***	0.0493 (8)***	-7.5232 (0)***	-7.5401 (1)***	0.0376 (8)***
Turkey	-14.5537 (0)***	-14.2699 (0)***	0.0408 (1)***	-14.5155 (0)***	-13.5539 (0)***	0.0344 (1)***

Notes:
1.***, ** ,* mean significance at 1%, 5%, 10% respectively.
2. The numbers within parenthesis represent lag length.

With use of Johansen cointegration procedure we try to investigate the existence of long run relationship between the BRIC-T countries' stock markets (Stock prices are integrated in first difference). A model of two or more time series, which are non-stationary in levels and have individual stochastic trends, can share common stochastic trend; in this case those series are accepted be cointegrated (Hammoudeh et al, 2004). We use Akaike Information Criterion and Schwarz Information Criterion to estimate optimal lag length in VAR model. After VAR model we applied Johansen cointegration approach The Johansen cointegration results are displayed in Table 6. We found relationships between India and China, also Turkey and China. Our findings indicate there is at most 1 cointegration among all countries. In long run, it can be seen that there is long run relationship between India-China and Turkey-China.

Table 6

Johansen Cointegration Test

Null Hypothesis	Trace Statistic	Max-Eigen Statistic	5% Critical Values	
			Trace	Max-Eigen
Brazil-China (1to10)				
r = 0	13.1962	12.6226	15.4947	14.2646
r ≤ 1	0.5736	0.5736	3.8414	3.8414
Brazil-India (1to10)				
r = 0	7.0755	5.5892	12.3209	11.2248
r ≤ 1	1.4862	1.4862	4.1299	4.1299
Brazil-Russia (1to2)				
r = 0	4.5486	4.4887	12.3209	11.2248
r ≤ 1	0.0599	0.0599	4.1299	4.1299
Brazil-Turkey (1to2)				
r = 0	3.7613	3.6757	12.3209	11.2248
r ≤ 1	0.0856	0.0856	4.1299	4.1299
Russia-India (1to9)				
r = 0	8.9439	8.7357	12.3209	11.2248
r ≤ 1	0.2081	0.2081	4.1299	4.1299
Russia-China (1to12)				
r = 0	16.9603	14.3362	20.2618	15.8921
r ≤ 1	2.6241	2.6241	9.1645	9.1645
Russia-Turkey (1to2)				
r = 0	7.4184	6.9829	12.3209	11.2248
r ≤ 1	0.4354	0.4354	4.1299	4.1299
India-China (1to9)				
r = 0	**30.6593**	**25.8721**	**21.4354**	**19.3870**
r ≤ 1	9.2238	12.5179	9.2238	12.5179
India-Turkey (1to1)				
r = 0	8.9495	12.3209	7.8665	11.2248
r ≤ 1	1.0830	4.1299	1.0830	4.1299

China-Turkey (1to10)				
r = 0	**31.3519**	**22.0158**	**25.8721**	**19.3870**
r ≤ 1	9.3360	9.3360	12.5179	12.5179
All Countries (1to10)				
r = 0	**109.2078**	**41.9018**	**79.3414**	**37.1635**
r ≤ 1	**67.3059**	**37.9979**	**55.2457**	**30.8150**
r ≤ 2	29.3079	17.7426	35.0109	24.2520
r ≤ 3	11.5653	8.5652	18.3977	17.1476
r ≤ 4	3.0001	3.0001	3.8414	3.8414

Notes: The numbers within parenthesis represent lag length.

According to Granger (1969, 1988), causality test helps us to determine the causality direction between two time series and if there exists a cointegration vector among variables, there is at least one direction between variables are concerned in the model. After cointegration test, we employed Granger causality test to first differences of stock prices. Akaike Information Criterion is used to determine the optimal number of lags. According to Table 7, there are unilateral causality between China and India (5%), Russia and India (5%), Brazil and India (5%), Brazil and Russia (1%), Brazil and Turkey (1%) while there is a bilateral causality relationship between Turkey and India.

Table 7

Granger Causality Test (Lag=2)

Null Hypothesis:	**F-Statistic**	**Probability**
INDIA does not Granger Cause CHINA	0.85453	0.4271
CHINA does not Granger Cause INDIA	**3.24312**	**0.0412**
RUSSIA does not Granger Cause CHINA	0.57307	0.5648
CHINA does not Granger Cause RUSSIA	1.00560	0.3678
TURKEY does not Granger Cause CHINA	0.97717	0.3783
CHINA does not Granger Cause TURKEY	0.28195	0.7546
BRAZIL does not Granger Cause CHINA	1.12164	0.3279
CHINA does not Granger Cause BRAZIL	0.93726	0.3935
RUSSIA does not Granger Cause INDIA	**2.99925**	**0.0522**
INDIA does not Granger Cause RUSSIA	1.82733	0.1637
TURKEY does not Granger Cause INDIA	**3.21798**	**0.0422**
INDIA does not Granger Cause TURKEY	**2.34438**	**0.0987**

BRAZIL does not Granger Cause INDIA	**3.31338**	**0.0385**
INDIA does not Granger Cause BRAZIL	1.41264	0.2460
TURKEY does not Granger Cause RUSSIA	1.02930	0.3592
RUSSIA does not Granger Cause TURKEY	2.12649	0.1221
BRAZIL does not Granger Cause RUSSIA	**5.11365**	**0.0069**
RUSSIA does not Granger Cause BRAZIL	0.81291	0.4451
BRAZIL does not Granger Cause TURKEY	**7.68324**	**0.0006**
TURKEY does not Granger Cause BRAZIL	0.10042	0.9045

Notes: Series are at first difference level.

5. Result and Conclusion

Particularly after financial crisis in late 1990s, BRIC economies have become powerful emerging countries in the world. BRICs are already major players n the world economy and their role is only likely to increase over time. According to IMF's 2015 predictions BRICs will be accounted for approximately 41.8 per cent of world's population, 21.6 percent of world's GDP, 20.1 per cent of world's export and 18.8 per cent of world's import (IMF, 2011). Nowadays BRICs are assumed to be at a similar level of newly advanced economic development. Besides BRIC countries, Turkey's economy with over 8 percent annual growth rate in 2010 and 2011 was the one of fastest growing economy in the world. Because of being major players in the world economy, our motivation has conducted on these integrations' stock markets.

In this study we examine the stock market efficiency or the random walk hypothesis in Brazil, Russia, India, China (BRIC) and Turkey stock markets applying analysis of autocorrelation, unit root tests, Johansen cointegration and Granger causality. Monthly data covers the period from July 1997 to December 2013.

Our findings indicate the efficiency among the BRIC-T stock markets in the weak form. Weak form of market efficiency implies that technical analysis cannot be used to predict future price movements and investors cannot earn excess return in BRIC-T markets. In other words investors cannot obtain abnormal returns from transactions in the markets.

According to autocorrelation test, we found an evidence of weak efficiency form in Brazil, India and Turkey. Unit root test results confirm these findings. The cointegration test for the indices indicate that there are long run relationships between India and China and Turkey and China. This means that in long run India and China and Turkey and China move together.

Causality test presents that there is a bidirectional relationship between Turkey and India's stock markets that Turkey is the India's Granger cause in 5% level of significance while India is the Turkey's Granger cause in 10% level of significance. Also we find unidirectional causal relationships between China and India stock markets in 5% level of significance (direction is from China to India), Russia and India stock markets in 5% level of significance (direction is from Russia to India), Brazil and India stock markets in 5% level of significance (direction is from Brazil to India), Brazil and Russia stock markets in 1% level of significance (direction is from Brazil to Russia) and Brazil and Turkey stock markets in 1% level of significance (direction is from Brazil to Turkey).
In all, we believe our study improves our knowledge of weak form efficiency with use of traditional techniques. We hope our empirical findings could be useful for policy maker, managers and investors who need information to understand the behavior of stock market efficiency. Future researchers could eliminate some of our limitations, carry over with an extended sample and apply more comprehensive methods.

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