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The Day-of-the-Week Anomaly in Light of the COVID–19 Pandemic on an Example of Selected OMX Indices

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Abstract

This paper analyzes market efficiency (EMH) with the day-of-the-week effect and the changes that might appear after the outbreak of the COVID–19 pandemic, based on the example of the OMX Exchange and its indices. Before the pandemic, only the OMX Baltic All-share index was efficient; during the COVID–19 pandemic, the OMXCPI Index, which represents the Copenhagen stock market, was not affected by the day-of-the-week anomaly. The change in market efficiency was observed in relation to the periods before and during the pandemic, and additionally between specific days of the week. The value added of this paper is related to the evidence that COVID–19 influenced market efficiency but not the quality of trading.

Keywords: COVID–19, market efficiency, day-of-the-week anomaly

JEL: G10, G12, G14

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Introduction

The COVID–19 outbreak was a shock for markets, and this may have changed the way investors made their decisions in the area of market efficiency described by the Efficient Market Hypothesis (Fama 1960). Evidence of market changes regarding the reaction of prices and investors' decisions has been presented in many studies. To the existing literature, this paper adds an analysis of OMX (Open Mobile Exchange) market efficiency and the possible change in this efficiency during the COVID–19 pandemic regarding the day-of-the-week anomaly.

The objective of this study is to test the market efficiency before and during COVID–19. The authors hypothesize that the markets were efficient and that the COVID–19 pandemic affected their efficiency. The value added of this paper is that it enriches the relevant literature on market efficiency in relation to a pandemic, which is a health crisis and in comparison to not a financial one. So, the results of this study will show evidence that COVID–19 influenced the market efficiency of the selected OMX markets. An additional uniqueness of our paper is the investigation of the OMX markets, which also enriches the literature for academics. The results will also be of interest to investors and practitioners since they can see how a health crisis affects their investment decisions, and they can take precautions in a future similar situation.

OLS panel data regression models with fixed effects were tested to detect the differences between two periods: pre-COVID–19 and the time of the pandemic. Due to technical limitations related to the fixed effects analysis, only some of the OMX markets were considered: the Estonian OMXTGI, the Latvian OMXRGI, and the Lithuanian OMXVGI. Additionally, the OMX BGI – the OMX Baltic All-share index – which comprises selected equity securities listed on each of the Nasdaq Baltic Exchanges (AB Nasdaq Vilnius, Nasdaq Riga, AS, Nasdaq Tallinn AS), are examined. The Scandinavian group comprises the indices from Denmark, Iceland, and Norway. The OMXCPI Index is the OMX Copenhagen stock market index for the Copenhagen Stock Exchange, the OMXIPI is the OMX Iceland All-Share Index, which includes all the shares listed on the OMX Nordic Exchange Iceland, and the OSEAX index is the Oslo Børs All Share Index, which comprises all shares listed on the Norwegian market.

The paper is composed of several sections. The next section is the literature review. The third section presents the data description, the testable hypotheses, and the methodology. The fourth section presents and analyzes the results, and the final section offers conclusions and future research directions.

Review of the literature

The investigation of many markets and their reaction to the COVID–19 pandemic around the world have been presented in a great number of papers. Ngwakwe (2020, pp. 255–269) analyzed the global stock markets and found that the indices he considered reacted differently, and there was a change in their behavior before and during the COVID–19 pandemic. Ashraf (2020b) found that overall, stock markets reacted negatively to the COVID–19 outbreak. However, this reaction was only significant for the growth in COVID–19 cases but not for the growth in deaths. Narayan, Devpura, and Wang (2020) analyzed the Japanese market, and they found significant differences in the market between the periods before and after the critical day that the COVID–19 pandemic was announced. Yilmazkuday (2020) found that the negative effects of COVID–19 cases in the U.S. on the S&P 500 Index were mostly observed during March 2020. The critical period after the outbreak of the pandemic was strongly affected by uncertainty and the worst scenarios that were taken into consideration by market participants.

The papers related to the COVID–19 issue cover topics such as government actions that influenced or not the market rates of return. For example, based on the analysis of 20 markets around the world, Chang, Feng, and Zheng (2021, pp. 1–18) found that the stock market did not react significantly to government interventions in the health system. The response to the market was also analyzed by Liu et al. (2020), who found that countries in Asia experienced more negative abnormal returns than other countries on other continents.

Bash (2020, pp. 34–38) analyzed the effect of the first registered case of COVID–19 on stock market returns using event study analysis for 30 countries. He found that stock market returns experienced a downward trend and that significant negative returns following the COVID–19 outbreak. Ashraf (2020a) analyzed stock market returns from 77 countries and found that social distancing measures imposed by governments had a direct negative effect on stock market returns due to their adverse effect on economic activity. They also found an indirect positive effect by reducing confirmed COVID–19 cases. Chundakkadan and Nedumparambil (2021) found that the Google Search Volume Index related to the volume of the pandemic was associated negatively with daily returns. They also found that the COVID–19 sentiment generated excess volatility in the market. Other studies reported that stock markets reacted to the COVID–19 pandemic with strong negative returns (Al-Awadhi et al. 2020; Ashraf 2020b; Baker et al. 2020, pp. 742–758).

Many findings related to market volatility suggest a change in behavioral patterns. Apergis and Apergis (2020, pp. 1–9) found a significant negative effect of the COVID–19 pandemic on Chinese stock returns. They also found that the daily increases in COVID–19 cases and deaths increased market volatility due to investors' fear and uncertainty. Zhang, Hu, and Ji (2020) analyzed the volatility of the top 10 mar-

kets around the world regarding the number of cases and found that the risk levels of all the countries increased substantially. Engelhardt et al. (2021) investigated if trust affected global stock market volatility during the COVID–19 pandemic based on a sample of 47 national stock markets. He found that stock market volatility was significantly lower in high-trust countries' reactions to COVID–19 case announcements. Other papers on stock returns and volatility for global markets regarding the COVID–19 crisis were presented by Ali, Alam, and Rizvi (2020), Gil-Alana and Claudio-Quiroga (2020, pp. 19–22), Haroon and Rizvi (2020), Prabheesh (2020), Salisu and Akanni (2020), Salisu and Sikiru (2020).

This paper compares developed and developing markets, including OMX. These markets became highly volatile and unpredictable during the COVID–19 pandemic. Li and Zhong (2020) explored the effect of global economic policy uncertainty shocks on China's financial conditions index. They found that the uncertainty shocks emanating from China itself were the major sources of China's financial market volatility. The US market reaction appeared to be the most significant exogenous cause of the fall in the financial conditions index in China.

Narayan, Devpura, and Wang (2020, pp. 191–198) found that COVID–19 had a heterogeneous effect on sectors of the Australian exchange, with health, information technology, and consumer staples sectors gaining. Yarovaya et al. (2020) investigated the contagion phenomenon in light of COVID–19, considering it a "black swan" event. Aslam, Mohti, and Ferreira (2020) stated that the COVID–19 outbreak became one of the biggest threats to the global economy and financial markets. Therefore, they analyzed the effects of COVID–19 on 56 global stock indices using a complex network method. The findings revealed a structural change in the topological characteristics of the network.

A contagion effect was also identified in the network structure of emerging markets, and the number of positive correlations in the global stock indices increased during the outbreak. Contessi and De Pace (2021) identified periods of mildly explosive dynamics and collapses in the stock markets of 18 major economies during the first wave of the COVID–19 pandemic in 2020. They also found statistical evidence of instability transmission from the Chinese stock market to all other markets. The recovery, on the other hand, was heterogeneous and generally non-explosive.

Ashraf (2020c) reported that stock markets around the world reacted to the COVID–19 pandemic with negative returns, but this reaction was not uniform across countries. Their explanation was the national level of uncertainty avoidance, which determines how sensitive the members of a nation are to uncertainty and moderates the stock markets' reaction to the pandemic.

Seven and Yilmaz (2021) found that following the spread of the COVID–19 pandemic, most global equity market indices experienced significant falls, and many governments

announced unprecedented economic rescue packages. However, the recovery performance varied significantly across countries. Cao et al. (2020, pp. 1–5) analyzed 14 indices affected by COVID–19. They found that markets would likely recover in respnse to improved survival of COVID–19 patients, the natural development of herd immunity, and the projected success in vaccine development in the next 18 months. Goodell (2020) suggested that the COVID–19 pandemic might have a significant impact on the functioning of the financial sector and is a promising research domain.

The COVID–19 impact on the OMX market was examined by Ashraf (2020a; 2020b; 2020c), Aslam et al. (2020), Bash (2020, pp. 34–38), Pardal et al. (2020, pp. 627–650), Chundakkadan and Nedumparambil (2021), Contessi and De Pace (2021), and Yang and Deng (2021), but not in terms of the day-of-the-week anomaly or market efficiency compared to the pre-COVID–19 period.

There are many findings of the day-of-the-week effect on the OMX markets before COVID–19. For instance, Zhang, Lai, and Lin (2017, pp. 47–62) investigated the day-of-the-week anomalies in stock returns of the main indices in 28 markets from 25 countries using the calendar effect performance ratio to measure the significance of the day-of-the-week anomalies. The stock markets of Estonia, Latvia, and Lithuania are small, younger, and developing, which implies that there will be inefficiencies compared to more mature and developed stock markets, such as the Scandinavian markets. The weak form efficiency for Latvia and Lithuania was examined by Kvedaras and Basderant (2002), Mihailov and Linowski (2002), and Milieska (2004), but only Milieska showed that these Baltic markets were weak form efficient. Furthermore, Kiete and Uloza (2005) tested for the semi-strong form efficiency in the Lithuanian and Latvian stock markets by examining their reaction to earnings announcements from 2001 to 2004. They found that both markets were inefficient regarding earnings announcements, implying that brokers and investors could find several investment opportunities.

Some other studies found no day-of-the-week effect, since the returns on each weekday were not statistically different or significant. Lyroudi, Patev, and Kanaryan (2003) examined the day-of-the-week effect anomaly for the markets of Romania, Hungary, Latvia, the Czech Republic, Russia, Slovakia, Slovenia and Poland for 1997 to 2002. It was not present for the Latvian market. Only the Slovak market had significant negative Wednesday returns, while the Russian market had significant negative Wednesday returns and positive Friday returns. The Slovenian markets had significant positive Thursday and Friday returns. No day-of-the-week anomaly was found by Chukwuogor-Ndu (2006, pp. 112–124) for the markets of Switzerland and Denmark; by Apolinario et al. (2006) for 1997 to 2004 for Austria, Belgium, the Czech Republic, Denmark, France, Germany, Holland, Italy, Portugal, Spain, Sweden, and Switzerland; by Lyroudi (2007) for 2004 to 2007 for the Baltic markets comprising the OMX Bal-

tic all share index; by Borges (2009) for 1994 to 2007 for Austria, Denmark, France, Hungary, Italy, Poland, Portugal, Spain, Switzerland, and the United Kingdom.

Another day-of-the-week phenomenon is when we observe positive Monday returns – "the reverse Monday effect". Brusa and Liu (2004, pp. 19–30) tried to explain the "reserve" Monday effect in the USA stock markets between 1988 and 1998. They found a positive link between the trading activities of institutional investors and positive Monday returns because the former provided excess liquidity to the market. For the period 2006 to January 2019 for the Swedish stock market, Sandahl (2019) found a reverse Monday effect (positive Monday returns) and positive Thursday returns for small-capitalization stocks. He also found positive Wednesday, Thursday, and Friday returns for mid-capitalization stocks, while for large-capitalization stocks, there was no day-of-the-week anomaly.

For the Eastern European countries of Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovakia and Slovenia between 1994 or 1999 to 2002, Ajayi, Mehdian, and Perry (2004, pp. 53–62) found significant negative Monday returns for the Estonian and Lithuanian markets. Additionally, there was a reverse Monday effect for the Russian market, negative Tuesday returns for the Lithuanian market, and positive Friday returns for the Slovenian market.

For Lithuania, Mexico, Estonia, Indonesia, Malaysia, Slovenia, Thailand, and Turkey, Yalcin and Yucel (2006, pp. 258–279) observed negative Monday returns. Lithuania, Mexico, India, and South Korea had the highest Wednesday positive returns, while Estonia, the Czech Republic and Hungary had the highest positive Thursday returns. Thus, the phenomenon varies across countries. Borges (2009) found positive Friday returns in Greece, Iceland, Ireland and Norway, positive Tuesday returns in Germany, and negative Monday returns in Iceland between 1994 and 2007.

For the former East European Post-Communist stock markets of Bosnia, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Kazakhstan, Latvia, Lithuania, Montenegro, Poland, Romania, Russia, Serbia, Slovakia, Slovenia, and Ukraine from January 2005 to March 2014, Oprea and Ţilica (2014, pp. 119–129) found that most had no significant day-of-the-week effect. Only Bosnia, Croatia and Latvia had significant negative Friday average returns, while Bulgaria, Serbia and Slovenia had significant negative Monday average returns. Slovenia was the only one that had significant positive Thursday returns.

For the period 1999 to 2013, Cinko et al. (2015, pp. 96–108) found a significant positive Thursday effect for Norway and significant positive returns on Fridays for Denmark, Finland, and Norway.

Data, methodology, and testable hypothese

To achieve the objective of this study, closing prices of the OMX Indices were used to calculate the daily returns. The data used in the present study were collected from the EIKON Thomson database for the period after the economic crisis of 2008, from January 1st, 2009, to February 15th 2021. The entire research period was divided into two sub-periods:

- 1st period – pre-COVID, from January 2009 to January 2020.
- 2nd period – during the COVID pandemic, from February 2020 to February 2021.

The Baltic markets examined are the Estonian stock exchange in Tallinn, represented by the OMXTGI, the Latvian stock exchange in Riga, represented by the OMXRGI, and the Lithuanian stock exchange in Vilnius, represented by the OMXVGI. There is also the OMX BGI index – the OMX Baltic All-share index – which comprises selections of equity securities listed on each of the Nasdaq Baltic Exchanges.

The Nordic group comprises the Scandinavian markets, Denmark, Iceland and Norway, represented by the equivalent indices.

To test the hypothesis for the presence of the day-of-the-week effect in each of the OMX stock markets, we used the following regression model:

$$R_t = \propto_1 Mon_t + \propto_2 Tues_t + \propto_3 Wed_t + \propto_4 Thu_t + \propto_5 Fri_t + \varepsilon_t, \quad (1)$$

where:
Rt – index return on day *t*;
Mont – dummy variable equal to 1 if *t* is a Monday and 0 otherwise;
Tuest – dummy variable equal to 1 if *t* is a Tuesday and 0 otherwise;
Wedt – dummy variable equal to 1 if *t* is a Wednesday and 0 otherwise;
Thut – dummy variable equal to 1 if *t* is a Thursday and 0 otherwise;
Frit – dummy variable equal to 1 if *t* is a Friday and 0 otherwise;
et – error term.

The coefficients of the above regression equation (a_1, a_2, a_3, a_4, a_5) are the average returns for Monday through Friday. The OLS heteroskedasticity corrected panel data method was run with dummy variables for each day of the week. Tests for the presence of fixed and random effects were also carried out (the Wald Test for redundant fixed effects, and the Breusch-Pagan Test for random effects).

Based on the research question of whether the COVID–19 pandemic had any impact on the day-of-the-week anomaly in the Baltic and Scandinavian markets, the following hypotheses were formulated:

H_1: The surveyed markets are efficient;

H2: The market efficiency of the surveyed indices was affected by the COVID–19 pandemic.

Results and analysis

First, information about the tested groups is provided. The statistics for the indices before and during the COVID–19 pandemic are presented in Table 1.

Table 1. Statistics of the samples

	pre-COVID–19 period			COVID–19 period		
	Number of observations	Mean returns	Standard deviation	Number of observations	Mean returns	Standard deviation
OMXTGI. OMX TALLINN – Estonia	2776	0.0006	0.009463	258	0.0004	0.012807
OMXRGI. OMX RIGA – Latvia	2776	0.0005	0.012448	258	0.0005	0.015723
OMXVGI. OMX VILNIUS – Lithuania	2776	0.0005	0.008687	258	0.0598	1.064850
OMX BGI BALTIC COUNTRIES	8328	0.0005	0.010326	776	0.0005	0.013152
OMXCPI – COPENHAGEN – Denmark	6023	0.0004	0.010654	260	0.0010	0.013617
OMXIPI – OMX all share REYKJAVIK – Iceland	6732	0.0003	0.012496	259	0.0015	0.014045
OSEAX – OSLO Bors all-share – Norway	9305	0.0005	0.012786	264	0.0004	0.017313

Source: own study.

Based on the data in Table 1, it can be concluded that positive average rates of return were observed for all indices, both before and during the COVID–19 pandemic. The indices related to the Scandinavian countries were characterized by higher average rates of return than those in the Baltic countries, both before and during the pandemic. The volatility of the analyzed rates of return, measured by the standard deviation, was also higher in the Scandinavian countries. There is one exception, however. The Lithuanian market, the OMXVGI Index, was characterized by the highest average rate of return during the pandemic but also the highest volatility among all analyzed indices. Before testing the regression models, the Wald test and the Breusch-Pa-

gan test were performed to find fixed and random effects. The results of both tests for the pre-COVID–19 and COVID–19 periods are presented in Tables 2 and 3.

Table 2. The results of tests for the occurrence of fixed and random effects in the pre-COVID-19 period

	The results of the tests for the occurrence of fixed effects with respect to time (Wald test)	Results of tests for the occurrence of random effects with respect to time (Breusch-Pagan test)
OMXTGI. OMX TALLINN – Estonia p-value	634.163 (0.000)	0.0901 (0.7639)
OMXRGI. OMX RIGA – Latvia p-value	14.1236 (0.0008)	0.8471 (0.3573)
OMXVGI. OMX VILNIUS – Lithuania p-value	128.298 (0.000)	0.0131 (0.9089)
BALTIC COUNTRIES p-value	0.7696 (0.0681)	0.5021 (0.5439)
OMXCPI – COPENHAGEN – Denmark p-value	1484.66 (0.000)	0.7804 (0.3770)
OMXIPI – OMX all share REYKJAVIK – Iceland p-value	228.887 (0.000)	1.0710 (0.3007)
OSEAX – OSLO Bors all share – Norway p-value	63.6024 (0.000)	0.0791 (0.7784)

For p-value < 0.05, the Wald test indicates the presence of fixed effects; for p-value < 0.05, the Breusch-Pagan test indicates the presence of random effects
Source: own study.

Table 3. The results of tests for the occurrence of fixed and random effects in the COVID-19 period

	The results of the tests for the occurrence of fixed effects with respect to time (Wald test)	Results of tests for the occurrence of random effects with respect to time (Breusch-Pagan test)
OMXTGI. OMX TALLINN – Estonia p-value	1408.24 (0.000)	7.9631 (0.477)
OMXRGI. OMX RIGA – Latvia p-value	1722.55 (0.000)	0.2351 (0.6277)
OMXVGI. OMX VILNIUS – Lithuania p-value	1551.56 (0.000)	10.4404 (0.1232)

	The results of the tests for the occurrence of fixed effects with respect to time (Wald test)	Results of tests for the occurrence of random effects with respect to time (Breusch-Pagan test)
BALTIC COUNTRIES p-value	3.2041 (0.3612)	1.4728 (0.2248)
OMXCPI – COPENHAGEN – Denmark p-value	0.9810 (0.000)	0.8431 (0.3584)
OMXIPI – OMX all share REYKJAVIK – Iceland p-value	20.8969 (0.000)	0.0779 (0.7801)
OSEAX – OSLO Bors all share – Norway p-value	314.666 (0.000)	0.2102 (0.6465)

For p-value < 0.05, the Wald test indicates the presence of fixed effects; for p-value < 0.05, the Breusch-Pagan test indicates the presence of random effects
Source: own study.

Based on the results in Tables 2 and 3, it can be concluded that the Wald test indicated the presence of fixed effects in the model for both periods. On the other hand, the results of the Breusch-Pagan test in almost all cases indicated that there were no random effects in the models for both periods. It can be concluded that the effects did not change their pattern in both periods. Moreover, they were not random but related to specific events and companies' behavior. Panel data analysis can confirm both fixed and random effects, but only the OLS regressions with fixed effects are tested in the next step. Before the pandemic, the Baltic Countries Index was characterized by fixed effects on a more liberal level of confidence. During the pandemic, it was difficult to determine which effects dominated. This influenced the regression results later in the analysis.

Therefore, to address hypothesis (H1), we test the parameters of Equation (1) for each market index to investigate if the markets were efficient. These regression results (coefficients, R-squared, t-statistics and F-statistic) are shown in Table 4 for the pre-COVID–19 period and in Table 5 for the COVID–19 period. The regular OLS model with fixed effect was tested. The model specification was also analyzed using the RESET test, which indicates the correctness of the model.

Table 4. OLS regression results with fixed effect – pre-COVID–19 period. Explained variable: Average daily returns

	Sample	Const.	Mon	Tues	Wed	Thu	Fri	R^2 %	F-stat.
OMXTGI. OMX TALLINN – Estonia	2778	–0.0003***	0.00086*	0.00013	0.00157	0.0014***	0.00071	0.3491	0.0931596
OMXRGI. OMX RIGA – Latvia	2778		–0.0101**	–0.0104**	–0.0107**	–0.0097**	–0.0108 *	0.158	0.057298
OMXVGI. OMX VILNIUS – Lithuania	2778	0.00062***	0.0005	0.0008	–0.0005	–0.0004	0.00052	0.2416	0.109013
BALTIC COUNTRIES	8334	0.00381	–0.0031	–0.0035	–0.0033	–0.003	–0.0033	0.0388	0.700184
OMXCPI – COPENHAGEN – Denmark	6023	–0.0017***	0.0016**	0.00191***	0.00251	0.00178**	0.00215	0.0702	0.0145087*
OMXIPI – OMX all share REYKJAVIK – Iceland	6737	0.00101***	–0.0017***	–0.0008**	–0.0003	– 5.45E–05	–0.0003	1.8375	3.13522
OSEAX – OSLO Bors all share – Norway	9305	0.01675***	–0.0168**	–0.0162***	–0.0158**	–0.0166**	–0.0158***	0.2876	0.10991**

Note: */**/*** The coefficients or F-statistic are significant at the 10% / 5% / 1% level.
Source: own study.

Based on Table 4 for Estonia (OMXTGI; OMX TALLINN Index), the estimates of the returns were statistically significant and positive on Mondays and Thursdays for the pre-COVID–19 period. Thus, there was a day-of-the-week effect for this index.

For Latvia (OMXRGI; OMX RIGA Index), the estimates of the returns were negative on all weekdays and statistically significant at the 5% level of a two-tailed t-test for the examined COVID–19 period. Thus, there was a day-of-the-week effect for this index.

For Lithuania (OMXVGI; OMX VILNIUS Index), the estimates of the returns were positive on Mondays and Fridays and negative on Tuesdays, Wednesdays and Thursdays; none of them was statistically significant. Therefore, the day-of-the-week effect anomaly was not present in the stock market of Lithuania for the pre-COVID–19 period.

For all Baltic Countries (OMX BGI Index), the estimates of the returns were negative on all weekdays, but none were statistically significant for the pre-COVID–19 period. Thus, there was no day-of-the-week effect for this index.

For Denmark, the OMXCPI Index was investigated. The estimates of the returns on the OMXCPI Index were positive on all the weekdays. However, only Mondays, Tuesdays and Thursdays were characterized by statistically significant results at the 5% level of a two-tailed t-test for the pre-COVID–19 period, indicating a reverse Monday effect.

For Iceland, the OMXIPI Index was analyzed. The estimates of the average returns were negative on all the weekdays. Only Mondays and Tuesdays were characterized by statistically significant results at the 5% level of a two-tailed t-test for the pre-COVID–19 period.

For Norway, the OSEAX Index was surveyed. The estimates of the returns on the OSEAX Index were negative on all the weekdays. They were statistically significant at the 5% level of a two-tailed t-test on Mondays, Wednesdays and Thursdays and at the 1% level of a two-tailed t-test on Tuesdays and Fridays for the pre-COVID–19 period. Therefore, it can be stated that the day-of-the-week effect anomaly was present in the Norwegian stock market for this index.

Based on the results in Table 4, it can be concluded that the only efficient market without the day-of-the-week effect was the Baltic Countries Index. For the other indices, the day-of-the-week effect was found.

In the next stage, the parameters of Equation 1 were tested to investigate the market efficiency for the COVID–19 period. In this case, the period of one year related to the pandemic from February 2020 to February 2021 was analyzed for all selected indices. Table 5 shows the regression results (coefficients, R-squared, t-statistic and F-statistic) for the analyzed markets during the COVID–19 period.

Table 5. OLS regression results with fixed effect – COVID–19 period. Explained variable: Average daily returns

	Sample	Const.	Mon	Tues	Wed	Thu	Fri	R^2 %	F-stat.
OMXTGI. OMX TALLINN – Estonia	259	–0.001***	0.00508**	0.00108	0.00016	0.00295	–0.0024	10.80	10.0844
OMXRGI. OMX RIGA – Latvia	259	–0.0047***	0.00812***	0.0044***	0.00602***	0.00683***	0.00088***	4.5668	<0.0001***
OMXVGI. OMX VILNIUS – Lithuania	259	0.01569***	–0.0147***	–0.016***	–0.0132***	–0.0143***	–0.0174***	9.6209	4.29171***
BALTIC COUNTRIES	777	–0.0089***	0.01185***	0.00873***	0.01001***	0.01091***	0.00592**	2.4847	10.5239***
OMXCPI – COPENHAGEN – Denmark	261	0.0037***	–0.002	–0.0015	–0.002	–0.0044	–0.0039	10.006	0.177901
OMXIPI – OMX all share REYKJAVIK – Iceland	260	0.01703***	–0.0182	–0.0111	–0.014*	–0.0181*	–0.017**	5.2082	0.315061
OSEAX – OSLO Bors all share – Norway	265	–0.0147***	0.01268**	0.02143***	0.01558***	0.0108***	0.01515***	6.1605	8.80584***

Note: */**/*** The coefficients or F-statistic are significant at the 10% / 5% / 1% level.
Source: own study.

Based on the results in Table 5, for Estonia (OMXTGI. OMX TALLINN Index), the estimates of the returns were statistically significant and positive on Mondays only for the examined COVID–19 period. Thus, there was a day-of-the-week effect for this index.

For Latvia (OMXRGI. OMX RIGA Index), the estimates of the returns were positive on all weekdays and statistically significant at the 1% level of a two-tailed t-test for the COVID–19 period. Thus, there was a day-of-the-week effect for this index.

For Lithuania (OMXVGI. OMX VILNIUS Index), the estimates of the returns were negative on all weekdays and statistically significant at the 1% level of a two-tailed t-test for the COVID–19 period. Thus, there was a day-of-the-week effect for this index.

For all Baltic Countries (OMX BGI Index), the estimates of the returns were positive on all weekdays and statistically significant at the 1% level of a two-tailed t-test for the COVID–19 period. Thus, there was a day-of-the-week effect for this index.

For Denmark, the OMXCPI Index was analyzed. The estimates of the returns were negative on all weekdays, but none of them was statistically significant. Therefore, the day-of-the-week effect anomaly was not found for the COVID–19 period.

For Iceland, the OMXIPI index was analyzed. The estimates of the returns were negative on all the weekdays. They were statistically significant at the 10% level of a two-tailed t-test on Wednesdays and Thursdays and at the 5% level of a two-tailed t-test on Fridays for the COVID–19 period.

For Norway, the OSEAX Index was analyzed. The estimates of the returns on the OSEAX Index were positive on all weekdays and statistically significant at the 1% level of a two-tailed t-test for the COVID–19 period. Thus, there was a day-of-the-week effect for this index during the pandemic.

Based on the results for the COVID–19 period in Table 5, it can be concluded that the Denmark market was efficient, and the day-of-the-week anomaly was not found there during the COVID–19 period.

In the next step, the regression results related to hypothesis (H2) before and during the COVID–19 pandemic periods were compared with the effects that appeared on different weekdays. The results are presented in Table 6.

Table 6. The difference between effects on surveyed markets

	Before COVID–19	COVID–19 period	Result after outbreak
OMXTGI. OMX TALLINN – Estonia			
Monday	+	+	No change
Tuesday	–	–	No change
Wednesday	–	–	No change
Thursday	–	–	No change
Friday	–	–	No change
OMXRGI. OMX RIGA – Latvia			
Monday	+	+	No change
Tuesday	+	+	No change
Wednesday	+	+	No change
Thursday	+	+	No change
Friday	+	+	No change
OMXVGI. OMX VILNIUS – Lithuania			
Monday	+	+	No change
Tuesday	–	+	Change
Wednesday	–	+	Change
Thursday	–	+	Change
Friday	–	+	Change
OMXBGI, BALTIC COUNTRIES			
Monday	–	+	Change
Tuesday	–	+	Change
Wednesday	–	+	Change
Thursday	–	+	Change
Friday	–	+	Change
OMXCPI – COPENHAGEN – Denmark			
Monday	+	–	Change
Tuesday	+	–	Change
Wednesday	–	–	No change
Thursday	+	–	Change
Friday	–	–	No change
OMXIPI – OMX all share REYKJAVIK – Iceland			
Monday	+	–	Change
Tuesday	+	–	Change

	Before COVID–19	COVID–19 period	Result after outbreak
Wednesday	–	+	Change
Thursday	–	+	Change
Friday	–	+	Change
OSEAX – OSLO Bors all shares – Norway			
Monday	+	+	No change
Tuesday	+	+	No change
Wednesday	+	+	No change
Thursday	+	+	No change
Friday	+	+	No change

Source: own study.

The results in Table 6 help us understand the changes related to the health crisis in the selected markets. The Latvian, Estonian and Norwegian markets registered no change at all in their efficiency. There was no change in the Lithuanian market regarding the Monday anomaly. In Denmark, there was a lack of anomalies on Wednesdays and Fridays before the COVID–19 pandemic. However, changes were found, and some anomalies appeared in the Lithuanian, Baltic Countries Index and Icelandic market on Wednesday, Thursday and Friday. The anomalies disappeared in Denmark, and this market became fully efficient after the pandemic, while the Baltic Index lost its efficiency. This could have happened due to the increased importance of random effects related to the outbreak of the COVID–19 pandemic.

Conclusions

This study examined the OMX stock exchanges in the Baltic and Scandinavian markets. It empirically investigated the existence of the day-of-the-week effect anomaly for the equivalent indices and the change caused by the outbreak of the COVID–19 pandemic. The objective of this study was to test the market efficiency before and during COVID–19. It was hypothesized that the markets were efficient, and the COVID–19 pandemic affected their efficiency.

The results showed that the Baltic Markets, as indicated by the OMXBGI index, were efficient before COVID–19 started spreading around the world, but the index lost its efficiency during the pandemic period. On the other hand, the Danish market was inefficient before the pandemic, but efficient during the COVID–19 period. The other OMX markets were not efficient during the whole period; only some changes were registered on the days the anomaly appeared.

It can be concluded that the COVID–19 disease influenced OMX market efficiency. Investors changed their behavior profile and exhibited irrational behavior based on different profiles before and during the outbreak of the pandemic. This also shows that even a health crisis in the market can affect the efficiency of exchanges and the rates of return. Future research could focus on the influence of market liquidity on changes in market efficiency in relation to market crises.

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Anomalia dni tygodnia w świetle pandemii COVID–19 na przykładzie wybranych indeksów OMX

Niniejszy artykuł miał na celu zbadanie efektywności rynku oraz zmian, jakie mogły pojawić się w tym obszarze po wybuchu pandemii COVID–19. Giełda OMX i jej indeksy zostały wzięte pod uwagę ze względu na to, że reprezentują różne rynki zintegrowane na tej samej platformie giełdowej, a poza tym badaniu ich efektowności podczas pandemii nie poświęcono uwagi. Analizowane były dwa okresy: przed wybuchem pandemii COVID–19 i po jej wybuchu, a hipoteza efektywnego rynku (EMH) była testowana poprzez wykorzystanie anomalii efektu dnia tygodnia. Wyniki pokazują, że przed wybuchem pandemii tylko Indeks Krajów Bałtyckich był efektywny, ale stracił tę cechę podczas pandemii, podczas gdy rynek duński ją zyskał. Zaobserwowano zatem efektywność niektórych rynków oraz zmiany wywołane przez COVID–19.

Słowa kluczowe: COVID–19, anomalie dni tygodnia, efektywność rynku