8. AN INVESTIGATION OF THE DAY-OF-THE-WEEK EFFECT IN CONDITIONAL VARIANCE AT THE BUCHAREST STOCK EXCHANGE

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Abstract

The Efficient Market Hypothesis (EMH) advances the idea that the prices of financial assets reflect all the existent information and that investors cannot obtain abnormal returns by exploiting past trading records, public or private information. Despite this fact, financial literature has heavily documented that stock returns may vary during the trading week which could be considered a challenge for the classical EMH specifications. This paper considers these oscillations that are associated to the day-of-the effect. In a GARCH-based framework, we test for the presence of this seasonal anomaly among a series of most liquid companies listed on the Bucharest Stock Exchange. Our results demonstrate the absence of the day-of-the-week anomaly for the Romanian stock market.

Keyword: day-of-the weak, efficient market hypothesis, calendar anomalies
JEL Classification: G02, G14, G17

I. Introduction

The existence of stock market anomalies has attracted the attention of an abundant literature that challenged the concept of weak-form market efficiency. Among these anomalies, a special attention was given to calendar effects, the presence of which shed consistent doubts on the robustness of the Efficient Market Hypothesis (EMH).

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This theoretical construction derives from the seminal work of Fama (1970) which stipules that all the existent information regarding an asset is incorporated in its price. Following this logic, all assets will be characterized by a price in direct relationship with their risk-return features, and investors cannot obtain abnormal returns. Despite this fact, a substantial block of literature introduced various empirical investigations showing deviations from this theoretical framework, considered anomalous behavior. A specific line of this literature focuses on seasonal effects, which category marks the tendency of certain assets to exhibit an inconsistent behavior over o certain interval such as a day, week or month. One of the calendar anomalies that attracted a large wave of academic attention is the day-of-the-week (DoW). It shows that returns are not uniform for all days of the trading week. Under this observation, it can be asserted that, technically, investors can obtain abnormal returns by speculating this return orientation.

Moreover, investigations on the DoW have shown that stocks have an inclination to exhibit lower or negative returns on Mondays and higher or positive returns on Fridays. Pioneering work in this direction has been conducted by Cross (1973), French (1980) or Lakonishok and Levi (1982).

Should the above-mentioned inclination be systematic, it could result in predictability of returns which will in turn lead to abnormal returns and therefor a contradiction of the Efficient Market Hypothesis.

One interesting feature of the literature covering the day-of-the-week is that it has been studied for both mature and emergent markets.

Starting form a data set specific to the Romanian market, containing the companies that are included in the computation of the BET-XT index for the period ranging from January 4 2010 to May 19 2017, this study tries to document the presence of the DoW effect. The following section offers a condensed review of the previous literature. Section three expands on the data employed and on the methodological specifications. Section four comments on the results and section five concludes.

II. Literature Review

The first empirical analysis on the day-of-the-week effect was brought by Cross (1973). Focusing on the SandP 500 Index for the period ranging from 1953 to 1970, Cross (1973) demonstrates the definition of the anomaly, namely that the average returns for Fridays are higher than those for Mondays. An early explanation derives from the contribution of Gibbons and Hess (1981). The authors attribute the difference in stock returns to the time distance between one specific transaction and its settlement, and hint to the idea that acquisitions conducted on Fridays can be regarded as a free loan extending over the weekend until the settlement stage, which translates into higher volumes and thus higher prices.

Jaffe and Westerfield (1985) demonstrate the presence of the weekend of effect for a series of matures markets such as Australia, Canada, Japan and the UK. The conclusions indicate that for these markets there is clear evidence of statistically negative returns for Monday and higher ones for Friday. In a contemporaneous contribution, similar results are reported by Wong and Ho (1986) who scrutinize the DoW for the Singapore market.

Ajayi *et al*. (2004) dedicate their study to the DoW for a sample of Eastern European states and point out the existence of a positive Monday effect for the Russian stock market. Heininen and Puttonen (2008) also focus on the CEE markets, this time for the 1997-2008 interval. The authors confirm the presence of a Friday effect for the case of Russia for the full sample period.

In a regression based study, Tsangarakis (2007) aims to determine the presence of the DoW for the Greek market. The author considers a full sample approach and then turns to two sub-sample intervals and notices a relevant Friday effect.

Gonzalez-Perez and Guerro (2013) start from an SandP oriented data set for the 2004 – 2011 interval. The results cannot refute the classical perspective of the EMH given the failure to detect traces of the day-of-the week anomality. The authors argue also on the idea that abnormal returns cannot be obtained. In the same line, Carlucci *et al*. (2013) obtain symmetrical results for the case of the US and Canada for a similar time frame.

Chia (2014) focuses on the investigation of daily trends adding a compensation for asymmetric behavior for the case of Austriala and New Zealand. In a TAR-GARCH framework, the author documents on a disappearing DoW effect for both markets. In addition to this, the author considers this effect to be country specific. Kohers *et al*. (2004) considers the stock markets of Japan and Australia when examining for the existence of the DoW effect. The author demonstrates that the returns recorded on Monday tend to be far lower than those of any day of the weak. Despite this fact, the effect tends to dissipate through the investigation period.

Cincko *et al*. (2015) aim to study the presence of DoW on a series that is transformed to 24 indices from 16 countries. The authors notice slim evidence of some indices but the overall analysis fails to point out a systematic pattern.

In a study that is closely related to the present one, Bampinas *et al*. (2016) test the presence of the day-of-the-week effect for a batch of real estate indices for global, European and country levels. The authors focus on the sample dependency of the daily seasonality. Using various GARCH-type models and considering both full sample and rolling regression techniques, Bampinas *et al*. (2016) obtain several representative effects for Mondays. Despite the above-mentioned evidence, the authors conclude that the effects are not persistent and thus the daily seasonality might be influenced by sample selection.

Akbalik and Ozkan (2017) examine the day-of-the-week effect for the stock markets of “the fragile five” countries employing the Kruskal-Wallis test and Wilcoxon rank procedure. The results demonstrate the absence of the DoW anomality for all countries except Indonesia for which limited traces are detected. In a parallel investigation, Chatterjee and Hubble (2017) also rely on GARCH modeling and succeed in confirming the presence of the DoW effect for the biotechnology index for the 2002-2015 period. Moreover, the authors notice that the detected higher returns for the case of Wednesday, Thursday, and Friday in comparison to Mondays are valid for biotechnology stocks even when the modeling construction incorporates the previsions of Fama and French (2004) and Carhart (1997). In addition to this, Chatterjee and Hubble (2017) argue that the relation between the small firm effect and momentum specifications and the stock returns could be speculated by investors.

Jain (2017) focuses on both the day-of-the-week effect and the month-of-the-year anomaly for the case of the Indian stock market. Using a sample that ranges from January 1993 to March 2015 for the BSE 100 and regression approach with dummy variables, Jain (2017) tests for the two anomalies for the normal sample of returns and for a trimmed set that excludes outliers. The author does not confirm the presence of DoW, but argues in favor of the presence of a negative April effect in the normal return series. The author observes that for the outliers-adjusted series both anomalies disappear.

III. Data and Methodology

We used data on the companies that are included in the computation of the BET-XT index, disseminated by the Bucharest Stock Exchange. We used the stock exchange website to download the historical prices (end of day) for all the twenty-five equities for the period January 4, 2010, to May 19, 2017, and we eliminated the companies for which we found that more than 30% of data were not available (especially companies that were listed later in the time sample).

Table 1

Statistical Properties of Log-returns for the Companies in Our Analysis

	Means	STD	Skewness	Kurtosis	Max	Min	Jarque-Bera p-value	Jarque-Bera test
TLV	0.01	0.17	-0.25	10.76	1.27	-1.29	0.00	4847.50
FP	0.00	0.19	-0.37	12.21	1.33	-1.43	0.00	6846.23
SNP	0.00	0.18	-1.15	20.43	1.39	-1.97	0.00	24789.65
SNG	0.00	0.21	-2.90	45.51	1.37	-2.88	0.00	147620.20
BRD	0.00	0.18	-0.39	14.17	1.38	-1.45	0.00	10053.10
TEL	0.00	0.15	-0.37	15.38	0.91	-1.62	0.00	12336.26
SIF5	0.00	0.16	-0.41	12.65	1.20	-1.48	0.00	7521.56
SIF1	0.00	0.19	0.42	12.44	1.61	-1.13	0.00	7208.90
SIF2	0.00	0.27	-8.85	242.05	1.74	-6.97	0.00	4608827.71
SIF3	0.00	0.11	-0.30	9.67	0.56	-0.73	0.00	3594.17
SIF4	0.00	0.35	20.71	708.82	11.84	-1.61	0.00	40095435.17
BVB	0.00	0.21	0.45	11.65	1.59	-1.44	0.00	6065.65
ELMA	0.00	0.16	-0.39	11.76	1.15	-1.59	0.00	6210.27
IMP	0.00	0.15	-0.25	8.11	0.99	-1.05	0.00	2111.50
BRK	0.01	0.14	-1.08	16.15	1.17	-1.20	0.00	14238.93
MCAB	0.00	0.17	-0.19	13.18	1.11	-1.46	0.00	8330.27
ROCE	0.00	0.18	-0.41	12.82	1.34	-1.51	0.00	7791.45

Source: Authors' calculations.

We notice the series of daily returns exhibit the usual stylized facts observed in the markets, *i.e.* rather low means and high skewness and kurtosis.

We follow the methodological line found in Albu *et al*. (2015) and Albu *et al*. (2016) and consider the specifications found in Lupu and Călin (2014) and Călin *et al*. (2014) and employ the large set of GARCH models investigated by the above studies. Therefore,

we consider the exact batch of modeling specifications tested by Albu *et al*. (2015, 2016) for which the authors present the following mathematical structure:

GARCH model:

$$\sigma_t^2 = \alpha_0 + \sum_{i=1}^{m} \alpha_i a_{t-i}^2 + \sum_{j=1}^{s} \beta_j \sigma_{t-j}^2$$

EGARCH model:

$$\log \sigma_t^2 = \omega + \sum_{i=1}^{m} \beta_i \log \sigma_{t-i}^2 + \sum_{j=1}^{s} \alpha_j \left[\frac{|a_{t-j}|}{\sigma_{t-j}} - E\left(\frac{|a_{t-j}|}{\sigma_{t-j}} \right) \right] + \sum_{j=1}^{s} \gamma_j \left(\frac{a_{t-j}}{\sigma_{t-j}} \right)$$

GARCH – GJR model

$$\sigma_t^2 = \omega + \sum_{i=1}^{m} \beta_i \sigma_{t-i}^2 + \sum_{j=1}^{s} \alpha_j a_{t-j}^2 + \sum_{j=1}^{s} \gamma_j I_{t-j} a_{t-j}^2$$

A-PARCH model

$$\sigma_t^\delta = \omega + \sum_{i=1}^{m} \beta_i \sigma_{t-i}^\delta + \sum_{j=1}^{s} \alpha_j \left(|a_{t-j}| - \gamma_j a_{t-j} \right)^\delta$$

TARCH model

$$\sigma_t = \omega + \sum_{i=1}^{m} \beta_i \sigma_{t-i} + \sum_{j=1}^{s} (\alpha_j a_{t-j}^+ + \gamma_j |a_{t-j}^-|)$$

NAGARCH model

$$\sigma_{t+1}^2 = \omega + \alpha R_t^2 + \beta' \sigma_t^2 - 2\alpha\delta z_t \sigma_t^2$$

IGARCH model

$$\sigma_t = \omega + \sum_{i-1}^{q} \alpha_i \, \varepsilon_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2$$

FIGARCH model

$$\sigma_t^2 = \frac{\omega}{1-\beta(L)} + \left\{ 1 - \frac{\alpha(L)(1-L)^d}{1-\beta(L)} \right\} a_t^2 = \frac{\omega}{1-\beta(L)} + \lambda(L) a_t^2$$

We perform the investigation of the existence of day-of-the-week patterns in the series of conditional volatilities by means of the following simple regression:

$$\sigma_{t,m,i}^2 = \alpha_i + \beta_{Tue} D_{Tue,t} + \beta_W D_{W,t} + \beta_{Th} D_{Th,t} + \beta_F D_{F,t} + u_t$$

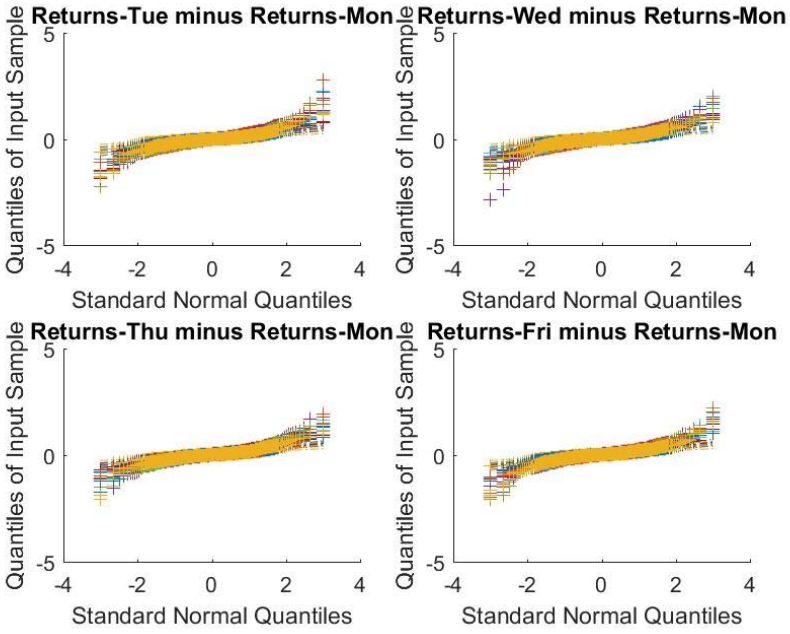
where $\sigma_{t,i}^2$ is the conditional variance estimated with a GARCH-type model m for company i and $D_{Tue,t}$, $D_{W,t}$, $D_{Th,t}$ and $D_{F,t}$ are the dummy variables corresponding to Tuesday, Wednesday, Thursday and Friday, respectively.

IV. Results

Our first analysis consisted in the computation of the weekly returns for each day-of-the-week in excess of the returns corresponding to Monday. We depict the distribution of these returns in Figure 1. With the exception of some particular outliers (not captured in the charts for reasons of keeping the scales at comparable levels), the quantile-quantile plots of these excess returns do not seem to exhibit any particular specific pattern. They all have the fat-tail effect and negative skewness and they deviate from normality. Some noticeable deviations are observed in the case of the excess returns corresponding to Tuesdays, which shows that the difference between log-returns from Tuesday and log-returns from Monday are in general rather different, but not necessarily sign-dependent. This could be seen as an indicator to further investigate the pattern of volatilities.

Figure 1

Q-Q Plot Representations of the Weekly Returns Corresponding to Each Day in Excess to Monday Returns



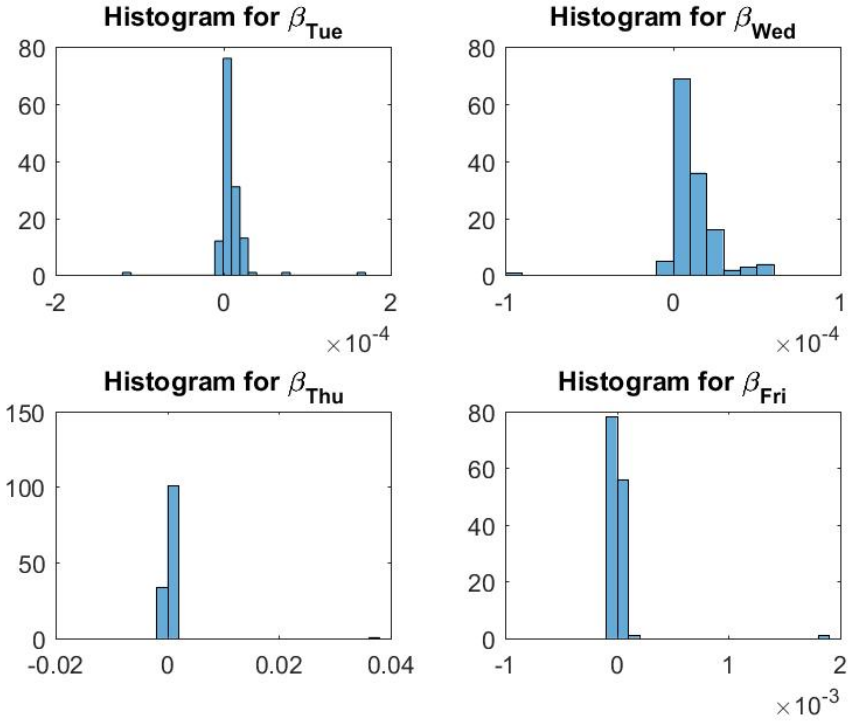
Source: Authors' calculations.

The calibration of the GARCH models presented in the previous section expanded the conditional variance coefficients that were used in the regressions with dummy variables corresponding to each day. We performed 17 regressions (corresponding to each company in our sample) for each of the 8 GARCH models, which means that we have results for 136 regressions. We analyze the results of these regressions by investigating the following charts.

First, we constructed a figure with the histograms for all the beta coefficients corresponding to each of the four dummy variables across all the companies and all the volatility models. Their distribution is generally centered around zero, which means that there is not enough statistical evidence to confirm any day-of-the-week effect for the volatilities, on average, across all the models taken into account in our analysis. We also notice that beta coefficients exhibit some large deviations from the group around the average, which could be interpreted as a correspondence with the large skewness and kurtosis coefficients observed for the daily returns, *i.e.* deviations from normality. If the beta coefficients corresponding to Tuesday and Wednesday are rather symmetric around their mean, we notice that the coefficients for Friday exhibit a larger variation and positive skewness, apart from the large kurtosis.

Figure 2

The Histogram for Each Beta Coefficient across All Models and Companies



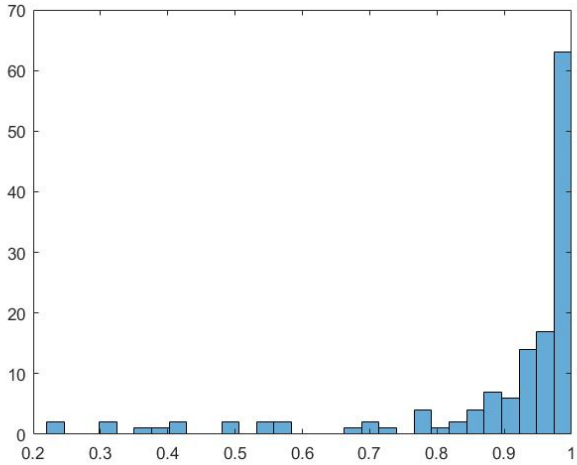
Source: Authors' calculations.

The coefficients corresponding to Thursday also show positive skewness but they have a variation that is smaller than the others, (ranging between -0.02 and 0.04), which means that the differences between the Monday volatilities and the Thursday volatilities are rather random, with no particular patterns. We can therefore conclude that the larger variation corresponds to the volatilities realized on Fridays in excess of those from Mondays.

Figure 3 depicts the empirical distribution of the p-values computed for the F-statistic for all the regressions, i.e. across all companies and all GARCH models. We notice that there are very few situations in which these statistics are low, while the large majority corresponds to situations in which we cannot reject the null that all the beta coefficients are zero.

Figure 3

Histogram of P-values across All Regressions

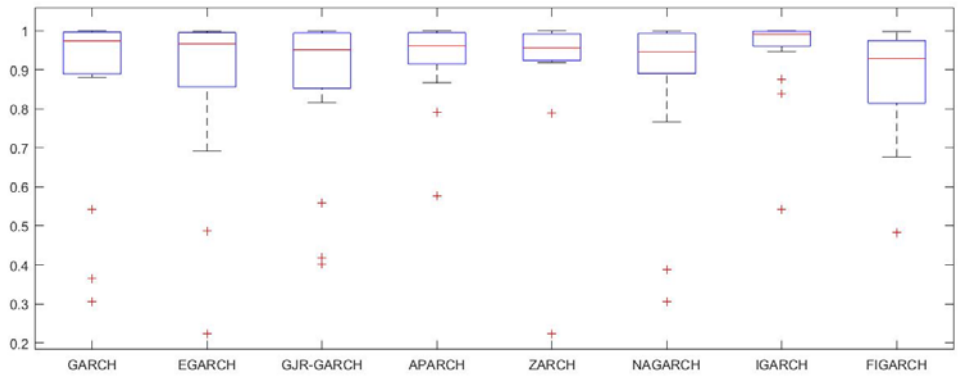


Source: Authors' calculations.

We could therefore consider that there is no evidence that the day-of-the-week effect is evidenced by empirical analysis. However, even though the majority of p-values are larger than 0.8, both Figure 3 and Figure 4 show that the p-values are volatile conditional on the model used and across companies. We could therefore refine our investigation and consider the existence of patterns in the dynamics of conditional volatilities for each weekday.

Figure 4

Boxplot for the P-values of F-test

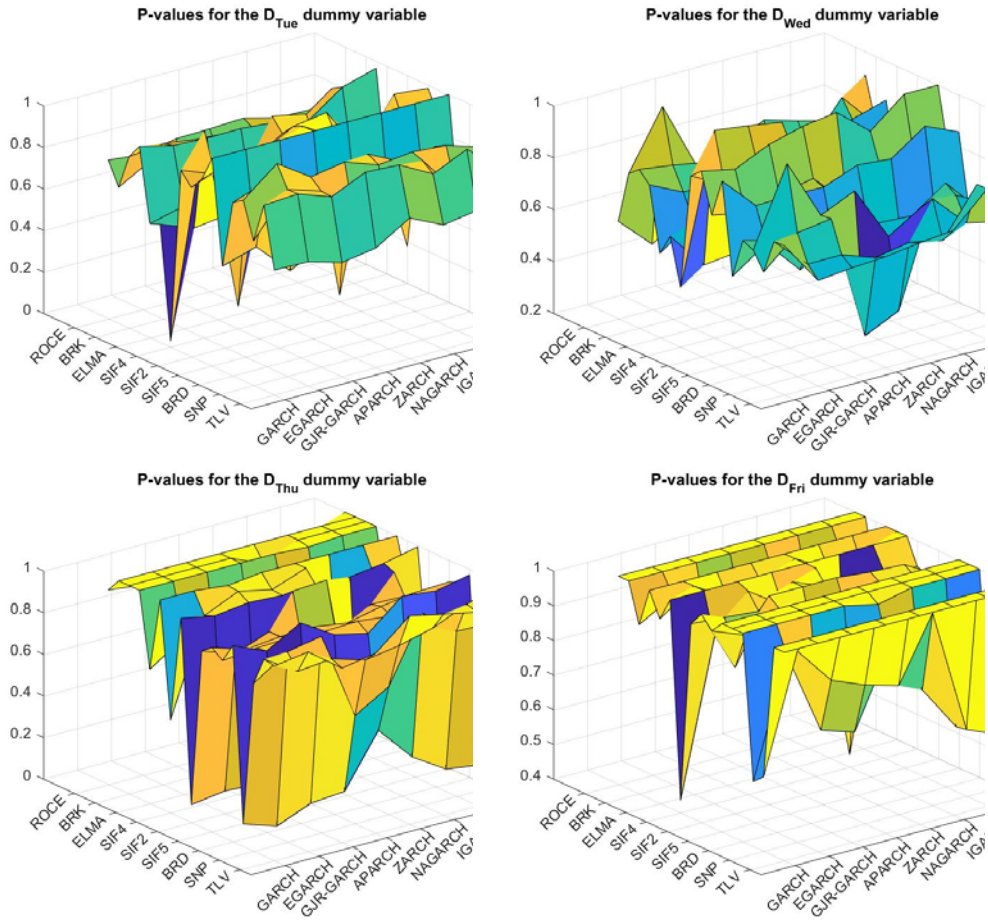


Source: Authors' calculations.

An investigation of the significance for each of the beta coefficients across all models and all the companies in our sample is depicted in figure 5. The representation of the p-values shows that the majority of regressions show almost no significance for the coefficients corresponding to the Tuesday and Wednesday dummy variables, but with lower values for the case of Thursday and Friday. All the downward pointing spikes correspond to significant regressions, and they tend to be quite variable in the case of the Wednesday dummy variable too.

Figure 5

P-values for Each Dummy Variable



Source: Authors' calculations

V. Conclusions

The purpose of our paper is to investigate the existence of day-of-the-week patterns in the dynamics of the volatilities computed for the stock market returns for the most liquid

companies listed at the Bucharest Stock Exchange. We employed a large sample of data covering the period January 2010 until May 2017 and we investigated the existence of differences in the values of the conditional volatilities computed through eight different GARCH-type models.

Our results show that despite a large variation in the significance of our beta coefficients, we cannot find any evidence that could support the hypothesis of day-of-the-week patterns in conditional volatilities. Nevertheless, we showed that the analysis of the level of significance is not straightforward; we notice the existence of rather different returns for the trading sessions happening of Fridays than those on Mondays, which could provide incentive for the development of further models that could investigate the patterns of the distribution of returns for each particular day.

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