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# The influence of holiday effect on the rate of return of emerging markets: a case study of Slovenia, Croatia and Hungary

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**ABSTRACT**
Taking into account the current trends and opportunities in the financial markets of developing countries, the subject of the research is to analyse, test and quantify the impact of the holiday effect on the daily return rates from investing activities for the observed financial markets of Slovenia, Croatia and Hungary. The aim of the research is to gain a concrete, empirically tested and quantified knowledge of the capabilities and effectiveness of autoregressive conditional heteroscedasticity (A.R.C.H.) and generalized autoregressive conditional heteroscedasticity (G.A.R.C.H.) models, in order to quantify the impact of the holiday effect on the rates of return from investing activities in the observed financial markets. The time period covered by the research is 2003–2016, where the length of the research time horizon makes possible model effectiveness testing in the periods before, during and after the global financial crisis. The methodology also includes S.I.C.–A.I.C. (Schwarz and Akaike) model selection criteria and a number of tests suitable for or adapted to the specific characteristics of financial markets in developing countries. The research results confirm the role and importance of the application of econometric models in order to quantify the risks of investing activities in the financial markets of developing countries.

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## 1. Introduction

Current conditions in financial markets following the global financial crisis, which resulted in highly volatile and recessionary trends, significantly contributed to the change in the perception of financial markets including investment activities. Methods of fundamental technical analyses used to predict the movement and

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decision-making of investing activities were significantly altered compared to the period before the crisis. Since the functionality and the symmetry of the daily return rates in the financial markets have a different form in the post-crisis period, researchers must use customised models to analyse and quantify the risks of investing activities.

The financial markets of developing countries, which are rather volatile, underdeveloped and 'shallow' securities markets, characterised by the lack of continual stock trading, market liquidity and high traffic, did not react significantly to the changing market conditions. Taking into consideration the efficient-market hypothesis in developing countries, it has become particularly interesting to study characteristic anomalies in developed financial markets. Calendar anomalies in financial markets, such as 'January effect', 'monthly effect', 'day-of-the-week effect', 'Monday effect' and holiday effect, ignore the weak form of efficiency in financial markets. Such situations make abnormal yields and losses possible and initiate thorough research on the calendar anomalies, especially in the financial markets of developing countries. Consequential altered investment expectations and a tendency to optimise the effects of such activities are directed towards risk minimisation. Quantification and risk analysis have a special place, role and importance in the financial markets of developing countries.

The research aim is to analyse, test and quantify the impact of the holiday effect on yields from investing activities in the financial markets of developing countries. The paper tests and quantifies the holiday effect significance for the daily return rates from investing activities in the observed markets (The Republic of Slovenia, Republic of Croatia and Hungarian People's Republic). The research time period is 2003–2016. The width of the study time frame makes it possible to test the efficiency of autoregressive conditional heteroscedasticity (A.R.C.H.) and generalised autoregressive conditional heteroscedasticity (G.A.R.C.H.) models in the periods before, during and after the global financial crisis.

The research aim is to gain a concrete, practically tested and quantified knowledge of the capability and efficiency of A.R.C.H. and G.A.R.C.H. models, in order to quantify the impact of the holiday effect on the return rates from investing activities in the observed financial markets of developing countries. Specific research objectives are focused on the model efficiency testing in the pre-crisis, crisis and post-crisis periods

Testing and analysing of the holiday effect using A.R.C.H. and G.A.R.C.H. econometric models in the financial markets of developing countries not only provide qualitative information on the impact efficiency but also examine the differences between the observed financial markets in the pre-crisis, crisis and post-crisis periods. The following hypotheses were tested in the study:

The main hypothesis H0: The application of A.R.C.H. and G.A.R.C.H. models successfully tests the impact of the holiday effect on the return rates of investment activities in the financial markets of the observed countries.

Accordingly, the additional (derived) hypothesis was tested as follows:

H1: The use of A.R.C.H. and G.A.R.C.H. models shows the various impacts of the holiday effect in the pre-crisis, crisis and post-crisis periods.

The paper is structured as follows: the research purpose, its objective and hypotheses are defined in the introductory remarks. The next part of the paper presents the relevant literature in the research field. The third part discusses the methodology and the sample used in the study. The results and the discussion are presented in the next section, which is followed by the conclusions and references used in the study.

## 2. Literature review

Taking into account the dynamic conditions in the financial markets, it is evident that the frequency of volatile market movements significantly affects the flow and effects of daily return rates of investing activities. Due to the global economic crisis and redefined market and business conditions, different risk management models in investment activities are the focus of many studies. In the paper by Dajčman and Festić (2012), the authors use the D.C.C.-G.A.R.C.H. model, which was proven to be statistically significant for quantifying the effects of the return dynamics between the Slovenian Stock Exchange and six European stock exchanges (United Kingdom, German, French, Austrian, Hungarian and Czech stock exchanges). The analysis of the zero-yield rates and price pressure measures for all the shares at Zagreb Stock Exchange in the period 2005–2009 showed that the level of liquidity of the Croatian financial market was very low. It is further concluded that the least illiquid was the year 2007 (the year before the crisis) and the most illiquid year was 2009, additionally proving that the Croatian market was less illiquid than the Serbian one (Minovic, 2012).

There are numerous anomalies in the financial markets, which have seasonal and non-seasonal effects. However, they all indicate that the market efficiency hypothesis has not been confirmed and that there is significant volatility. The reasons for the effects are found in tax-loss selling, window dressing, information availability, increased liquidity and optimistic expectations (Rossi, 2015). Those significant for the study will be briefly introduced.

The primary explanation of the holiday effect is based on behavioural finance (e.g., Thaler, 1999). The behaviour argument is consistent with the notion that happier people tend to believe in more positive outcomes (Kavanagh & Bower, 1985). According to this argument, the higher pre-holiday returns are a result of a positive holiday sentiment. This occurs when people look forward to the holiday period; they are optimistic and focused on non-work activities, and hence reluctant to trade or close out positions on the stock that they hold. This argument is supported by Hirshleifer and Shumway (2003) who suggest that the weather may have a psychological effect on investors' mood and how they perceive information. This behavioural trait of investors may also explain the holiday effect, as investors' outlook can become more positive around public holidays.

Gama and Vieira (2013) reason that since trading is possible, finding a significant holiday effect suggests that 'holiday euphoria' characterises investors' behaviour, in contradiction to the weak form efficiency hypothesis. Indeed, they find that trading volume and volatility are lower and that returns close-to-close and close-to-open are higher on a national holiday trading days than on a typical non-holiday-related trading day. Moreover, these effects are robust to day-of-the-week regularities, and international and local financial crisis. Nevertheless, they also show that this is a characteristic behaviour of small stocks. Sensitive investors could benefit from this regularity by scheduling the sale of small stocks that they need to trade to the opening of a holiday trading day.

The investment strategies based on the January and holiday effects have the lowest returns. This corresponds to earlier reported findings of a relatively weak January effect in the last two decades. The holiday effect generates about the same returns as the January effect, but is invested in the stock market only 3.3% of all trading days in a period of 1963–2008. The January effect is already weak by itself, mostly due to its recent poor performance. For the Weekend and Holiday effect, it is of vital importance that they coincide with the Halloween or T.O.M. effect. This is a striking result, as multivariate linear regression does not account for these non-linear interaction effects. In the remaining 8.5% of the cases on which there is a weekend or a holiday effect without the Halloween or T.O.M. effect, the equity premium is only 0.09% (Swinkels & Van Vliet, 2011).

Holiday effect is described as a totally predictable effect of the stock exchange closing due to national holidays. This affects the performances of the daily return rates. In contrast with daily, weekly or monthly effects, the holiday effect can vary from market to market in time, duration and frequency. One of the known features of the holiday effect is that it has unusual results, in particular, it produces either high or low yields. Recent studies of the holiday effect indicate that the average pre-holiday returns are positive and high if compared with the post-holiday returns. Rates of return in the post-holiday season are consistently significantly positive, but not significantly different from the normal trading days (Faber & Matthews, 2015). It is shown that returns seem to be abnormally high on the last day before holidays, which is consistent with the explanation of Fridays having the highest returns before the weekend (Burton & Shah, 2013).

Dodd and Gakhovich (2011) analysed the holiday effect in the 14 emerging Central and Eastern European (CEE) markets, covering the period 1991–2010, and finding evidence for the holiday effect for 10 out of the 14 CEE markets. Their results show that about 80% of the analysed firms have lower volumes on the day before holidays. According to the authors, this evidence suggests an improvement in market efficiency in the CEE markets, which is consistent with previous findings of Chong, Hudson, Keasey, and Littler (2005) and Marquering, Nisser, and Valla (2006), in what concerns the US market and of Iorgova and Ong (2008), who analysed a sample of emerging European countries.

Dumitriu et al. (2011) analysed the holiday effects in the Romanian stock market in the period 2002–2011, covering a period affected by the global crisis. Although the authors' results did not indicate any effect of the global crisis on the holiday returns, they found evidence of a pre-holiday effect for the main indexes of the stock market. Casado, Muga, and Santamaria (2013) analysed the effect of U.S. holidays in the European markets on European non-holidays for the period 1991–2008, finding evidence of a significant impact of US holidays on the European stock markets returns. They conclude that it is not explained by calendar anomalies, such as the pre-holiday effect, as well as by behavioural finance models, which predict a positive relationship between trading volume and returns (Hong & Stein, 2007). According to the authors, a possible explanation for this evidence is the information and the volume trading.

Studies on emerging stock markets provide consistent results of the holiday effect. For instance, McGuinness and Harris (2011) examined the Chinese Lunar New Year (CNY[1]) return effects in the context of the mainland Chinese and Hong Kong marketplaces. They found positive returns in the three days prior to and one day after the CNY holiday.

The review of scientific literature shows different results of the holiday effect in various financial markets. Whether the holiday effect is significant and to what extent, in relation to the periods before, during and after the global financial crisis in the financial markets of the developing countries (Slovenia, Croatia and Hungary), will be presented onwards.

## 3. Data and methodology

The study sample includes daily values and calculated return rates of the stock exchange indices CROBEX (the representative share index of Croatia), SBI TOP 50 (the representative share index of Slovenia) and BUX (the representative share index of Hungary). The research time period is from 1 January 2003 to 31 December 2016. The returns showing the holiday effect are sampled from the second half of December to mid-January (Christmas and New Year – two holidays). The width of the research time frame makes it possible to test the effectiveness of the model in the period before, during and after the outbreak of the global financial crisis, in the equation. According to (Brooks, 2008) rate of return can be presented:

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

where the $Y_t$ is the logarithmic return rate of the stock index in a time $t$, while $P_t$ and $P_{t-1}$ are empirical values of the observed series in the period $t$ and the prior period, i.e., the period of the first delay.

The paper used the appropriate methodology for volatility modelling and research hypotheses testing. A.R.C.H. and G.A.R.C.H. models were used to confirm the main H0 hypothesis in the study, with the most favourable model representing the significant impact of the holiday effect chosen for each country and for each period.

All models in this paper were estimated using EViews, by the Marquardt algorithm optimisation and Bollerslev and Wooldridge, (1992) method for standard errors estimates. G.A.R.C.H. model parameters are estimated using the quasi-maximum likelihood – QML (Brooks, 2008, p. 399). The maximum likelihood estimation produces asymptotically more efficient estimates than the estimates which can be obtained by using other methods.

The A.R.C.H. model describes the processes in which volatility changes are as follows (Brooks, 2008). The paper uses the A.R.C.H.$(q)$ model for $Y_t$

$$Y_t = c + \varepsilon_t \tag{2}$$

$$\varepsilon_t = \sqrt{h_t \eta_t}, \quad \eta_t{}^{\mathrm{IID}} IID N(0,1) \tag{3}$$

$$h_t = a_0 + \sum_{i=1}^{q} a_i \varepsilon^2{}_{t-i} \tag{4}$$

where $h_t$ is an error variance or a conditional deviation $\varepsilon_t$, according to the available information in a time $t$, $c$ is the constant and $h_t$ represents a conditional variance, i.e., conditional deviation from the $\varepsilon_t$ (a model error, i.e., $\{\varepsilon_t\}$ is an error process in the modelling). The holiday effect has been included in the basic A.R.C.H. model in order to measure the impact, so the used A.R.C.H. model is represented to estimate the A.R.C.H.(5)-model as follows:

$$Y_t = \gamma_0 + \gamma_1 Z'_t \pi + \gamma_2 h_t + \gamma_3 + \varepsilon_t \tag{5}$$

$$h^2{}_t = c + \alpha_1 \varepsilon^2{}_{t-1} + \alpha_2 \varepsilon^2{}_{t-2} + \alpha_3 \varepsilon^2{}_{t-3} + \alpha_4 \varepsilon^2{}_{t-4} + \alpha_5 \varepsilon^2{}_{t-5} + \ \gamma_4 Z'_t \pi \tag{6}$$

where $h^2{}_t$ is a conditional variance, or forecast variance in the coming period, based on the past information, $\gamma$ represents optional parameters of model, $Z'_t\pi$ represents exogenous or predetermined regressors (holiday effect), c represents the A.R.C.H. constant; $\alpha_1 \varepsilon^2{}_{t-1} \dots \ \alpha_5 \varepsilon^2{}_{t-5}$ represent the squares of standardised residuals, i.e., the delay coefficients $\alpha_i$ of the asymmetric tailored fifth-order A.R.C.H. model.

The G.A.R.C.H.(1.1) model for time series has been applied further in the paper (Brooks, 2008)

$$Y_t = c + X'_t \theta + \varepsilon_t \tag{7}$$

$$\varepsilon_t = \sqrt{h_t \eta_t}, \quad \eta_t{}^{\mathrm{IID}} IID N(0,1) \tag{8}$$

$$h_t = a_0 + \sum_{i=1}^{q} a_i \varepsilon^2{}_{t-i} + \sum_{j=1}^{p} b_j h_{t-j} \tag{9}$$

$$h^2{}_t = c + \alpha \varepsilon^2{}_{t-1} + \beta h^2{}_{t-1} \tag{10}$$

where $h_t$ is a conditional variance, i.e., deviation from $\varepsilon_t$, according to the information available in a time $t$, $X'_t\theta$ represents the exogenous variables included in the mean equation, $c$ is constant term, $\varepsilon^2{}_{t-1}$ is a component of the A.R.C.H. model and presents the information about the volatility in the previous period, which was calculated as the lag of squared residuals from the mean equation; $h^2{}_{t-1}$ is a member of the G.A.R.C.H. model and represents the forecast variance for the last period. The G.A.R.C.H.(1.1) model connects a conditional variance $h_t$ with the past squared errors and past conditional variances. The holiday effect has been included in the basic G.A.R.C.H. model in order to measure the impact, so the used G.A.R.C.H. model is now represented as follows:

$$h^2{}_t = c + \sum_{i=1}^{p} \alpha_i \varepsilon^2{}_{t-i} + \sum_{j=1}^{q} \beta_j h^2{}_{t-j} + Z'_t \pi \tag{11}$$

In order to select the best variations of the G.A.R.C.H. model, the following types of G.A.R.C.H. models have been used: the E.G.A.R.C.H. model in the form:

$$\log(h_t) = a_0 + \sum_{i=1}^{q} a_i g(\eta_{t-1}) + \sum_{i=1}^{p} b_i \log(h_{t-i}) \tag{12}$$

where $\varepsilon_t = \sqrt{h_t \eta_t}$ and $g(\eta_t) = \theta\eta_t + \gamma\left[\left|\eta_t - \mathrm{E},\right|\right]\eta_t$, which are the pondered values of innovation in a model with an asymmetric effect between the positive and negative returns of the financial asset, while $\theta$ and $\gamma$ are constant. The holiday effect has been included in the basic E.G.A.R.C.H. model in order to measure the impact, so the used E.G.A.R.C.H. model is now represented as follows:

$$log\ \left(h_t{}^2\right) = c + \sum_{j=1}^{q} \beta_j log\left(h^2{}_{t-j}\right) + \sum_{i=1}^{p} \alpha_i \left|\frac{\varepsilon_{t-i}}{h_{t-i}}\right| + \sum_{k=1}^{r} \gamma_k \frac{\varepsilon_{t-k}}{h_{t-k}} + Z'_t \pi \tag{13}$$

Note that the left-hand side is the log of the conditional variance. This implies that the leverage effect is exponential, rather than quadratic, and that forecasts of the conditional variance are guaranteed to be nonnegative. The presence of leverage effects can be tested by the hypothesis that $\gamma_i < 0$. The impact is asymmetric if $\gamma_i \neq 0$. There are two differences between the EViews specification of the E.G.A.R.C.H. model and the original Nelson model (Nelson, 1991). First, Nelson assumes that the $\varepsilon_t$ follows a generalised error distribution (G.E.D.), while EViews offers you a choice of normal, Student's t-distribution or G.E.D. Second, Nelson's specification for the log conditional variance is a restricted version and the T.A.R.C.H. model that has the following form:

$$h_t{}^2 = w + \sum_{i=1}^{p} \alpha_i \varepsilon_t{}^2 + \sum_{j=1}^{q} \beta_j h_{t-j}{}^2 + \sum_{i=1}^{p} \gamma_i I_{t-i} \varepsilon_{t-i}{}^2 \tag{14}$$

where is $I_{t-i} = \begin{cases} 1\ if\ \ \varepsilon_{t-i} < 0 \\ 0\ if\ \ \varepsilon_{t-i} \geq 0 \end{cases}$, where the function indicator is $I_{t-i}$, while $\alpha$ and $\beta$ represent non-negative parameters that satisfy the condition $\alpha + \beta < 1$. In addition, in the T.A.R.C.H. model, conditional volatility $h_t{}^2$ is positive if $\alpha + \gamma \geq 1$, while the process is stationary in a covariance, if and only if $\left(\alpha + \frac{\gamma}{2}\right) + \beta < 1$. The parameter $\gamma$ measures the asymmetric or leverage effect in the sense that the artificial variable takes the value 1 if the residuals are negative, i.e., the value is 0 if the residuals are non-negative. The basic version of the T.A.R.C.H. model includes the holiday effect to measure the impact, so the T.A.R.C.H. model is now represented as follows:

$$h^2{}_t = c + \sum_{i=1}^{p} \alpha_i \varepsilon^2{}_{t-i} + \sum_{j=1}^{q} \beta_j h^2{}_{t-j} + \sum_{k=1}^{r} \varepsilon^2{}_{t-k} I_{t-k} + Z'_t \pi \tag{15}$$

In the study, the selection of the adequate model was based on A.I.C. (Akaike information criterion) and S.I.C. (Schwarz information criterion) that were used to

**Table 1.** Representative A.I.C. and S.I.C. for the optimal model selection.

| | A.R.C.H. | | G.A.R.C.H. 1.1 | | T.A.R.C.H. | | E.G.A.R.C.H. | |
|---|---|---|---|---|---|---|---|---|
| Period of observation | A.I.C. | S.I.C. | A.I.C. | S.I.C. | A.I.C. | S.I.C. | A.I.C. | S.I.C. |
| **Entire period** | **−6.555113** | **−6.541168** | **−6.632647** | **−6.623931** | **−6.633059** | **−6.622601** | **−6.632859** | **−6.622401** |
| **Pre-crisis** | **−6.324812** | **−6.143800** | **−6.399992** | **−6.286859** | **−6.315287** | **−6.179528** | **−6.375704** | **−6.239945** |
| **Crisis** | **−6.134127** | **−5.883118** | **−6.138416** | **−5.981535** | **−6.110827** | **−5.922571** | **−6.168435** | **−5.980178** |
| **Post-crisis** | **−7.146120** | **−6.922422** | **−7.165631** | **−7.025820** | **−7.149906** | **−6.982133** | **−7.109698** | **−6.941925** |

Source: the author's calculations.

**Table 2.** Heteroscedasticity test: A.R.C.H.

| Dependent variable | Financial market | Probability Chi-square (1) | A.R.C.H. effect |
|---|---|---|---|
| **WGT_RESID○2** | Croatia: CROBEX | 0.5922; $p = 0.5922 > 5\%$ | |
| **WGT_RESID○2** | Hungary: BUX | 0.6463; $p = 0.6463 > 5\%$ | |
| **WGT_RESID○2** | Slovenia: SBI TOP | 0.9441; $p = 0.9941 > 5\%$ | |

Source: the author's calculations.

**Table 3.** Augmented Dickey–Fuller (DF) test statistic.

| Period of observation | Financial market | DF test statistic t-value | 5% level | 1% level | Probability |
|---|---|---|---|---|---|
| **Pre-crisis** | **Croatia: CROBEX** | −19.33206 | −2.863022 | −3.433962 | 0.0000 |
| **Crisis** | | −9.522169 | −2.903566 | −3.527045 | 0.0000 |
| **Post-crisis** | | −9.396194 | −2.895924 | −3.509281 | 0.0000 |
| **Pre-crisis** | **Hungary: BUX** | −8.222808 | −2.885450 | −3.485115 | 0.0000 |
| **Crisis** | | −5.042427 | −2.914517 | −3.552666 | 0.0000 |
| **Post-crisis** | | −10.35023 | −2.894332 | −3.505595 | 0.0000 |
| **Pre-crisis** | **Slovenia: SBI TOP** | −8.721652 | −2.885249 | −3.484653 | 0.0000 |
| **Crisis** | | −9.481863 | −2.902358 | −3.524233 | 0.0000 |
| **Post-crisis** | | −6.838515 | −2.901779 | −3.522887 | 0.0000 |

Source: the author's calculations.

confirm H1 that assumes significant differences in the results of models in different financial markets in pre-crisis, crisis and post-crisis periods. According to Gujarati (2010), information criteria can be calculated as follows:

$$AIC = \ln\left(\hat{\sigma}^2\right) + \frac{2k}{T} \tag{16}$$

$$SIC = \ln\left(\hat{\sigma}^2\right) + \frac{k}{T}\ln T \tag{17}$$

$$HQC = \ln\left(\hat{\sigma}^2\right) + \frac{2k}{T}\ln(\ln(T)) \tag{18}$$

where $\hat{\sigma}^2$ is a residual variance, which is equivalent to the residual sum of the squares divided by the number of observations in the series, $k = p + q + 1$ is the total number of estimated parameters and $T$ is the sample size. From the above criteria, the strictest penalties are imposed by the S.I.C. Although, according to Brooks (2008), the best criterion cannot be claimed, the most favourable models in the study were chosen according to the lowest A.I.C (Table 1).

**Table 4.** The estimated parameters of the chosen A.R.C.H. and G.A.R.C.H. models for CROBEX in different observation periods.

| CROBEX entire period | | CROBEX pre-crisis period | | CROBEX crisis period | | CROBEX post-crisis | |
|---|---|---|---|---|---|---|---|
| Variance equation A.R.C.H. | | Variance equation T.A.R.C.H. | | Variance equation T.A.R.C.H. | | Variance equation E.G.A.R.C.H. | |
| C | 2.82E-05 | C | 7.83E-05 | C | 1.83E-05 | C(1) | −13.96991 |
| | (0.0000) | | (0.0000) | | (0.0000) | | (0.0000) |
| RESID(-1)^2 | 0.212833 | RESID(-1)^2 | 0.128260 | RESID(-1)^2 | −0.155875 | C(2) | −0.448083 |
| | (0.0000) | | (0.4801) | | (0.0018) | | (0.0524) |
| RESID(-2)^2 | 0.233901 | RESID(-1)^2*(RESID(-1)<0) | −0.151717 | RESID(-1)^2*(RESID(-1)<0) | 0.105070 | C(3) | −0.002972 |
| | (0.0000) | | (0.4308) | | (0.2061) | | (0.9855) |
| RESID(-3)^2 | 0.113847 | GARCH(-1) | 0.257815 | GARCH(-1) | 0.976701 | C(4) | −0.419159 |
| | (0.0000) | | (0.0201) | | (0.0000) | | (0.1733) |
| RESID(-4)^2 | 0.163192 | EF_HOL | −3.22E-05 | EF_HOL | −8.78E-06 | EF_HOL | 0.161163 |
| | (0.0000) | | (0.0000)* | | (0.1391) | | (0.5336) |
| RESID(-5)^2 | 0.151596 | – | – | – | – | – | – |
| | (0.0000) | | | | | | |
| EF_ HOL | −0.000108 | – | – | – | – | – | – |
| | (0.0000)* | | | | | | |

C represents the A.R.C.H. constant; RESID (-1 … -5)^2 represent the squares of standardised residuals, i.e., the delay coefficients of the asymmetric tailored fifth-order A.R.C.H. model; EF_HOL represents the independent holiday effect variable; C and C (1) are constants; RESID (-1)^2 is the square of standardised residuals, i.e., the delay coefficient of the asymmetric tailored first-order T.A.R.C.H. model; G.A.R.C.H. (-1) is the G.A.R.C.H. effect of the univariate T.A.R.C.H. model; RESID(-1)^2*(RESID(-1)<0) is the asymmetric or leverage effect; C(2) is the A.R.C.H. effect; C(3) is the leverage effect; C(4) is the G.A.R.C.H. effect. *P*-values are given in parentheses below each coefficient value, where **, * represent statistical significance at 10% and 5%, respectively.
Source: the author's calculations.

**Table 5.** Sample distribution in the different observation periods.

| CROBEX entire period | | CROBEX pre-crisis | | CROBEX crisis | | CROBEX post-crisis | |
|---|---|---|---|---|---|---|---|
| Series: standardised residuals | | Series: standardised residuals | | Series: standardised residuals | | Series: standardised residuals | |
| Sample 1 3541 | | Sample 1 125 | | Sample 1 73 | | Sample 1 89 | |
| Observations 3541 | | Observations 125 | | Observations 73 | | Observations 89 | |
| Mean | −0.008571 | Mean | 0.028126 | Mean | 0.058701 | Mean | −0.044646 |
| Median | −0.031468 | Median | 0.058607 | Median | −0.021071 | Median | −0.155299 |
| Maximum | 9.459573 | Maximum | 2.814888 | Maximum | 2.509448 | Maximum | 2.570402 |
| Minimum | −7.882703 | Minimum | −4.057353 | Minimum | −2.060992 | Minimum | −3.825913 |
| Std. Dev. | 1.001949 | Std. Dev. | 1.006023 | Std. Dev. | 1.041225 | Std. Dev. | 1.005436 |
| Skewness | −0.117004 | Skewness | −0.641383 | Skewness | 0.142545 | Skewness | −0.078027 |
| Kurtosis | 10.58005 | Kurtosis | 5.389177 | Kurtosis | 2.438083 | Kurtosis | 4.641082 |
| Jarque–Bera | 8485.399 | Jarque–Bera | 2.814888 | Jarque–Bera | 1.207625 | Jarque–Bera | 10.07741 |
| Probability | 0.000000 | Probability | 0.000000 | Probability | 0.546723 | Probability | 0.006482 |

Source: the author's calculations.

**Table 6.** Representative A.I.C. and S.I.C. for the optimal model selection.

| | A.R.C.H. | | G.A.R.C.H. 1.1 | | T.A.R.C.H. | | E.G.A.R.C.H. | |
|---|---|---|---|---|---|---|---|---|
| Period of observation | A.I.C. | S.I.C. | A.I.C. | S.I.C. | A.I.C. | S.I.C. | A.I.C. | S.I.C. |
| **Entire period** | **−6.835185** | **−6.745473** | **−6.922435** | **−6.871172** | **−6.995449** | **−6.931370** | **−6.961973** | **−6.897894** |
| **Pre-crisis** | **−7.155355** | **−6.979770** | **−6.382984** | **−6.273244** | **−6.274176** | **−6.142488** | **−7.111575** | **−6.979887** |
| **Crisis** | **−6.794898** | **−6.547695** | **−6.851060** | **−6.696561** | **−6.827319** | **−6.641920** | **−6.860077** | **−6.674678** |
| **Post-crisis** | **−5.972111** | **−5.735622** | **−5.968398** | **−5.820593** | **−6.011787** | **−5.834420** | **−5.965421** | **−5.788055** |

Source: the author's calculations.

In order to quantify the impact of the holiday effect, G.A.R.C.H. 1.1, T.A.R.C.H. and E.G.A.R.C.H. models including macroeconomic factors movements were applied for all the returns in the developing countries in the observation periods (entire period, pre-crisis, crisis and post-crisis). Then, based on A.I.C., S.I.C. and HQC information criteria, the most optimal model was selected among A.R.C.H., G.A.R.C.H. 1.1, T.A.R.C.H. and E.G.A.R.C.H. models for all the observed periods, and separately for each observed financial market (Slovenia, Croatia and Hungary). Finally, the result comparison of the selected most optimal A.R.C.H./G.A.R.C.H. models have been presented in order to quantify the impact of the holiday effect and test the hypotheses.

## 4. Results and discussion

In this part of the study, the results of the research on the A.R.C.H. and G.A.R.C.H. models will be presented, as well as the analysis, testing and quantification of the impact of the holiday effect on yields from investing activities in the financial markets of developing countries. First, for each observed country individually, there will be made a heteroscedasticity test: A.R.C.H. and augmented Dickey–Fuller test statistic selection in pre-crisis, crisis and post-crisis periods (Table 2 and 3). Second, for each observed country individually, there will be made a selection of the best econometric models in pre-crisis, crisis and post-crisis periods, and then, the movement of the residuals will be graphically presented (Figures 1, 2 and 3). The following tables will present the best econometric models, as well as to display the normal distribution of the sample depending on the period of observation (Tables 4, 5, 6, 7, 8, 9, 10 and 11).

**Table 7.** The estimated parameters of the chosen A.R.C.H. and G.A.R.C.H. models for SBI TOP 50 in different observation periods.

| SBI TOP 50 entire period | | SBI TOP 50 pre-crisis | | SBI TOP 50 crisis | | SBI TOP 50 post-crisis | |
|---|---|---|---|---|---|---|---|
| Variance equation A.R.C.H. | | Variance equation T.A.R.C.H. | | Variance equation A.R.C.H. | | Variance equation E.G.A.R.C.H. | |
| C | 1.72E-05<br>(0.0000) | C | 6.73E-05<br>(0.2704) | C | 3.56E-05<br>(0.0285) | C(1) | −14.95802<br>(0.0000) |
| RESID(-1)^2 | 0.221296<br>(0.0000) | RESID(-1)^2 | 0.147923<br>(0.4094) | RESID(-1)^2 | 0.191918<br>(0.2652) | C(2) | 0.598978<br>(0.0011) |
| RESID(-2)^2 | 0.134729<br>(0.0005) | RESID(-1)^2*(RESID(-1)<0) | 0.047586<br>(0.8841) | RESID(-2)^2 | 0.014682<br>(0.9223) | C(3) | 0.390889<br>(0.8580) |
| RESID(-3)^2 | −0.003357<br>(0.6365) | GARCH(-1) | 0.588814<br>(0.0925) | RESID(-3)^2 | 0.105459<br>(0.6522) | C(4) | −0.471058<br>(0.0003) |
| RESID(-4)^2 | 0.037369<br>(0.1873) | EF_HOL | 1.63E-05<br>(0.1445) | RESID(-4)^2 | 0.150423<br>(0.4741) | EF_HOL | −0.120786<br>(0.0886)** |
| RESID(-5)^2 | 0.208143<br>(0.0000) | – | – | RESID(-5)^2 | −0.069973<br>(0.4419) | – | – |
| EF_HOL | 4.56E-06<br>(0.0052)* | – | – | EF_HOL | −7.55E-06<br>(0.5293) | – | – |

C represents the A.R.C.H. constant; RESID (-1 … -5)^2 represent the squares of standardised residuals, i.e., the delay coefficients of the asymmetric tailored fifth-order A.R.C.H. model; EF_HOL represents the independent holiday effect variable; C and C (1) are constants; RESID (-1)^2 is the square of standardised residuals, i.e., the delay coefficient of the asymmetric tailored first-order T.A.R.C.H. model; G.A.R.C.H. (-1) is the G.A.R.C.H. effect of the univariate T.A.R.C.H. model; RESID(-1)^2*(RESID(-1)<0) is the asymmetric or leverage effect; C(2) is the A.R.C.H. effect; C(3) is the leverage effect; C(4) is the G.A.R.C.H. effect. *p*-values are given in parentheses below each coefficient value, where **, * represent statistical significance at 10% and 5% respectively.
Source: the author's calculations.

**Table 8.** Sample distribution in the different observation periods.

| SBI TOP 50 entire period | | SBI TOP 50 pre-crisis | | SBI TOP 50 crisis | | SBI TOP 50 post-crisis | |
|---|---|---|---|---|---|---|---|
| Series: standardised residuals | | Series: standardised residuals | | Series: standardised residuals | | Series: standardised residuals | |
| Sample 1285 | | Sample 1 131 | | Sample 1 75 | | Sample 1 81 | |
| Observations 285 | | Observations 131 | | Observations 75 | | Observations 81 | |
| Mean | 0.141217 | Mean | 0.101843 | Mean | 0.016730 | Mean | 0.016299 |
| Median | 0.070712 | Median | 0.056138 | Median | 0.015533 | Median | −0.014194 |
| Maximum | 2.949972 | Maximum | 3.004304 | Maximum | 1.926733 | Maximum | 2.505444 |
| Minimum | −7.060768 | Minimum | −5.459090 | Minimum | −2.439421 | Minimum | −2.302194 |
| Std. Dev. | 0.993683 | Std. Dev. | 0.997129 | Std. Dev. | 1.000159 | Std. Dev. | 0.990553 |
| Skewness | −1.386003 | Skewness | −1.223786 | Skewness | −0.221548 | Skewness | 0.173417 |
| Kurtosis | 12.95770 | Kurtosis | 10.87503 | Kurtosis | 2.715690 | Kurtosis | 2.749487 |
| Jarque–Bera | 1268.724 | Jarque–Bera | 371.2033 | Jarque–Bera | 0.866141 | Jarque–Bera | 0.617797 |
| Probability | 0.000000 | Probability | 0.000000 | Probability | 0.648515 | Probability | 0.734255 |

Source: the author's calculations.

**Table 9.** Representative A.I.C. and S.I.C. for the optimal model selection.

| | A.R.C.H. | | G.A.R.C.H. 1.1 | | T.A.R.C.H. | | E.G.A.R.C.H. | |
|---|---|---|---|---|---|---|---|---|
| Period of observation | A.I.C. | S.I.C. | A.I.C. | S.I.C. | A.I.C. | S.I.C. | A.I.C. | S.I.C. |
| **Entire period** | **−6.162578** | **−6.070996** | **−6.146148** | **−6.093815** | **−6.161956** | **−6.096541** | **−6.147283** | **−6.081868** |
| **Pre-crisis** | **−6.129076** | **−5.950824** | **−6.147154** | **−6.035747** | **−6.148855** | **−6.015166** | **−6.192201** | **−6.058512** |
| **Crisis** | **−5.127008** | **−4.854864** | **−5.182080** | **−5.011990** | **−5.122772** | **−5.018664** | **−5.175277** | **−4.971169** |
| **Post-crisis** | **−6.551556** | **−6.332270** | **−6.666553** | **−6.529499** | **−6.557062** | **−6.392597** | **6.661281** | **−6.496817** |

Source: the author's calculations.

Table 12 presents a comparative presentation of the results of the holiday effect impact for the case studies of Croatia, Slovenia and Hungary. Finally for each observed country individually, there will be made a post-checking and forecast influence of holiday effects (Table 13).

In the following section, the results of the case study for Croatia will be presented.

Best model selection based on the given criteria demonstrates that there is a significant impact of the holiday effect on the daily return rates on the CROBEX stock exchange index. In the observed periods (the entire period, the pre-crisis period, the crisis period), the negative influence of the holiday effect variable on the rates of return has also been proven, but a statistically significant influence of the holiday effect is confirmed throughout the entire period and in the pre-crisis period. In the observed post-crisis period, the positive influence of the holiday effect variable on the rates of return has been noted, but it is not statistically significant. From the obtained model functions, it is deduced that the holiday effect is differently manifested depending on the observed period.

For the entire period 2003–2016, the normal distribution does not exist. The distributions are more elongated, which is the characteristic of developed financial markets, as well as the negative asymmetry. As for the other periods, they show different estimates of normal distribution in the observed periods, indicating a small number of observations and a stronger influence of the holiday effect on the movement of the daily return rates on the stock exchange index CROBEX.

In the following section, the results of the case study for Slovenia will be presented.

**Table 10.** The estimated parameters of the chosen A.R.C.H. and G.A.R.C.H. models for BUX in different observation periods.

| BUX entire period | | BUX pre-crisis | | BUX crisis | | BUX post-crisis | |
|---|---|---|---|---|---|---|---|
| Variance equation G.A.R.C.H. 1.1 | | Variance equation A.R.C.H. | | Variance equation T.A.R.C.H. | | Variance equation A.R.C.H. | |
| C | 8.16E-05<br>(0.2119) | C | 0.000145<br>(0.0003) | C | 0.000181<br>(0.0155) | C | 0.000109<br>(0.0001) |
| RESID(-1)^2 | −0.065659<br>(0.1744) | RESID(−1)^2 | −0.037258<br>(0.7608) | RESID(−1)^2 | −0.217019<br>(0.1062) | RESID(−1)^2 | −0.142408<br>(0.1373) |
| GARCH(−1) | 0.404671<br>(0.4310) | RESID(−2)^2 | −0.023704<br>(0.7558) | RESID(−1)^2*(RESID (−1)<0) | 0.575088<br>(0.1561) | RESID(−2)^2 | −0.140016<br>(0.0126) |
| EF_HOL | 3.60E − 06<br>(0.5618) | RESID(−3)^2 | 0.009699<br>(0.9246) | GARCH(−1) | 0.356090<br>(0.1261) | RESID(−3)^2 | 0.031008<br>(0.8392) |
| – | – | RESID(-4)^2 | −0.012604<br>(0.9025) | EF_HOL | 8.77E-05<br>(0.0877)** | RESID(-4)^2 | 0.041225<br>(0.6417) |
| – | – | RESID(-5)^2 | −0.131319<br>(0.3001) | – | – | RESID(-5)^2 | −0.144770<br>(0.0023) |
| – | – | EF_HOL | 1.58E-05<br>(0.0871)** | – | – | EF_HOL | 5.16E-06<br>(0.6542) |

C represents the A.R.C.H. constant; RESID (-1 … -5)^2 represent the squares of standardised residuals, i.e., the delay coefficients of the asymmetric tailored fifth-order A.R.C.H. model; EF_HOL represents the independent holiday effect variable; C is the constant; RESID (-1)^2 is the square of standardised residuals, i.e.. the delay coefficient of the asymmetric tailored first-order model; G.A.R.C.H. (-1) is the G.A.R.C.H. effect of the univariate T.A.R.C.H. and G.A.R.C.H. 1.1 models; RESID(-1)^2*(RESID(-1)<0) is the asymmetric or leverage effect; C(2) is the A.R.C.H. effect; C(3) is the leverage effect; C(4) is the G.A.R.C.H. effect. *p*-values are given in parentheses below each coefficient value, where **, * represent statistical significance at 10% and 5% respectively.
Source: the author's calculations.

**Table 11.** Sample distribution in the different observation periods.

| BUX entire period | | BUX pre-crisis | | BUX crisis | | BUX post-crisis | |
|---|---|---|---|---|---|---|---|
| Series: standardised residuals | | Series: standardised residuals | | Series: standardised residuals | | Series: standardised residuals | |
| Sample 1277 | | Sample 1 128 | | Sample 1 63 | | Sample 1 92 | |
| Observations 277 | | Observations 128 | | Observations 63 | | Observations 92 | |
| Mean | 0.076933 | Mean | −0.090499 | Mean | 0.028008 | Mean | 0.105043 |
| Median | 0.098252 | Median | −0.105309 | Median | 0.090799 | Median | 0.174174 |
| Maximum | 2.954016 | Maximum | 2.010965 | Maximum | 2.076887 | Maximum | 2.676952 |
| Minimum | −3.192877 | Minimum | −2.735570 | Minimum | −2.284417 | Minimum | −3.113359 |
| Std. Dev. | 0.998917 | Std. Dev. | 0.998441 | Std. Dev. | 1.003684 | Std. Dev. | 0.994147 |
| Skewness | −0.045812 | Skewness | −0.059691 | Skewness | −0.030252 | Skewness | −0.509102 |
| Kurtosis | 2.932179 | Kurtosis | 2.510324 | Kurtosis | 2.558917 | Kurtosis | 3.929565 |
| Jarque–Bera | 0.149979 | Jarque–Bera | 1.354850 | Jarque–Bera | 0.520315 | Jarque–Bera | 7.286521 |
| Probability | 0.927753 | Probability | 0.507923 | Probability | 0.770930 | Probability | 0.026167 |

Source: the author's calculations.

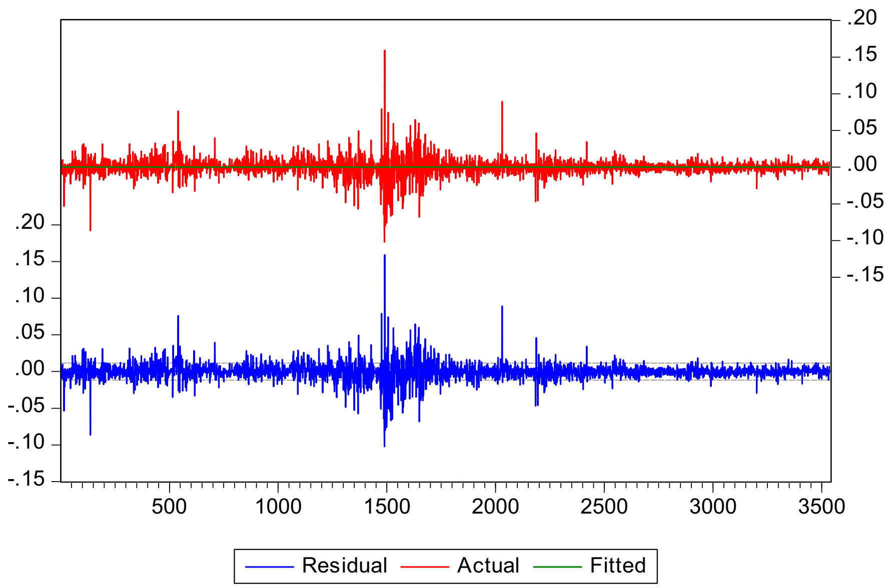


**Figure 1.** Residual trends of CROBEX for the observation period 2003–2016.
Source: the author's calculations.

Best model selection based on the given criteria demonstrates that there is a significant impact of the holiday effect on the daily return rates on the SBI TOP 50 stock exchange index. In the observed periods (the entire period, the pre-crisis period, the crisis period and the post-crisis period), the influence of the holiday effect variable on the rates of return has also been proven, but a statistically significant influence of the holiday effect is confirmed throughout the entire period and in the pre-crisis period. From the obtained model functions, it is deduced that the positive holiday effect is manifested in the entire period (statistical significance confirmed) and the pre-crisis periods, while the negative holiday effect is observed in the crisis and the post-crisis periods. The statistical significance was confirmed in the post-crisis period.

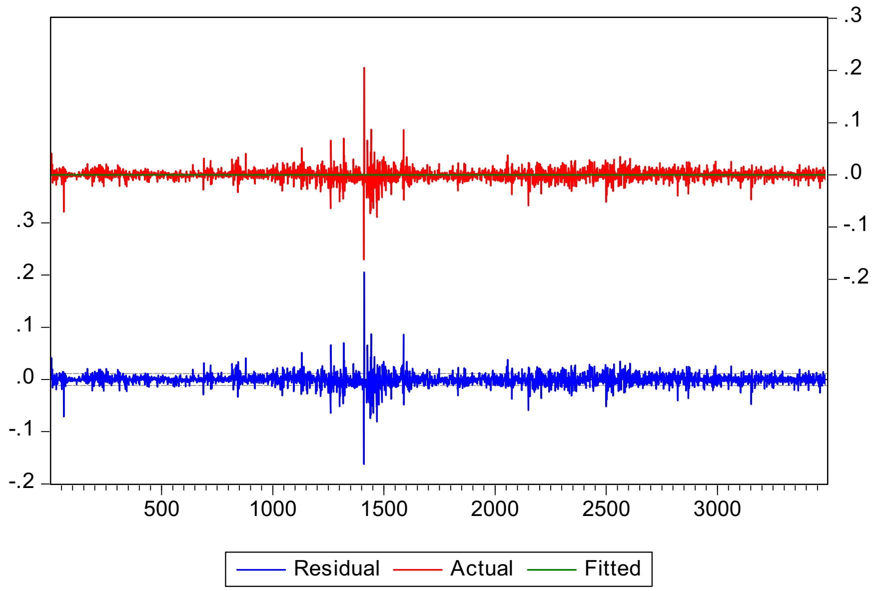


**Figure 2.** Residual trends of SBI TOP 50 for the observation period 2003–2016.
Source: the author's calculations.

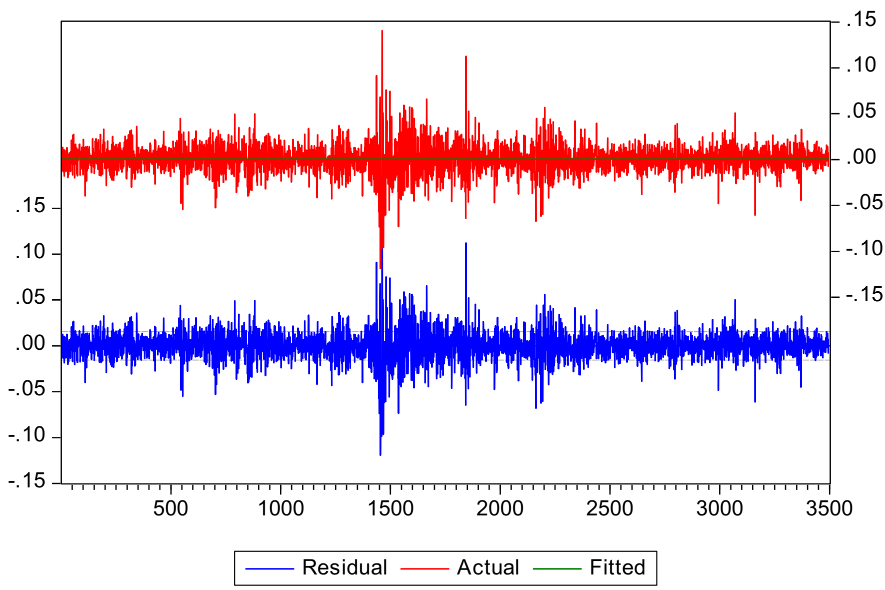


**Figure 3.** Residuals trends of BUX for the observation period 2003–2016.
Source: the author's calculations.

For the entire period 2003–2016, the normal distribution does not exist. The distributions are more elongated in the entire and pre-crisis periods, which is the characteristic of developed financial markets, while the elongation is normal in the crisis and post-crisis periods. The negative asymmetry is the characteristic of developed financial markets, as well. However, in the post-crisis period, SBI TOP 50 has the positive asymmetry. As for the other periods, they show different estimates of normal

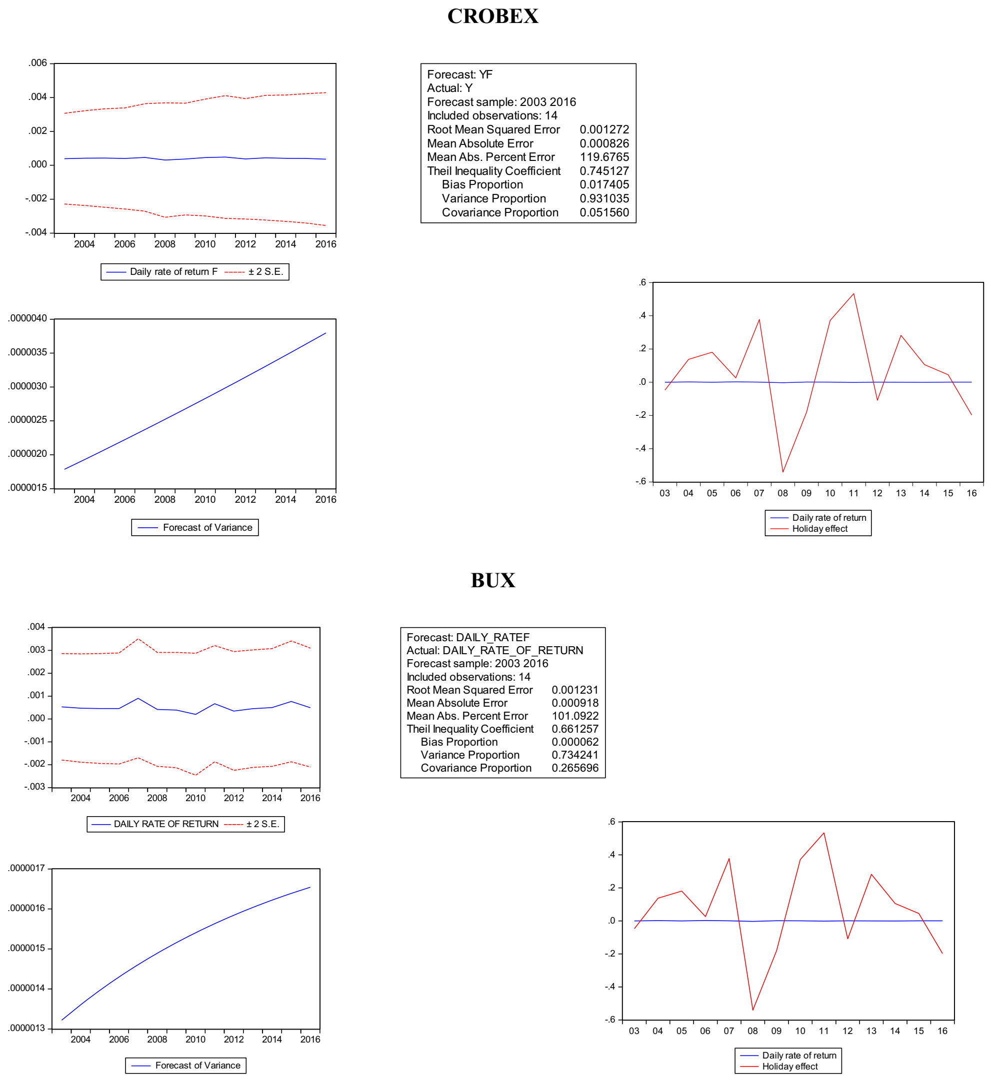


**Figure 4.** Evaluation of checking influence of holiday effect on daily rates of the return. Source: the author's calculations.

distribution in the observed periods, indicating a small number of observations and a stronger influence of the holiday effect on the movement of the daily return rates on the stock exchange index SBI TOP 50.

In the following section, the results of the case study for Hungary will be presented.

Best model selection based on the given criteria demonstrates that there is a significant impact of the holiday effect on the daily return rates of the BUX stock exchange index. In the observed periods (the entire period, the pre-crisis period, the crisis period and the post-crisis period), the positive influence of the holiday effect variable on the rates of return has also been proven, but a statistically significant influence of the holiday effect is confirmed in the pre-crisis and crisis periods. From

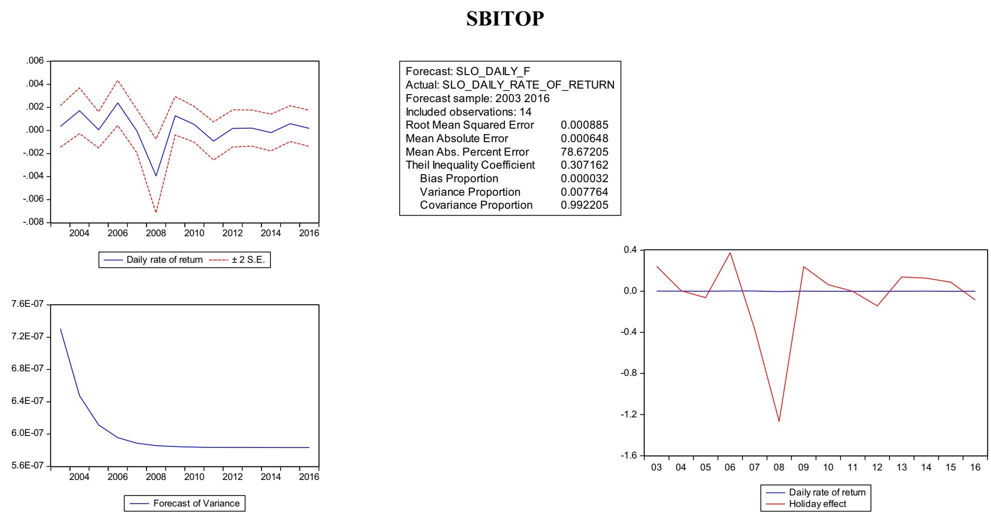


**Figure 4.** Continued.

the obtained model functions, it is deduced that the positive holiday effect was differently manifested depending on the observed period.

For the entire period 2003–2016, the normal distribution does not exist. The distributions are more elongated in the entire, pre-crisis and crisis periods, which is the characteristic of developed financial markets, while the elongation is normal in the crisis and the post-crisis periods. The negative asymmetry is the characteristic of developed financial markets, as well. As for the other periods, they show different estimates of normal distribution in the observed periods, indicating a small number of observations and a stronger influence of the holiday effect on the movement of the daily return rates on the stock exchange index BUX.

Table 12 shows the comparative overview of the impact of the holiday effect on the return rates measured (quantified) by choosing the optimal econometric model, based on information criteria in the observed countries, in the case studies of Croatia, Slovenia and Hungary. Figure 4 shows evaluation of checking influence of holiday effect on daily rates of the return in the observed markets. In the case study of the Croatian financial market, the holiday effect has a negative impact on the return rates in the observed periods (entire period, pre-crisis and crisis), while the positive impact of holiday effect was recorded in the post-crisis period. The holiday effect records statistical significance in the entire period and pre-crisis period. For CROBEX, the values of asymmetric distribution for the entire period (−0.12), as well as pre-crisis (−0.64) and post-crisis (−0.08) periods show the curvature to the left, which means that the asymmetry is slightly negative, i.e., the left (negative) tail in the distribution of daily returns is longer, implying multiple negative trends of CROBEX indices in those periods, which is not the case for the crisis period (0.14). The skewness values of CROBEX indices for the entire observed period (10.58), pre-crisis (5.38) and post-crisis (4.64) periods were over 3 and indicate extreme returns and high investment risk. The skewness in the crisis period (2.44) shows values below 3 which means that the probability of extreme return movements of CROBEX indices was low.

**Table 12.** Comparative presentation of the research results.

| CROBEX | | | | | SBI TOP 50 | | | | | BUX | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Model | Period | Result EF_Holiday | Skewness | Kurtosis | Model | Period | Result EF_Holiday | Skewness | Kurtosis | Model | Period | Result EF_Holiday | Skewness | Kurtosis |
| A.R.C.H. | Entire | −0.000108* | −0.12 | 10.58 | A.R.C.H. | Entire | 4.56E-06* | −1.38 | 12.96 | G.A.R.C.H. 1.1 | Entire | 3.60E-06 | −0.05 | 2.93 |
| T.A.R.C.H. | Pre-crisis | −3.22E-05* | −0.64 | 5.38 | T.A.R.C.H. | Pre-crisis | 1.63E-05 | −1.22 | 10.87 | A.R.C.H. | Pre-crisis | 1.58E-05** | −0.06 | 2.51 |
| T.A.R.C.H. | Crisis | −8.78E-06 | 0.14 | 2.44 | A.R.C.H. | Crisis | −7.55E-06 | −0.22 | 2.71 | T.A.R.C.H. | Crisis | 8.77E-05** | −0.03 | 2.56 |
| E.G.A.R.C.H. | Post-crisis | 0.161163 | −0.08 | 4.64 | E.G.A.R.C.H. | Post-crisis | −0.12078** | 0.17 | 2.75 | A.R.C.H. | Post-crisis | 5.16E-06 | −0.51 | 3.93 |

*Statistical significance at 5% level.
**Statistical significance at 10% level.
Source: the author's calculations.

**Table 13.** Evaluation of post-checking influence of holiday effect on daily rates of the return.

| Forecast of the holiday effect – entire period | −10% | −5% | 0 | 5% | 10% |
|---|---|---|---|---|---|
| **Daily return A.R.C.H. – CROBEX** | .008753869 | .008753000 | .008752610 | .008753636 | .008753582 |
| **Daily return A.R.C.H. – SBITOP** | .005981841 | .005981843 | .005981800 | .005981848 | .005981850 |
| **Daily return G.A.R.C.H. 1.1 – BUX** | .000569622 | .000569618 | .000569700 | .000569609 | .000569604 |

Source: the author's calculations.

The case study of Slovenia shows that holiday effect had a positive impact on the return rate on the stock exchange indices in the entire and pre-crisis observation periods, while in the crisis and post-crisis periods, it recorded a negative impact. The holiday effect records statistical significance in the entire period and post-crisis period. For SBI TOP 50, the values of asymmetric distribution for the entire period (−1.38), as well as pre-crisis (−1.22) and crisis (−0.22) periods show the curvature to the left, which means that the asymmetry is negative, i.e., the left (negative) tail in the distribution of daily returns is longer, implying multiple negative trends of the SBI TOP 50 indices in those periods, which is not the case for post-crisis period (0.17). The skewness values of the SBI TOP 50 indices for the entire observed period (12.96) and pre-crisis period (10.87) were over 3 and indicate extreme returns and high investment risk. The skewness values for the (2.71) and post-crisis (2.75) periods were below 3, which means that the probability of extreme return movements of the SBI TOP 50 indices was low.

The case study of the Hungarian financial market shows that the holiday effect has a positive impact on the return rate on the stock exchange index in all observation periods (entire period, pre-crisis, crisis and post-crisis). The holiday effect records statistical significance in the pre-crisis period and crisis period. For all the observed financial markets (Croatia, Slovenia and Hungary), the non-normality of the sample distribution is detected, as well as the different asymmetry (skewness) and distortion (kurtosis) in different observation periods (entire period, pre-crisis, crisis and post-crisis). For BUX, the values of asymmetric distribution for the entire period (−0.05), pre-crisis (−0.06), crisis (−0.03) and post-crisis (−0.51) periods show the curvature to the left, which means that the asymmetry is negative, i.e., the left (negative) tail in the distribution of daily returns is longer, implying multiple negative trends of the BUX indices in all the observed periods. The skewness values of BUX indices for the entire observed period (2.93), pre-crisis (2.51) and crisis (2.56) periods were below 3 and indicate a low probability of extreme returns. The skewness value for post-crisis (3.93) period was over 3, which indicates extreme return movements and high investment risk.

## 5. Conclusion

The study results undoubtedly indicate the importance of the research aim through the prism of validation, quantification and optimisation of the holiday effect in investing activities in the modern business environment. In practice, the study tests the place, role and importance of the holiday effect on the estimated daily return rates in the emerging financial markets of Croatia, Slovenia and Hungary. With the research focus on the financial markets of the developing countries, the authors emphasised the importance of the analysis and optimisation of the model performance in investing activities in the very unstable financial markets with low efficiency in the pre-crisis, crisis and post-crisis periods.

The scientific contribution of the study indicates the quality and importance of the research results, as well as in the possibilities of effective implementation methods that quantify the significance of the impact of the holiday effect on the daily return rates from investing activities in the observed financial markets of developing countries, in the context of risk management investments, which significantly expand the research field. The practical research contribution is reflected in the extended possibilities of efficient application of the estimated holiday effect on the daily return rates in the daily decision-making and investment processes.

A couple of hypotheses were tested in the study. Assuming that the application of A.R.C.H. and G.A.R.C.H. model successfully tests the impact of holiday effect on effective returns of the investment activity in the financial markets of the observed countries, the main hypothesis H0 has been confirmed. In the financial markets of the developing countries, namely Slovenia, Hungary and Croatia, the exact correlation between the movements in the daily return rates of stock exchange indices and the impact of the holiday effect for all observed periods (entire period, pre-crisis, crisis and post-crisis) has been found. Incorporating the impact of the holiday effect, the basic A.R.C.H. and G.A.R.C.H. models were expanded. The results obtained here are more favourable and contribute to the optimisation of the investment strategy. A.I.C. and S.I.C. information criteria were used in the research to select a more favourable model between A.R.C.H. and G.A.R.C.H. models with all variations (G.A.R.C.H. 1.1, E.G.A.R.C.H., T.A.R.C.H.) in different financial markets in the pre-crisis, crisis and post-crisis periods. It has been concluded that the same model cannot be used in each financial market to quantify the holiday effect that will have the best-estimated model parameters. Additionally, it can be concluded that the application of A.R.C.H. and G.A.R.C.H. models in the financial markets of developing countries successfully tested the impact of holiday effect and that it contributes to the optimisation of the investment strategy with well-defined results of both positive and negative impacts of holiday effect on the movement of the daily return rates in the observed financial markets.

Claiming that the use of A.R.C.H. and G.A.R.C.H. models shows the various impacts of the holiday effect in the pre-crisis, crisis and post-crisis periods, the hypothesis H1 has also been confirmed. This means that the research results show that the impact of holiday effect is different in various periods: pre-crisis, crisis and post-crisis periods. In the financial markets of Croatia, Slovenia and Hungary, the evidence was found that in all observation periods (the entire period, pre-crisis, crisis and post-crisis), the holiday effect recorded a different degree of correlation (the intensity of the correlation link ranging from $-1$ up to $+1$) with the movement of daily return rates depending on the observation period. The acceptance of the first auxiliary hypothesis means that the use of A.R.C.H. and G.A.R.C.H. models can determine the correct correlation between the effect of the 'holiday effect' and the daily rates of returns of stock exchange indexes in pre-crisis, crisis and post-crisis periods.

Based on the research results, the negative impact of the variable holiday effect on the return rates on the stock exchange index of the Croatian financial market in the observed periods was confirmed (whole period, pre-crisis, crisis), while in the post-crisis period, the holiday effect has a positive impact. The case study of Slovenian financial market proves that the holiday effect has a positive effect on the return rate on the stock exchange index in the entire observation period and the pre-crisis period, while in crisis and post-crisis periods, it has negative impacts. The research results of the Hungarian financial market show a positive impact of the holiday effect on the return rates in all the observed periods (entire period, pre-crisis, crisis and post-crisis). It is concluded that in all the observed financial markets (Croatia, Slovenia and Hungary), for the period 2003–2016, the non-normality of the sample distribution is detected, as well as the different sample asymmetry (skewness) and distortion (kurtosis).

The above-mentioned facts show the importance of testing the differences between the various models of the impact estimation of the holiday effect and their various 'behaviours' in the certain market conditions and the observed periods. The observed markets in the pre-crisis, crisis and post-crisis periods require a holistic, comprehensive and systematic approach to the analysis, quantification and validation of investment expectations. The special quality of the research results stems from the fact that the study is focused on the financial markets of developing countries of Croatia, Slovenia and Hungary, where there have been a relatively small number of studies on this subject. The research realised in the dissertation and the obtained results provide new knowledge about the dynamic relationship between the daily return rates and the impact of the holiday effect in the observed financial markets of developing countries. The testing of the holiday effect impact using the A.R.C.H. and G.A.R.C.H. models makes a scientific, i.e., academic contribution, which also opens opportunities for further research in the field. The results obtained by the research have multiple relevancies, especially for domestic and international investors (institutional investors, investment funds, portfolio managers, market analysts and others), which confirms the practical contribution of the dissertation. The obtained results help domestic and international investors in the process of defining an optimal investment strategy, as well as making investment decisions in the financial markets of developing countries. The results of the research indicate the practical contribution of whether the appropriate investment strategy should be applied and in which markets, depending on the economic conditions (in the pre-crisis, crisis and post-crisis periods) in order to protect and reduce the risks of investing.

The research results and the derived conclusions provide quantitative evidence of the exact interdependence of the holiday effect impact on the daily return rates of the stock exchange indices in the observed developing countries in different periods. The obtained results undoubtedly prove the significance of the impact of the holiday effect, which affects the optimal investment decision-making in the segmented observation periods (pre-crisis, crisis and post-crisis). The research objectives (both general and special) were fully accomplished, i.e., a comprehensive quality knowledge tested in practice was gained about the possibilities and specific effects of the practical application of A.R.C.H. and G.A.R.C.H. models in the financial markets of developing countries. The special quality of the research is reflected in its broad time span, in the sense that the research is focused on the periods before, during and after the outbreak of the global economic and financial crisis, which ensures full representation of the obtained research results.

During the research process, the authors paid attention to the specific problems and challenges in the financial markets in the developing countries and understood the need to adjust the tested A.R.C.H. and G.A.R.C.H. models to the specificities of these markets. The main challenge of this research has been to apply and adapt econometric models, and quantify the holiday effect in the observed markets and thus enable their successful application and obtain results based on the science and practice. The future research in this field should be directed towards the expanded research focus to other financial markets in developing countries and thus increase the flexibility of the tested A.R.C.H. and G.A.R.C.H. models in order to maximise the effects of investing activities. In this sense, the focus of the future research will be expanded and the methodology significantly modified to a higher level of flexibility and adaptability, taking into account the change dynamics in the financial markets caused by the globalised trends.

## Note

1. The CNY, also known as the Spring Festival, is the biggest holiday for the Chinese people.

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