Business and Management Review Vol. 3(09) pp. 31 – 38 July, 2014 ISSN: 2047 - 0398
Available online at http://www.businessjournalz.org/bmr

# THE "WEEK-DAY EFFECT" ANOMALY IN THE BEHAVIOR OF STOCK INDEX RETURNS OF BRAZIL, MEXICO AND THE U.S.A.

**Fabio Vogelaar Carlucci**
*School of Economics, Business Administration and Accounting at Ribeirão Preto - FEA-RP*
*University of São Paulo -USP.*
*Address: 3900 Avenue Bandeirantes – Zip Code: 14040-900 – Ribeirão Preto,SP,Brazil.*
E-mail: *fabio.vogelaar@gmail.com*

**Tabajara Pimenta Júnior**
*Associate Professor*
*Member of GRT – Finance (Group for Research and Teaching in Finance)*
*School of Economics, Business Administration and Accounting at Ribeirão Preto - FEA-RP*
*University of São Paulo -USP.*
*Address: 3900 Avenue Bandeirantes – Zip Code: 14040-900 – Ribeirão Preto,SP,Brazil.*
E-mail: *taba.jr@usp.br*

**Fabiano Guasti Lima**
*Associate Professor*
*Member of GRT – Finance (Group for Research and Teaching in Finance)*
*School of Economics, Business Administration and Accounting at Ribeirão Preto - FEA-RP*
*University of São Paulo -USP.*
*Address: 3900 Avenue Bandeirantes – Zip Code: 14040-900 – Ribeirão Preto,SP,Brazil.*
E-mail: *fabianoguastilima@gmail.com*

**Luiz Eduardo Gaio**
*Member of GRT – Finance (Group for Research and Teaching in Finance)*
*School of Economics, Business Administration and Accounting at Ribeirão Preto - FEA-RP*
*University of São Paulo -USP.*
*Address: 3900 Avenue Bandeirantes – Zip Code: 14040-900 – Ribeirão Preto,SP,Brazil.*
E-mail: *luiz.gaio@ymail.com*

**ABSTRACT**

*This paper aimed to detect the occurrence of the "wee-day effect" in the behavior of a series of returns offered by the variations in quotations of the main stock Exchange indexes of Brazil (Ibovespa), Mexico (InMex) and the U.S.A. (Dow Jones). Three statistical tools were used: regression analysis with dummy variables, hypothesis test for difference of means; and the Kruskal-Wallis non-parametric test. Historical series of returns of the three indexes, covering the period between 2004 and 2012, were analyzed. The results obtained showed that the occurrence of this anomaly was not detected for any of the three markets, which contradicts the results found in other studies for different markets and for different periods.*

**Keywords:** *Market efficiency, day-of-the-week effect, seasonality.*

## 1. INTRODUCTION

There are several pieces of information which influence the prices of securities issued by companies is the capital market. Fama (1970) developed a theory which relates the information influence on the behavior of the assets prices, which became known as Efficient-Market Hypothesis (EMH). According to it, in an efficient market, the price of a financial asset must reflect all the available relevant information.

There are some premises to validate the EMH. The first one is the non-existence of any transaction cost in operations of marketable securities. The second premise is that all information is available free of cost to all the participants of the market. The third one consists in the agreement of everyone regarding the implications of the available information for current price and for distributions of future prices. It is also assumed that the investors are rational and, therefore, make decisions based on reason and instead of emotion.

It is easy to accept that the premises of the Efficient-Market hypothesis are strong and difficult to be checked in fact. Since Fama´s (1970) seminal study, innumerous works on the impact of information in the asset prices behavior in financial markets were published. Many of them approached the efficiency of financial markets by the so called market anomalies.

There is a specific anomaly in the behavior of asset prices and financial indexes, called "Week-day effect", which was more researched in international markets. The week-day effect, according to Fama (1970), is related to the fact that the return of risky financial assets is different along the days of the week. This bias is considered a market anomaly. It causes a species of price behavior to exist, which mischaracterizes the expected random behavior of an efficient market. A market in which the price behavior, or returns, of the assets shows the "week-day effect" is considered inefficient, in the informal aspect established by the EMH. The detection of anomalies as this one is, therefore, a method to investigate whether the markets are or are not efficient.

Many researchers investigated the presence of the "week-day effect" anomaly in international markets, for different periods, such as: French (1980); Gibbons & Hess (1981); Barone (1990); Jaffe & Westerfield (1985); Poshakwale (1996); Bildik (1999); Patev, Lyroudi & Kanaryan (2003); Kiymaz & Berument (2003); Nath & Dalvi (2004); Dicle & Hassan (2006); Das & Arora (2007) and Al-Khazali (2008). Other authors, such as Costa Jr. (1990); Madureira & Leal (2001); Torres, Bonomo & Fernandes (2002); Bone & Ribeiro (2002); Silva, Figueiredo & Souza (2002) and Fajardo & Pereira (2008) studied the presence of this anomaly in the Brazilian Capital market.

In the current context, of global economies, the markets are more interdependent and the behaviors of their asset prices are, thus, more influential one on the others. The studies of phenomena which affect these behaviors are dynamics and always valuable to follow the market natural evolution and the changes in environment. For this study, the behavior of the returns offered by the variation of quotations of the main stock indexes of three Stock Exchange with the highest volume of operation in the American Continent (BM&FBovespa of Brazil, BMV of Mexico, and NYSE of the U.S.A.), aiming to check whether these three markets are efficient at the light of occurrence of the "week-day effect".

## 2. LITERATURE REVIEW

According to French (1980), the mean daily returns of risky financial assets are different along the days of the week. Gibbons & Hess (1981) state that even though the distribution of daily returns of financial assets during the week tend to be the same, in certain periods, there are evidences that the returns are distributed in an inequitable way. Several studies tested the occurrence of this phenomenon.

Brealey, Myers &Allen (2009) highlight two areas which present explanations for the apparent market anomalies through human psychology: Attitudes towards risk; and beliefs towards probabilities. A brief human behavior example is expressed by the "Monday effect". Curiously, the release of negative information on the weekend tends to reduce returns and increase the volatility of assets negotiated on Mondays, more than the ones that come up on the other days of the week. An interpretation is that since Monday is the first day of the week, the investors tend to be pessimist. On Friday, the investors tend to be more optimists (DICLE & HASSAN, 2006). For French (1980), even though this behavior is very possible, it would not cause systematic negative returns in assets of an efficient market. If it happened, the investors would already expect the publishing of negative information on the weekend and would price the assets negatively during the week, discounting, daily, a value for the information which would be then published.

It is interesting to notice that studies carried out with data of markets outside the U.S.A. revealed the anomaly for Tuesday. According to Nath & Dalvi (2004), the most satisfactory explanation for the "week-day effect" in other markets on Tuesday, happens because the news which are published in the U.S. on the weekend affect this market on Monday and spread to other markets with a delay, causing the effects a day later.

French (1980) checked the existence of negative returns for Mondays in the U.S.A. According to him, an investor could explain a strategy of purchasing the Standard & Poor´s stock index every Monday and sell his investments on Friday, obtaining an average yearly return of 13.4% between 1953 and 1977, while a maintenance strategy would give an average yearly return, in the same period, of 5.5%, ignoring, in both cases, the transaction costs. Costs of 0.25% per transaction, however, would make the securities maintenance strategy higher, which reveals that exploring the anomaly would not constitute a relative advantage. Nath & Dalvi (2004) discovered that, in the case of India, for example, Wednesdays present a mean return significantly higher.

Since the "week-day effect" is a phenomenon which invalidates the Efficient-Market Hypothesis for the market investigated, many studies, worldwide, have been carried out based on it. Some examples are: Jafe & Westerfield (1985); Gibbons & Hess (1981); Das & Arora (2007); Nath & Dalvi (2004), Poshakwale (1996); Dicle & Hassan (2006); Bildik (1999); Al-Khazali (2008); Barone (1990); Patev, Lyroudi & Kanaryan (2003); Kiymaz & Berument (2003).

In Brazil, the week-day effect for the São Paulo Stock Exchange was studies by authors such as: Silva, Figueiredo & Souza (2002), Costa Jr. (1990), Bone & Ribeiro (2002), Torres, Bonomo & Fernandes (2002) and Madureira & Leal (2001).

Costa Jr. (1990) studied several anomalies in the Brazilian market for the Ibovespa index, such as the week-day effect, the month-of-the-year effect, the company size effect, the price-profit effect. Once the data referring to the period from January/1986 to March/1989 were analyzed, the results showed that there was not the "month-of-the-year effect". The "week-day effect" was detected, though. Mondays presented lower relative returns, and Fridays had higher returns.

Silva, Figueiredo & Souza (2002) performed a study about the behavior of North-American, Argentinian and Brazilian stock Exchange indexes. The tool used was the multiple linear regression with dummy variables to verify the difference of daily mean returns. The data were collected from 1995 to 2001. In Brazil, no kind of week-day effect was found. In Argentina, on the other hand, the effect was observed with positive returns for Wednesdays and Thursdays and negative for Mondays. The results showed that the Dow Jones index presented the effect on Fridays, with positive returns, for a significance level of 10%.

In studied conducted in the Brazilian stock market, Bone & Ribeiro (2002) studied the week-day effect, the holiday effect, and also the importance of autoregressive terms for stocks of the São Paulo Stock Exchange index, in Brazil. For the generation of results, the study makes use of the Wald test, the White test and the LM test (Breusch & Godfrey) for autocorrelation, applied to 38 stocks. The Week-day effect was verified for approximately half of the stocks studied; being Tuesday the one with the most differentiated return, with positive returns above the average. Bone & Ribeiro considered that the existence of the anomaly on Tuesday may have appeared due to the so called "Brasilia effect", since this day is strongly associated to the congressmen participation in the national Congress. Only three stocks did not present any of the three anomalies studied (week-day effect, holiday effect or autoregressive terms.

Fajardo & Pereira (2008) carried out a study to investigate the market anomalies in the São Paulo Stock Exchange (BOVESPA) from January/1995 to December/2007, segmenting the period in sub periods according to the presidential terms. The anomalies studied were the week-day effect, the reversion of the Monday effect and the Holiday effect. The statistical tests used were the regression with dummy variables for the week-day effect and for the Holiday effect and the multiple regression for the reversion of the Monday effect. The ANOVA f-parametric test was also applied instead of the non-parametric one for K independent variables of the Kruskal-Wallis test. Concerning the week-day effect, abnormal returns were verified for Mondays, Wednesdays and Fridays. For the reversion of the Monday effect, a negative return was noticed for Mondays after negative weeks. The holiday effect did not take place for any of the samples studied in the article.

While some studies analyzed the occurrence of anomalies from the São Paulo Stock Exchange index (IBOVESPA), other studies did it from the stocks listed in this stock Exchange, assessing the efficiency of individual stocks facing the market information. Regarding the methodology, different statistical tools were used to analyze the week-day effect in the Brazilian Capital market. Some of the most used tests were the regression analysis with dummy variables and Kruskal-Wallis non-parametric test.

The Brazilian studies on the theme are relatively old. For most of them, there is the predominance of analysis on data of the 1990´s.This was one of the motivating factors for this work. With the significant development and improvement of the Brazilian capital market along the last decade, the behavior of returns, concerning the occurrence of anomalies, can have changed. In the international context, the changes in the economic environment were also remarkable. Even though there are a greater number of studies exploring the behavior of international stock exchange indexes, the theme is dynamic and the contributions for a wider comprehension of the anomalous phenomena, such as the "week-day effect" are always important.

## 3. METHODOLOGY

Historical series of daily returns of the IBOVESPA (Brazil), INMEX RT (Mexico) and DOW JONES (U.S.A.) referring to the period from January 1st, 2004 and December 31st, 2012 were analyzed.

The first econometric technique used was the regression analysis with dummy variables. When working with dummy variables, the independent variables are discreet dichotomous variables limited to two possible values (0 and 1). The equation adopted was:

$$R_t = \alpha_0 + \alpha_1 D_{1t} + \alpha_2 D_{2t} + \alpha_3 D_{3t} + \alpha_4 D_{4t} + e_t$$

Where:
$R_t$ = index return;
$D_{jt}$ = dummy variable for day j;
$\alpha_0$ = constant or expected return for Monday;
$\alpha_1, \alpha_2, \alpha_3, \alpha_4$ = difference between the expected return for Monday and the expected return for Tuesday, Wednesday, Thursday and Friday, respectively.
$e_t$ = Error term.

The dummy variables take the value 1 when the difference between the Monday mean return ($\alpha_0$) and the daily return of the specific weekday ($\alpha_1, \alpha_2, \alpha_3, \alpha_4$) is used to compose the index return. Thus, it is possible to assess the impact of each weekday in the global mean return of the stock exchange index for each market.

French (1980), Gibbons & Hess (1981), Costa Jr. (1990), Barone (1990), Jaffe & Westerfield (1985), Bildik (1999), Patev, Lyroundi & Kanaryan (2003), Silva & Figueiredo (2002), Nath & Dalvi (2004) and Das & Hassan (2007) were some of the authors who used the regression analysis with dummy variables to study the week-day effect and, thus, make considerations about the efficiency of some markets.

The series were also submitted to a Mean Difference Test, which include a bilateral or two-tailed hypothesis for the comparison between the mean return for each day of the week. The test is used to determine the probability that two means are different from each other, based on the t-statistics to verify the 5% significance level. This same technique was applied by Ajayi, Mehdian, Perry (2004), Lyroudi, Subeniotis, Komisopoulos (2002) and Wong, Hui, Chan (1992).

The hypotheses tested were:
$H_0$: $\alpha_i - \alpha_j = 0$
$H_1$: $\alpha_i - \alpha_j \neq 0$

Where:

$\alpha_i$ = Mean return of the i weekday;
$\alpha_j$ = mean return of the j weekday (subsequent).

The test verifies:

$$DMj = (\alpha_i - \alpha j) \; / \; (\sigma_i / \sqrt{N})$$

Afterwards, the Kruskal-Wallis non-parametric test was used. Due to the fact it is a simpler test which does not require specific parameters for its use, it is convenient for the generalization of the results. A rankings model was adopted to analyze the equality of the population means, with logic similar to the one of the Mean Difference Test.

The hypotheses tested were:
$H_0$: The mean returns of the weekdays are equal;
$H_1$: The mean return of at least a weekday is different.

## 4. RESULTS AND DISCUSSION

Table 1 presents the results of descriptive statistics for the three series studied.

The data of table 1 reveal that the Stock Exchange of emerging countries - Ibovespa (0.0198%) and INMEX (0.0150%)- presented a mean return in the period higher than the one verified in the U.S.A. market – Dow Jones (0.0130%). The standard deviations, a risk measure, were also higher for these countries.

Table 2 presents a descriptive analysis of the Ibovespa index for each weekday. The numbers reveal that the highest mean returns are the ones which take place on Wednesdays and Fridays.
Table 3 presents the descriptive analysis of the INMEX RT index return for each weekday. For this index, the highest mean returns are on Tuesdays and Wednesday and the lowest one takes place on Fridays.

Table 4 presents the descriptive analysis of the Dow Jones index return for each weekday. The numbers reveal similar results to Mexico´s Stock Exchange because the highest mean returns take place on Tuesdays and Wednesdays and the lowest, on Fridays.

Table 5 shows the test results for verifying the normality of return distribution of the three indexes analyzed. The normality hypothesis was rejected for the three cases.

Despite the non-normality of the series distribution, parametric and non-parametric tests were applied in the return behavior analysis, since the samples have great dimension.

Table 6 shows the adjustment degree of the regressions with dummy variables for each one of the stock indexes analyzed. For the three cases, the regressions showed to be well adjusted, with adjusted values of R and $R^2$ higher than 70%. The regressions revealed that there are no statistically significant differences between the mean returns of different weekdays for each one of the three indexes.

In the use of the Standard Mean Difference Test (ANOVA), it is assumed that the variables have equal variances. A Preliminary Variance Homogeneity Test on the series, whose hypotheses are:

$H_0$: The variances are equal;
$H_1$: The variances are not equal.

According to the data in Table 7, the null hypothesis was accepted only for the Dow Jones index, considered the 5% statistical significance level. Due to this result, the conventional ANOVA test was applied to Dow Jones return series index, and for the two other indexes, the test was used with the equality adjustment of not-assumed variances.

The ANOVA test allows us to analyze whether there are significant differences in the return means for each weekday studied. The hypotheses are:

$H_0$: The population means are equal;
$H_1$: There are at least two populations different between themselves.

The results presented in Table 8 show that the null hypothesis can not be rejected, at 5% statistical reliability level, for any of the three stock indexes, which means that there are no significant differences between the mean returns of each weekday, for each one of the indexes.

The Kruskal-Wallis test, which is non-parametric, was applied to compare the medians of daily mean returns of each weekday for each one of the stock indexes. Since the series did not present normal distribution and two of them do not have homogenous variances between the returns of the different weekdays, the use of a non-parametric test is more appropriate. The hypotheses are the following:

$H_0$: The daily mean returns are equal;
$H_1$: There is a different mean return different in at least a weekday.

The results presented in Table 9 show that the null hypothesis can not be rejected, at 5% statistical reliability level, for any of the stock indexes, which means that there are no significant differences between the mean returns of each weekday, for each one of the indexes.

**5. CONCLUSION**

It was possible to conclude, from the results of the statistical analyses performed, that there are no statistically significant differences between the mean returns of each weekday for the Ibovespa, INMEX RT and Dow Jones indexes.

Evidences that the index returns presented, in some days of the week, in the period studied, systematically higher values, while other presented lower values, without the proper statistical significance, were found. The Stock Exchanges of Mexico and the U.S.A. showed evidences of a lower mean return on Fridays, which would be a different result from the ones obtained by previous studies, if validated. The INMEX RT and Dow Jones indexes showed very close behaviors regarding the mean returns on each weekday.

Fajardo & Pereira (2008) highlighted that those market which presented anomalies in studies published in the 70´s and 80´s, do not show their presence in recent studies any more. A possible reason for this change can be the fact that when exploring the opportunities generated by anomalies, the investors, along the time, rebalanced the market, eliminating them.

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Table 1 – Descriptive Statistics of Daily Return Series

| | Number of Observations | Mean Return | Standard Deviation | Minimum Return | Maximum Return |
|---|---|---|---|---|---|
| IBOVESPA | 2126 | 0.01981944 | 0.01981944 | -0.11393 | 0.14659 |
| INMEX RT | 2164 | 0.01499776 | 0.01499776 | -0.07014 | 0.13608 |
| DOW JONES | 2160 | 0.01303918 | 0.01303918 | -0.07873 | 0.11080 |

Table 2 – Return Behavior of Ibovespa

| IBOVESPA | | | | | |
|---|---|---|---|---|---|
| Day of the week | Number of Observations | Mean Return | Standard Deviation | Minimum Return | Maximum Return |
| Monday | 424 | -0.000711 | 0.022390 | -0.093620 | 0.146590 |
| Tuesday | 425 | 0.001288 | 0.019337 | -0.066270 | 0.134230 |
| Wednesday | 432 | 0.001935 | 0.020198 | -0.113930 | 0.063350 |
| Thursday | 423 | 0.000470 | 0.019871 | -0.073360 | 0.074700 |
| Friday | 422 | 0.001757 | 0.016859 | -0.069110 | 0.095680 |

Table 3 – Return Behavior of INMEX RT

| INMEX RT | | | | | |
|---|---|---|---|---|---|
| Day of the week | Number of Observations | Mean Return | Standard Deviation | Minimum Return | Maximum Return |
| Monday | 427 | 0.000771 | 0.017402 | -0.066976 | 0.136077 |
| Tuesday | 439 | 0.001130 | 0.015807 | -0.059974 | 0.099392 |
| Wednesday | 441 | 0.001079 | 0.014682 | -0.070136 | 0.049990 |
| Thursday | 427 | 0.000888 | 0.014988 | -0.056890 | 0.064747 |
| Friday | 430 | 0.000491 | 0.011572 | -0.043205 | 0.053798 |

Table 4 – Return Behavior of Dow Jones

| DOW JONES | | | | | |
|---|---|---|---|---|---|
| Day of the week | Number of Observations | Mean Return | Standard Deviation | Minimum Return | Maximum Return |
| Monday | 405 | 0.000216 | 0.014617 | -0.077010 | 0.110800 |
| Tuesday | 443 | 0.000450 | 0.013591 | -0.051070 | 0.108780 |
| Wednesday | 445 | 0.000413 | 0.012380 | -0.078730 | 0.063480 |
| Thursday | 435 | -0.000084 | 0.013187 | -0.073330 | 0.066720 |
| Friday | 432 | -0.000481 | 0.011330 | -0.046400 | 0.065430 |
| TOTAL | 2165 | 0.000105 | 0.013024 | -0.078730 | 0.110800 |

Table 5 – Kolmogorov-Smirnov Test of Normality Distribution

| | IBOVESPA | INMEX RT | DOW JONES |
|---|---|---|---|
| Number of Observations | 2126 | 2164 | 2160 |
| Mean Return | 0.000951 | 0.000874 | 0.000105 |
| Standard Deviation | 0.019819 | 0.014998 | 0.013039 |
| Test Statistics (Bilateral) | 0.000000 | 0.000000 | 0.000000 |

Table 6 – Adjustment Degree of the Regressions with Dummy Variables

| | R | $R^2$ | Adjusted $R^2$ |
|---|---|---|---|
| IBOVESPA | 0.864 | 0.746 | 0.745 |
| INMEX RT | 0.855 | 0.731 | 0.731 |
| DOW JONES | 0.870 | 0.757 | 0.756 |

Table 7 – Variance Homogeneity Test

| | Levene Statistics | df1 | df2 | Significance |
|---|---|---|---|---|
| IBOVESPA | 4.150 | 5 | 2125 | 0.001 |
| INMEX RT | 5.181 | 5 | 2163 | 0.000 |
| DOW JONES | 1.542 | 5 | 2159 | 0.174 |

Table 8 – Variance Homogeneity Test

| | Sum of Squares | df1 | Statistics F | Significance |
|---|---|---|---|---|
| IBOVESPA | 0.002 | 5 | 1.026 | 0.400 |
| INMEX RT | 0.000 | 5 | 0.102 | 0.992 |
| DOW JONES | 0.000 | 5 | 0.311 | 0.907 |

Table 9 – Adjustment Level of Regressions with Dummy Variables

| | Chi-Square | df | Significance |
|---|---|---|---|
| IBOVESPA | 7.352 | 4 | 0.118 |
| INMEX RT | 1.052 | 4 | 0.902 |
| DOW JONES | 3.220 | 4 | 0.522 |