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The Day of the Week Effect in Stock Market Returns and Volatility : Evidence from BRIC Markets

Deepa Mangala* and Vandana Lohia**

** HSB, GJUS&T, Hisar*

*** HSB, GJUS&T, Hisar*

Abstract

Calendar anomalies may be defined as seasonalities or consistent patterns observed in stock returns that are not explained by any acceptable theory of finance. The primary objective of this paper is to investigate the day-of-the-week effect in returns and volatility of the BRIC stock markets namely Brazil, Russia, India and China. Daily return data of the selected indices for the period spanning from July 1997 to August 2011 has been used for the analysis. The empirical study was conducted using GARCH (1, 1) model. The results of the study exhibit existence of Wednesday and Thursday effect in the mean return of Russian and Chinese stock markets respectively. Seasonality is also evident in the stock return volatility in all the four emerging stock markets.

Key Words

EMH, Seasonality, Day-of-the-Week Effect, Dummy Variable, GARCH Model, BRIC Economies.

INTRODUCTION

Fama (1970) presented the famous efficient market hypothesis, stating that stock prices reflect all available private and public information regarding the value of the firm, and thus, no investor can make superior profit by having access to this information. The efficient market hypothesis paved new ways to investigate the randomness of stock prices. Since then various studies have been conducted to challenge the validity of efficient market hypothesis by documenting anomalous behavior of market and linking it with recurring periods of time. Calendar anomalies

may be defined as the tendency of stock returns to display consistent and systematic patterns at certain times of the day, week, month and year. Number of anomalies have been discovered and remain a matter of interest for researchers. Day-of-the-week effect occurs when stock returns are unidentically distributed across various days of the week. This effect states that financial assets return keep on changing and vary from day to day.

The present study investigates the existence of the day-of-the-week effect in stock index returns and volatility of BRIC markets. BRIC is an acronym that refers to the countries of Brazil, Russia, India and China, which are at a similar stage in their economic development. These four countries have experienced a huge growth and it is expected that, by the year 2050, the combined economies of BRIC nations could become among the four most dominant economies of the world. In fact, Goldman Sachs believes that by 2050 these will be the most important economies, leaving behind the US to fifth place. Brazil, Russia, India and China are today bigger than ever before and they play an essential role in the current world. They have become the favourite investment destination for FIIs and institutional investors the world over. It is, therefore, of vital importance to study the stock price behavior of these emerging super powers which might provide useful insight to institutional investors, portfolio managers and individual investors to strategise their investment decisions and diversify their portfolios internationally.

REVIEW OF LITERATURE

Stock market anomalies have been extensively investigated the world over and there have been divergent views on their existence. Some of the important theoretical and empirical studies related to day-of-the-week effect have been reviewed here. Cross (1973) studied the returns on S&P index for a period of eighteen years and found that the mean return on Friday was higher than the mean return on Monday. It was attributed as 'Monday Effect'. French (1980) examined the process that generates stock returns and found that the mean return for Monday was significantly negative, while the mean returns for the other days of the week were positive. Gibbons and Hess (1981) further examined the individual stocks and treasury bills returns in the U.S. They found Monday returns to be significantly negative. Further, the study of market-adjusted returns exhibited that day-of-the-week effect was not concentrated on Monday.

Rogalski (1984) employed intra-day data to provide additional insight into the weekend effect. It was found that all the average negative returns from Friday close to Monday close occurred mainly during the non-trading period. Jaffe and

Westerfield (1985) examined the stock market returns for four countries, namely U.K., Japan, Canada and Australia. They found the existence of day-of-the-week effect in each country. Miller (1988) found that the returns tend to be negative from Friday close to Monday close. The possible explanation was that the sell orders were more frequent on Monday than buy orders and this pattern reversed later in the week.

Chaudhury (1991) examined the existence of anomalous price behavior in the Indian stock market. He observed that the average return on Monday was indeed negative but Tuesday marked still higher level of mean negative return. Broka (1992) examined daily closing values of BSE National index and found that the mean daily returns were lowest (negative) on Wednesday and they rose to peak on Friday. Tang (1993) studied the existence of day-of-the-week effect in weekly data. The black Monday effect was reconfirmed by him.

Agarwal and Tandon (1994) examined five seasonal patterns in stock markets of eighteen countries: the weekend, turn-of-the-month, end-of-December, monthly and Friday-the-thirteenth effects. They found a daily seasonal in nearly all the countries, but a weekend effect in only nine countries. Brooks and Persand (2001) investigated the evidence for a day-of-the-week effect in five Southeast Asian stock markets : South Korea, Malaysia, Philippines, Taiwan and Thailand. Friday indicates significant seasonality for three of the five markets. Sarma (2004) explored the day-of-the-week effect on the Indian stock market returns in the post-reform era. He analyzed that the Indian stock markets do manifest seasonality in their returns' pattern. Aly, Mehdian and Perry (2004) investigated day-of-the-week effect in the Egyptian stock market. The study indicates that Monday returns in the Egyptian stock market are positive and significant on average, but are not significantly different from returns of the rest of the week.

Gao and Kling (2005) examined the calendar effect in Chinese stock market, particularly monthly and daily effects. They found that Mondays are weak trading days compared to the rest of the week. However, only Fridays exhibit significant results. Wong, Agarwal and Wong (2006) investigated the January effect, day-of-the-week effect, turn-of-the-month effect and holiday effect in the Singapore stock market over the period from 1993-2005. They found that these anomalies have largely disappeared from the Singapore stock market.

Bundoo (2008) investigated the day-of-the-week effect and January effect on the Stock Exchange of Mauritius (SEM) for the period January 2004 to December 2006. Positive and statistically significant Wednesday and Friday effect are observed. Selvarani and Janefa (2009) investigated the existence of a day-

of-the-week effect, financial year effect (April effect) in the NSE indices by analyzing the trends in annual returns and daily returns for the period 2002-07. They found that month-of-the-year effect is found more prevalent than the day-of-the-week effect in India. Muhammad and Rehman (2010) analyzed the data of Kuala Lumpur Composite Index (KLCI) from 4th January 1999 to 29st December 2006 to measure the day of the week effect in Malaysian stock market. Using dummy variable regression model, the study concluded that the Malaysian stock market was characterized by the presence of day of the week effect (Monday effect). Suman and Chahal (2011) analyzed the data of BSE Sensex from January 1999 to May 2010 to explore the day of the week effect on Bombay Stock Exchange (BSE) of India. Applying parametric and non-parametric tests, they found empirical evidence on day of the week effect in BSE volatility but not in returns. The present study is also an attempt in the same direction. The basic objective of the paper is to investigate the existence of the day-of-the-week effect in index returns and volatility of BRIC economies which have assumed an important place in the world economy and are considered as the future growth engines. The present study is an attempt to improve as it covers a very recent and longer time period.

RESEARCH METHODOLOGY

The objective of this paper is to examine the existence of day-of-the-week effect in BRIC (Brazil, Russia, India and China) stock markets. Table 1 presents the country wise details about the index used, reference period and source of data.

Table 1
Data Table

Country	Index	Period	Source
Brazil	BVSP INDEX (BOVESPA SAO PAULO Stock Exchange)	Jan. 1997 to Aug. 2011	Yahoo Finance
Russia	RTSI (RTS Exchange)	Jan. 1997 to Aug. 2011	www.rts.ru
India	BSE SENSEX (BSESN)	July 1997 to Aug. 2011	Yahoo Finance
China	SSE (Shanghai Stock Exchange)	Jan. 2000 to Aug. 2011	Yahoo Finance

The daily stock returns for the selected stock indices are calculated as follows :

$$R_t = \ln (P_t / P_{t-1}) * 100$$

Where R_t is daily return on the share price index for day t, Pt is the closing value of the index for the day t and P_{t-1} is the closing value of the index for the preceding day t–1.

To test empirically the existence of day-of-the-week effect in BRIC stock markets the following null hypotheses have been tested :

H_{01} : The mean daily stock returns across all the trading days of the week are statistically equal.

H_{02} : The volatility of daily stock returns across all the trading days of the week is statistically equal.

H_{03} : The mean daily return of every trading day of the week is not statistically different from the mean returns of rest of the days of the week.

Firstly, the summary statistics of the daily returns of the selected indices have been calculated, namely, mean, standard deviation, skewness and kurtosis. Jarque-Bera (JB) test of normality has been applied to the index return series. The non-parametric Kruskall-Wallis (H) test has been applied to test the first hypothesis of equality of mean daily returns across all the trading days of the week. The value of H is calculated by formula :

$$H \quad \frac{12}{N(N \quad 1)} \quad \sum_{i \ 1}^{k} \frac{R_j^2}{n_j} \quad 3(N \quad 1)$$

Where k is the number of samples, n_j is the number of values in the j^{th} sample, N is the total number of values and R_j is the sum of ranks in the sample. The calculated H value has been compared with the table value of the chi-square (x^2) distribution with (k – 1) degree of freedom. If the calculated H value is greater than (x^2) the null hypothesis is rejected and vice-versa. Levene's F-statistics has been computed to examine the second hypothesis of equality of variances across the trading days of the week. The Levene's F-statistics used here is :

$$W \quad \frac{N \quad K}{(K \quad 1)} \quad \frac{\sum_{i \ 1}^{k} N_i (z_i \quad z_j)^2}{\sum_{i \ 1}^{k} \sum_{j \ 1}^{N_i} Z_{ij} \quad Z_i^{\ 2}}$$

Where : W = the result of Levene's-statistics,

K = the is the number of different groups to which the samples belong,

N = total number of observations,

N_i = number of samples in the ith group,

Y_{ij} = value of the jth sample from the ith group,

$Z_{ij} = \begin{Bmatrix} |Y_{ij} \quad \hat{Y}_i| \\ |Y_{ij} \quad \hat{Y}_j| \end{Bmatrix}$, $\hat{Y}_i$ is a mean of i–th group, is a median of i-th group

Further, the Mann-Whitney U test has been applied to test the third hypothesis that the mean daily return of every trading day of the week is statistically different from the mean returns of other days of the week. The Mann-Whitney U-test is calculated as follows :

$$Z = \frac{U - m_u}{\sigma_2}$$

Where m_u and σ_u are the mean and standard deviation of U, n_1 is the sample size for sample 1and n_2 is the sample size for sample 2. m_u and σ_u are given by :

$$\sigma_u = \sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}} \qquad m_u = n_1 + n_2 / 2$$

$\hat{Y}_{I\,j}^{\,4}{}_{\,1}$

The following dummy variable regression model has been applied to examine the existence of the day-of-the-week effect by a number of researchers.

$$R_{it} = \beta_1 D_{1t} + \beta_2 D2t + \beta_3 D_{3t} + \beta_4 D_{4t} + \beta_5 D_{5t} + \varepsilon_t$$

Where R_{it} is the return of the index on month t, D_{jt} is the dummy variables which take on the value 1 if the corresponding return for day t is a Monday, Tuesday, Wednesday, Thursday or Friday, respectively and 0 otherwise, β_j is the coefficient which represent the average return for each day of the week and ?t is the error term. But this model suffers from two serious problems. Firstly, errors in the model may be auto-correlated, resulting in misleading inferences. Secondly, error in variance may not be constant over time, which means Heteroscedasticity. In order to account for the auto-correlation problem, we introduced the return with a one week delay into the regression model as used in the work by Berument and Coskun (2007), Corredor and Santamaria (1996) and Apolinario and Santana (2006), among others.

$$R_{it} = \beta_1 D_{1t} + \beta_2 D_{2t} + \beta_3 D_{3t} + \beta_4 D_{4t} + \beta_5 D_{5t} + \qquad \beta_{j+5}\, r_{t-j} + \varepsilon_t$$

In order to consider the second problem, the study adopts Engle (1982) autoregressive conditional heteroskedasticity (ARCH) models. These models assume that the variance of residuals (σ_t^2) is not constant over time. The generalized version of these models was proposed by Bollerslev (1986), where the variance

of the residual is expressed as the sum of a moving-average polynomial of order q on past residuals (the ARCH term) plus an autoregressive polynomial of order p, on vast variance (the GARCH term) :

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{a} \alpha_1 + \sum_{t=i}^{2} + \sum_{i=1}^{\gamma} \chi_1 + \sigma_{t-1}^2$$

To measure the day of the week effect on the volatility of underlying stock markets, the dummy variables have been introduced in the above equation which account for the possible stationary effects within the equation of variance. The result of this approach is that joint estimates of the day of the week effects are obtained, not only in the mean but also in the variance.

$$\gamma_{it} = \beta_1 D_{1t} + \beta_2 D_{2t} + \beta_3 D_{3t} + \beta_4 D_{4t} + \beta_5 D_{5t} + \quad {}_{j\ 1}^{4}\ \beta_{j+5}\ r_{t-j} + \varepsilon_t$$

$$\varepsilon_t \sim \text{iid}\ (0, \sigma_t^2)$$

$$\sigma_t^2 = \beta_1 D_{1t} + \beta_2 D_{2t} + \beta_3 D_{3t} + \beta_4 D_{4t} + \beta_5 D_{5t} +$$

$${}_{i\ 1}^{q}\ \alpha_{5+1} \quad {}_{t-1}^{2} \quad +$$

Before using time series in the GARCH model it is a precondition that the series must be stationary. So to ensure the stationarity in the series Unit root test has been applied. The Augmented Dickey-Fuller (ADF) unit root test is used for this purpose. The ADF regression used here is :

${}_{i\ 1}^{p} Y_t \quad {}_{t-i}^{2}$

$$\Delta Y_t = b_0 + \delta Y_{t-1} + \alpha_1 \Delta Y_{t-1} + \alpha_2 \Delta Y_{t-2} + \text{---------} + \alpha_p \Delta Y_{t-p} + e_t$$

(Minimum AIC is used to determine numbers of lags)

RESULTS AND DISCUSSION

The descriptive statistics of daily stock returns of BRIC stock markets is presented in Table 2. All the stock return series record a positive mean return during the study period. Brazil records the highest mean return of 0.0577 per cent closely followed by Russia (0.0568 per cent), India (0.0386 per cent) and China (0.0201 per cent) respectively. The higher returns for Brazil are also accompanied by higher value of standard deviation (4.4186) in comparison to standard deviation of Russia (2.7352), India (1.7222) and China (1.6332). All countries except Brazil record negative skewness which indicates the elements of persistency in the returns of the underlying stock indices. The value of kurtosis is greater than 3 in all the index return series which implies that the returns series have heavier tails than the standard normal distribution. The JB (Jarque-Bera) statistics is used to test the normality of a time series data. The computed values of JB statistics are significant at one per cent level for all the indices thus rejecting the null hypothesis of normality of index return distribution.

Table 2
Descriptive Statistics of Daily Stock Returns of BRIC Stock Markets Indices

Descriptive	Brazil	Russia	India	China
Mean	0.0577	0.0568	0.0386	0.0201
Std. Dev.	4.4186	2.7352	1.7222	1.6332
Skewness	8.1748	-0.4673	-0.0932	-0.1138
Kurtosis	19.009	10.479	8.2567	7.3784
Jarque-Bera	592.08*	8653.07*	4038.34*	2391.64*
Probability	0.0000	0.0000	0.0000	0.0000
Observations	3629	3655	3503	2986

* Significant at 1% level

Since the result of normality tests indicates that the distributions of return series are not normal, the non-parametric tests, namely the Kruskal-Wallis (H) and Levene's F-Statistics have been used to examine the equality of mean returns across weekdays and for the equality of variances across different days of the week. The results of K-W (H) statistics and Levene's F-statistics are presented in the Table-3. It is observed that the mean returns are not uniformally distributed in case of Russia and China. The null hypothesis of equality of mean returns across various days of the week stands rejected at 5 per cent level of significant indicating the presence of day of the week effect in Russian and Chinese stock markets. The Levene's F-statistics indicates that except Russia, rest of the three stock markets, namely, Brazil, India and China record a statistically significant variation in volatility across various days of the week. This gives a strong evidence of existence of seasonality in volatility across weekdays.

To further examine the nature of seasonality Mann-Whitney U-test has been used to investigate whether the mean return of a particular day is statistically different from the mean return of the rest of the days of the week. The results in Table 4 indicate that in Russia, Wednesday records significant negative mean return, different from mean returns of the rest of the days of the week. In case of India, Monday mean return is significantly different from the mean return of the rest of the days of the week but it is not significant enough to create seasonality in the overall return distribution. Mean Monday and Thursday returns are significantly different from the mean return of the rest of the days of the week in the Chinese stock market. Monday mean return is significantly higher than the mean return of the rest of the days whereas Thursday mean return is significantly lower than the mean return of the rest of the days of the week. Mean returns of Brazil is uniformly distributed across week days.

Table 3

Day-Wise Descriptive of Daily Stock Returns of BRIC Stock Markets Indices

Countries	Descriptive	Mon	Tues	Wed	Thu	Fri	K-W(H) Statistics	K-W(H) Statistics
Brazil	Mean	-0.0724	0.1560	0.1183	0.1219	0.2002	7.9172	7.9172
	Std. Dev.	2.3920	1.7857	2.1650	2.3636	2.1998	(0.0946)	(0.0946)
	Observations	725	722	744	719	719		
Russia	Mean	0.1033	0.0125	-0.1278	0.0883	0.2005	7.9774*	7.9774*
	Std. Dev.	2.8995	2.7052	2.8199	2.7818	2.4920	(0.0492)	(0.0492)
	Observations	690	736	742	738	721		
India	Mean	0.1209	0.0168	0.1020	-0.0071	-0.0408	6.5074	6.5074
	Std. Dev.	2.0531	1.5477	1.5921	1.5700	1.7963	(0.1643)	(0.1643)
	Observations	702	704	704	704	689		
China	Mean	0.1299	0.0425	0.0961	-0.1088	0.0266	10.561*	10.561*
	Std. Dev.	1.9715	1.5143	1.6106	1.5590	1.4576	(0.0319)	(0.0319)
	Observations	592	601	601	596	596		

Figures in the parenthesis denote the respective p-values.

*significant at 5% level, **significant at 1% level.

Table 4
Results of Mann-Whitney U-test

Countries	Days	Mean Difference	Z-value	P-value
Brazil	Mon	-0.0833	-1.9441	0.0621
	Tue	-0.1876	-0.6222	0.5342
	Wed	0.1560	-0.9423	0.3460
	Thu	-0.1448	-1.3571	0.1752
	Fri	0.2568	-1.7311	0.0841
Russia	Mon	0.1160	-1.4736	0.1410
	Tue	-0.0518	-1.3402	0.1802
	Wed	-0.2285	-1.9901*	0.0473
	Thu	0.0432	-0.6161	0.5381
	Fri	0.1830	-1.2923	0.1963
India	Mon	0.1029	-2.2423*	0.0251
	Tue	-0.0273	-0.5351	0.5922
	Wed	0.0793	-0.5228	0.6023
	Thu	-0.0573	-0.9701	0.3324
	Fri	-0.0989	-1.2671	0.2055
China	Mon	0.1369	-2.3180*	0.0201
	Tue	-0.0784	-0.3022	0.7631
	Wed	0.0951	-0.8051	0.3955
	Thu	-0.1611	-2.4381*	0.0151
	Fri	0.0080	-1.0304	0.3033

* Significant at 5% level

It may be inferred that the seasonality in mean returns across weekdays in Russia and China as indicated from the K-W (H) statistics (Table 3) is primarily because of significantly returns on Wednesday in Russian and on Monday and Thursday in Chinese stock markets.

In order to apply the GARCH model the stationarity of the index return series has been measured using Augmented Dickey Fuller (ADF) test. The results of the test in Table 5 confirm that the return series of Brazil, India, Russia and China are stationary at 1 per cent level it means they are integrated of zero order i.e. I (0).

Table 5

Results of Augmented Dickey Fuller Test

Variable	ADF Test Statistic With Intercept	ADF Test Statistic With Trend & Intercept
Brazil data series	-59.8148*	-59.8310*
Russia data series	-52.4011*	-52.3939*
India data series	-55.0478*	-55.0458*
China data series	-53.3222*	-53.3148*

* Significant at 1% level

Critical values for Intercept -3.4319(1% level), -2.8621 (5% level), -2.5671(10% level)

Critical values for Trend & Intercept -3.9606(1% level), -3.9606 (5% level), -3.1273(10% level)

The results of the GARCH estimations in mean equation are presented in Table-6. The Russian stock market depicts a Wednesday effect as evident from the significantly negative mean coefficient (-1.9091). On the other hand, the Chinese stock market exhibits a Thursday effect as indicated by significantly negative

Table 6

The Day-of-the-Week Effect in GARCH (1, 1) Model (Estimates of Mean Equation)

Countries		Mon (β_1)	Tues (β_2)	Wed (β_3)	Thur (β_4)	Fri (β_5)
Brazil	Coefficient	-0.0885	-0.1862	0.1572	-0.1441	0.2583
	t-value	-0.4673	-0.9853	0.8408	-0.7608	1.3658
	p-value	0.6403	0.3245	0.4005	0.4468	0.1721
Russia	Coefficient	0.0558	-0.0511	-0.2267	0.0429	0.1861
	t-value	0.4539	-0.4272	-1.9091*	0.3583	1.5458
	p-value	0.6499	0.6692	0.0501	0.7200	0.1222
India	Coefficient	0.1036	-0.0274	0.0792	-0.0574	-0.0988
	t-value	1.4038	-0.3721	1.0753	-0.7788	-1.3323
	p-value	0.1604	0.7098	0.2823	0.4361	0.1828
China	Coefficient	0.1311	-0.0767	0.0957	-0.1586	0.0097
	t-value	1.6635	-0.9784	1.2238	-2.0305*	0.1238
	p-value	0.1963	0.3279	0.2211	0.0424	0.9015

Figures in the parenthesis denote the respective p-values.

*significant at 5% level, **significant at 1% level.

mean coefficient (-2.0305). As far as India and Brazil are concerned none of the regression coefficient is statistically significant indicating the non-existence of day of the week effect in mean return distribution of Indian and Brazilian stock markets. The results of the model confirm the results of summary statistics and the non-parametric tests.

The structure of volatility as measured by ARCH and GARCH components in the variance equation is reported in Table-7. It may be observed that the past news as indicated by GARCH (1) as well as the recent news indicated by ARCH (1) coefficient have a positive and significant bearing on the volatility of the returns of the underlying stock market indices. The magnitude of the coefficient of GARCH (1) is comparatively higher than that obtained in case of ARCH (1) which implies that the historical information affects the stock market in a significant way and shocks to conditional variance take a long time to die out in stock markets.

In case of Brazil it is evident that volatility is significantly low on Friday as indicated by the negative sign of the coefficient. The results indicate significant and higher volatility on Monday and Tuesday and low on Friday in Russia. In case of India volatility is significantly high on Monday and low on Wednesday and in Chinese stock market Monday records significant and higher volatility and Friday registers low volatility.

Friday records statistically significant low volatility in three out of four stock markets investigated namely Brazil, Russia and China. This implies that end of the trading week is marked by lower level of price fluctuations attributable to the two days long non-trading weekend. Monday exhibits significantly high volatility in all the stock markets except Brazil. Thus, it may be inferred that the trading week commences with higher level of volatility.

CONCLUSION

The assumption that stock prices are random is basic to efficient market hypothesis. There has been an ongoing progress in research in the field of market efficiency and the related anomalies. The present paper made an attempt to examine the existence of day-of-the-week effect in stock index returns and volatility of BRIC (Brazil, Russia, India and China) stock markets. Indian and Brazilian stock markets did not exhibit any significant evidence for the presence of day-of-the-week anomaly in return series whereas Chinese and Russian stock markets record statistically significant negative Thursday and Wednesday effect respectively. All the stock markets under investigation exhibit seasonality in volatility of stock return distributions across weekdays as indicated by the results of the variance

equation of GARCH model. The trading week commences (Monday) with a significantly high level of volatility whereas the close of the trading week, i.e., Friday is marked by lower levels of volatility. The results of the study indicate the presence of day of the week seasonality in both the stock return series and volatility, though the timing of the seasonality is not identical in all the investigated stock markets. The results of the study may help the investors to take advantage of relatively regular shifts in the market and strategise their investment decisions accordingly.

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