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The Impact of Lockdown Announcements during the COVID-19 Crisis: An Event Study from the Portuguese Stock Market

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Master's in Finance

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Abstract

The COVID-19 pandemic impacted global financial markets in an unprecedented manner. It is well-documented the negative effect in stock markets and increased volatility caused by the preventive measures adopted to combat the disease. This study aims to analyse how lockdowns and other restrictive measures affected the Portuguese index PSI-20 and its constituents. Specially, it investigates the effect over the three first waves of COVID-19 in Portugal, using the STOXX600 European index as benchmark, between March 2020 and April 2021. To test the hypothesis of whether lockdown measures affected stock returns, an event study methodology is employed to detect the presence of abnormal returns around each event date. Using a set of 21 events and a 5-day event window for each event, the abnormal returns are analysed with parametric and nonparametric tests. The test results show a negative market response over strict lockdown announcements, and a positive response over the withdrawals of such restrictions. The results suggest investors are likely to respond negatively to government's impositions, especially in extraordinary situations. Nevertheless, the impact declines as the period of impositions extends. In addition, the companies most affected by the Portuguese government impositions are Ibersol and EDP Renováveis, while the least affected companies are Jerónimo Martins and Pharol.

Keywords: event study, abnormal Returns, lockdowns, COVID-19, financial crisis, efficient market hypothesis

JEL Classification: C30, G01, G14

Sumário

A pandemia da COVID-19 teve um impacto sem precedentes nos mercados financeiros mundiais. Está bem documentado o efeito negativo nos mercados bolsistas e o aumento da volatilidade causada pelas medidas preventivas adotadas para combater a transmissão da doença. Este estudo visa analisar como os confinamentos e outras medidas preventivas afetaram o índice bolsista Português PSI-20, assim como os seus constituintes. Em especial, investiga o efeito nas três primeiras vagas da COVID-19 em Portugal, utilizando o índice Europeu STOXX600 como referência, entre Março de 2020 e Abril de 2021. Para testar a hipótese se as medidas de prevenção afetaram os retornos das ações, é utilizada uma metodologia de estudo de eventos para detetar a presença de retornos anormais durante cada evento. Utilizando um conjunto de 21 eventos e um período de 5 dias para cada evento, os retornos anormais são analisados com testes paramétricos e não paramétricos. Os resultados dos testes mostram uma resposta negativa do mercado em relação a anúncios de confinamento, e uma resposta positiva em relação à retirada de tais restrições. Os resultados sugerem que os investidores são suscetíveis de responder negativamente às restrições do governo, especialmente em situações extraordinárias. No entanto, o impacto decresce à medida que o período de restrições se estende. Adicionalmente, as empresas mais afetadas pelas imposições do governo Português são a Ibersol e a EDP Renováveis, enquanto as empresas menos afetadas são a Jerónimo Martins e a Pharol.

Palavras-chave: estudo de evento, retorno anormal, confinamento, COVID-19, crises financeiras, hipótese dos mercados eficientes

Código de Classificação JEL: C30, G01, G14

Index

List of Figures

List of Tables

Glossary

AAR – Average Abnormal Return

ACWI – All Country World Index

AR – Abnormal Return

CAAR – Cumulative Average Abnormal Return

CAR – Cumulative Abnormal Return

COVID-19 – Corona Virus Disease 19

CSAR – Cumulative Standardized Abnormal Returns

EMA – European Medicines Agency

EMH – Efficient Market Hypothesis

EUR – Euro

GARCH – Generalized Autoregressive Conditional Heteroskedasticity

GDP – Gross Domestic Product

GFC – Global Financial Crisis 2008

GICS – Global Industry Classification Standard

IMF – International Monetary Fund

MAM – Market Adjusted Return Model

MM – Market Model

MMG – Market Model with GARCH Adjustment

OECD – Organization of Economic Co-operation and Development

OLS – Ordinary Least of Squares

PSI-20 – Portuguese Stock Index

S&P500 – Standard and Poor's 500

SAR – Standardized Abnormal Returns

SCAR – Standardized Cumulative Abnormal Returns

STOXX600 – STOXX Europe 600

US – United States

WHO – World Health Organization

I

The Impact of Lockdown Announcements during the COVID-19 Crisis

The unprecedented lockdown measures adopted during the COVID-19 pandemic were one of the key causes driving the global economy into crisis. Since the first reported cases at the end of 2019, the COVID-19 has spread globally, leading to 207 million confirmed cases and 4.5 million reported deaths[1]. In this study, we aim to examine the impact of restriction announcements on the Portuguese stock market by the application of an event study. Our primary goal is to examine the performance of the PSI-20 index constituents across the many regulation plans during the pandemic. Therefore, we aim to contribute to the literature on the financial market's impact of the COVID-19 pandemic, and in specific on the investor's reaction to the lockdown announcement news and its correspondent extensions. The usage of the event study methodology also contributes to the efficient market hypothesis (EMH) discussion, providing additional empirical evidence for this debate. Finally, this research also adds to the literature on the effects of natural disasters on stock markets, focusing on pandemics.

Prior research has empirically revealed a negative connection between stock market returns and the intensity of restrictions imposed by countries. The constraints provoked the collapse of various industries and the decline in the consumer activity, which rapidly spilled over financial markets. Also, the extraordinary government measures, added to the vaccination rumours, increased the fear in the market, as well as the uncertainty upon future scenarios. Most literature on this topic focuses on how COVID-19 affected different stock markets (Zhang, Hu, & Qiang, 2020). For instance, the impact of the first registered case in each country (Bash, 2020); the cross-sectional study on the World Health Organization (WHO) declaration of the disease as a pandemic (Ibrahim et al., 2020); or the impact of stock prices across different sectors (P. He et al., 2020). Although multiple studies have been conducted, the country-specific analysis is narrow. In consequence, we have identified an opportunity to study the impact of the COVID-19 in the Portuguese stock market, in which there is no literature published to this date.

The vast extent of studies makes clear the importance of research on this topic. The COVID-19 pandemic has created a unique context for governments, businesses, and individuals. As revealed in Gates (2020), "we are facing a once in a century pathogen" (p.1677-1679). The pandemic has caused a great deal of fear and uncertainty worldwide, leading to an unprecedented global outlook in the past decades. On March 11, the WHO classified the

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[1] WHO Coronavirus Disease Dashboard (August 2021): https://covid19.who.int/

disease as a pandemic, forcing governments on taking preventive measures to fight the transmission of the disease. The social distancing and lockdown key measures had a powerful impact on the global economy, disrupting global supply chains, labour markets, and consumer behaviour. As a result, it forced companies to close their doors, unemployment claims reached highs, and in April 2021 the International Monetary Fund estimated a real GDP fall of -6.6% in the Euro Area for 2020. As for the situation in Portugal, in August 2021 there were 1 million confirmed cases and 17,500 deaths. At the date of this study, Portugal places as the 24th country in cumulative confirmed cases per million people in the world, and 15th in Europe with 98,508 cumulative cases per million[2]. The IMF estimated a decrease in the Portuguese GDP in 2020 by -7.6%, which stands below the average in the Eurozone. In such an unparalleled scenario, aggravated by the daily announcements on recent cases and deaths, the consequences spilled to the financial markets by early March 2020. The PSI-20 recorded the second and third largest daily loss in its history of -9.76% on March 12; and -8.66% on March 9. This meant a total value reduction generated in the index from the previous 25 years. Between its peak on February 19 and its bottom one month later, the index lost over one third of its value. However, after some significant losses the index started a bullish pattern. By June, the PSI-20 recovered 28% of its value from its February low. In addition, the value rebounded close to pre-pandemic levels by January 2021. It is an extremely fast recovery in value, taking into account the severe daily losses at the beginning of 2020. The annual return for the PSI-20 in 2020 was -4.80%, very distant to the -51.29% and -27.60% from 2008 and 2011, respectively.

We have adopted the event study methodology to examine 21 lockdown events for each of the 18 constituents of the PSI-20. The hypothesis tested include the existence of excess returns on the day of the announcement, as well as the following days, revealing the Portuguese stock market reaction to the different restrictions. The set of regulations analysed in this study include lockdown events and its correspondent extensions. As for lockdown events, the Portuguese Government adopted three regulation states: emergency situation, calamity situation and contingency situation. In addition, we also study the impact of the WHO pandemic announcement because of its relevance to the scope of our research.

The study is organised as follows: Section II describes the existent literature; Section III defines the research goals; Section IV describes the methodology used for the test statistics; Section V defines the data; Section VI shows the empirical results and its discussion; Section VII concludes with the limitations and future research suggestions.

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[2] https://ourworldindata.org/covid-cases

II

Review of Literature

As the COVID-19 pandemic emerged, many studies have covered several aspects of the crisis, including its economic developments[3]. As new information arrives in the financial markets, it generates scepticism over market efficiency and the interrogation on investors over or under-reaction to the news. Although the existent literature examines a wide variety of theories on the equity market over COVID-19, this review centres on the stock market responses to lockdowns, number of cases and media news. In addition, this section also reveals existing literature on the effect of natural disasters and terrorism, as well as the causes of previous financial recessions.

2.1. Efficient Market Hypothesis

The Efficient Market Hypothesis (EMH) is one of the main discussed theories in finance literature, which defends the impossibility of outperforming the market consistently on a risk-adjusted basis. Introduced by E. F. Fama (1970), this theory defines an efficient market as a market in which asset prices reflect all past and present information. Only new information moves security prices, and as new information is unknown and occurs at random, upward or downward price movements are unknown and therefore move randomly. An important point in market efficiency is that prices should only react to information that is not expected by investors, otherwise the piece of information should already be considered at the security price. The main conclusion behind the EMH is that securities always trade at their fair market value, meaning that it is virtually impossible to sell overvalued stocks at a premium or to buy undervalued ones at a discount. In a highly effective market, investors prefer passive investment strategy to an active investment strategy due to lower costs, such as transaction or information-seeking costs.

In his study, E. F. Fama (1970) suggested three types of efficiency: a weak form, a semi-strong form and a strong form. The author defined each form according to the availability of information that is reflected in prices.

- Weak form: security prices fully reflect all past market dates. If markets are weak-form, past trading is already reflected in security prices and investors cannot forecast future

[3] Covid Economics, Vetted and Real-Time Papers: https://cepr.org/content/covid-economics-vetted-and-real-time-papers-0

price changes. As a result, it assumes that technical analysis does not offer any consistent excess return over the market.

- Semi-strong form: security prices fully reflect all publicly available information, including financial statement data and market data. Therefore, it improves the weak form by assuming that neither technical nor fundamental analysis provides an advantage over the market.
- Strong form: security prices fully reflect public and private information. Thus, no investor can achieve higher returns than others because of inside information. However, this is an unlikely scenario because of the strict prohibitions against insider trading.

Based on the literature, there are two opposing schools of thought regarding market efficiency. The first school of thought claims that markets are efficient and that investors cannot forecast returns. On the other hand, the second school of thought provides empirical evidence that challenges the theory of efficient markets. Behavioural finance appeared for the first time in Bondt & Thaler (1985) attempting to explain that emotions and human behaviour play a significant role in investor decisions. The theory does not assume that investors consider all available information and act rationally when deciding. The main assumption behind behavioural finance is that investors are humans and, therefore, not perfect. A key point for explaining this theory are the behavioural biases of individuals, which explain market inefficiencies. These biases include loss aversion (Bondt & Thaler, 1985), herd behaviour (Hwang & Salmon, 2004), overconfidence (Scott et al., 2003) or information cascades (Hirshleifer et al., 2009), among other explanations. Between a large set of studies challenging market efficiency[4], Shiller (2000) published the first edition of *Irrational Exuberance*, a key evidence which puts several arguments to prove that the stock market was overvalued during the 90s decade. In his book, Shiller defines the term *bubble* as a "an unsustainable increase in prices brought on by investors' buying behavior rather than by genuine, fundamental information about value." Shiller (2000, p. 5).

Even if many individual investors are irrational, believers in efficient markets argue that "arbitrage" makes the market efficient. Arbitrageurs are expected to take opposing positions in order to quickly correct any mispricing caused by irrationality. As a result, rational traders should be able to counteract the effects of behavioural traders. In addition, the term "anomalies" was introduced to explain the difference in a stock's performance from its expected price trajectory, as according to the EMH.

[4] (Haugen & Lakonishok, 1988; Lo & MacKinlay, 1999; Shleifer, 2000)

2.2. Market Anomalies

Although there is significant evidence showing that markets are efficient, researchers have identified several apparent market inefficiencies, called anomalies (Jensen, 1978). If a change in the price of an asset cannot be attributed to the release of new information, it surges an anomaly over market efficiency.

Based on the analysis method that identified the anomaly, there are two types of categories: time-series anomalies, which use time series of data; and cross-sectional anomalies, which use a sample of companies. Time-series anomalies can be sub-categorized in calendar anomalies, which are situations linked to a particular point in time; and momentum and overreaction anomalies, which relate to short-term price patterns. Calendar anomalies include the January effect (Rozeff & Kinney, 1976), the weekend effect (Keim & Stambaugh, 1984) or the turn-of-the-month effect (Ariel, 1987). Momentum and overreaction anomalies were introduced in Bondt & Thaler (1985) by affirming that most people tend to overreact to unexpected and dramatic event news. In addition, Folkinshteyn et al. (2015) document a recurring trend of investor overreacting through five of the most important stock market crashes of the last three decades. As for cross-sectional anomalies, two of the most researched situations are the size effect and the value effect. The size effect, first observed by (Banz, 1981), results from the observation that small-cap companies stock tend to outperform large-cap companies' stock. The value effect results from the observation that value stocks[5] have consistently outperformed growth stocks through long periods of time (Basu, 1977). In addition, later research has found that the size and value effects have a strong power in explaining stock returns (Li et al., 2013).

In a response to EMH criticism, E. F. Fama (1990) and Schwert (1990) hold that occasional anomalies do not violate market efficiency. As they lose their predictive capacity when detected, and do not hold on the long run, these anomalies are not robust in different sample periods. Moreover, many of the different market pricing anomalies have no conclusive explanation, only persisting in a specific period and are corrected by arbitrageurs. As for the size and value effects, Fama and French developed a three-factor model to predict stock returns, which adds the size and value risk factors to the market risk in the CAPM (E. Fama & French, 1995). The outperforming is explained by the risk factor that value stocks and small-cap stocks face because of their higher cost of capital and increased business risk. This explanation supports the efficiency side over the cross-sectional anomalies.

[5] Generally referred to as stocks that have below average price-to-earnings and market-to-book ratios, and above average dividend yields

2.3. Event Studies Methodology

The event study is a common empirical test used to measure the investors' reaction to information releases, and therefore a tool to validate the EMH. It examines the effect of an unanticipated event on the price of an asset, most commonly company stocks and stock indices. Therefore, event studies can reveal how a security is likely to react to a specific situation, such as earning announcements or special dividends announcements.

The pioneer event studies measured the impact of income reports (Ball & Brown, 1968) and stock-splits (E. F. Fama et al., 1969) on security price adjustments. The conclusions state that the market was efficient in incorporating the new information into securities prices, as they detected the existence of abnormal returns on the event day. Since then, the volume of papers testing this method has increased substantially to measure the reaction to a different type of news. Eckbo (2007) reports that 565 event studies were published in five different journals between 1974 and 2000.

This methodology relates to the semi-strong form of efficient markets. If security prices react quickly to public information, they are consistent with the semi-strong hypothesis. In other words, it is expected to find excess returns (also called abnormal returns) at the time of a relevant announcement. However, finding consistent abnormal returns after the announcement would show market inefficiency and a trading opportunity where arbitrageurs profit from the price divergence.

Additionally, the event study methodology has many applications in finance and accounting. It can apply to both company-related events and economic-wide events. The company-related event studies include stock splits (Grinblatt et al., 1984), earnings announcements (Whisenant et al., 2003), dividends announcements (Suwanna, 2012), among other situations. On the other hand, the economic-wide event studies go from macroeconomic announcements such as to real economy and inflation (McQueen & Roley, 1993) through changes in the regulatory environment (Schwert, 1981). Both types of event study attempt to measure how each announcement affects the pricing of securities, revealing patterns or market trends.

Along with the extensive literature on the event study methodology, this methodology was particularly used to address different research questions on the stock market reaction to the COVID-19 pandemic (Alam et al., 2020; Bash, 2020; Liu et al., 2020). This set of studies focuses both on the international-level as on the country-level.

2.4. COVID-19 Impact on Stock Markets

Many research articles address the direct impact of COVID-19 on global financial markets. Among different methodologies and research questions, the conclusions are consistent for a negative effect of the pandemic on stock markets. Liu et al. (2020) use an event study to assess the short-term effects on 21 leading stock indices in the countries most affected by the pandemic. By using January 20, 2020 as the event day – date in which the COVID-19 emerged in global press – their findings suggest a significant negative impact across all countries in the study. In addition, they also find that confirmed infectious cases have also a significant adverse effect on the indices.

Similarly, Zhang et al. (2020) explore the systematic risk reaction to the pandemic and the potential impact of future policy interventions. The study uses a volatility and correlation analysis, as well as a minimum spanning tree methodology to investigate the systematic correlation among countries. The conclusions of this study establish an increase in global financial market risks, and also that individual securities are linked to the gravity of the outbreak in each country.

Gormsen & Koijen (2020) explore investors' expectations during this unpredictable scenario. They use aggregate stock and dividend futures data to investigate on investors' outlooks in response to the outbreak and consequent policy responses. The study suggests that stock prices have fallen because of changes in discount rates that were driven by deviations in the investor sentiment, risk aversion and uncertainty over the long-run growth.

Q. He et al. (2020) uses t-tests and nonparametric Mann-Whitney tests to investigate the direct and spill-over effects of the pandemic on stock markets. In line with the previous studies, the results show the negative impact of the pandemic, but it also introduces the bidirectional spill-over effects between Asian countries and American and European countries. The latter introduction sets that the shocks in the Asian market are responsible to bring changes in the European and vice versa.

Finally, McKibbin & Fernando (2020) examine different scenarios on macroeconomic outcomes and financial markets for the COVID-19 evolution. Because of the uncertainty of these scenarios, the policymaker's measures are a critical and challenging issue to address. In addition, it also proposes the pandemic has a greater negative effect in less developed countries with higher population density and less developed health care systems.

2.5. COVID-19 Related Events

A second set of papers seeks to analyse the linkage between the market and event-related issues. These topics include the number of active cases/deaths, lockdown announcements, news in the media, monetary stimulus, among others.

Ashraf (2020) uses a panel data study to examine the impact of changes in confirmed cases and deceases on stock returns from 64 countries. It shows that as the number of cases increased, stock returns decreased. Another finding is that the market reacts more strongly to increases in confirmed cases than to deaths caused by the virus. Overall, the analysis reveals a quick response from the stock market to the pandemic.

As for lockdowns, stock market returns and the intensity of lockdowns are negatively connected (Alexakis et al., 2021), and account for a significant amount of the declines in consumer spending (Coibion et al., 2020). In addition, according to Davis et al. (2021) stricter social distancing measures drove to larger declines in national stock prices across 35 countries. This set of studies suggests investors consider harder lockdowns measures as negative news about future economic performance, which contribute to larger drops in stock prices.

Regarding media news, Baker, Bloom, Davis, et al. (2020) uses text-based methods to examine the stock market volatility derived from major US newspaper's headlines. It shows that the COVID-19 developments have no historical precedence in US stock market, as next-day newspaper accounts for a significant number of market moves. Altig et al. (2020) examined non-conventional uncertainty indicators as newspaper-based measures and Twitter-based economic uncertainty index, to evidence large volatility jumps. Moreover, the indicators in this study reach their higher values on record. Ahundjanov et al., (2020) and Lyócsa & Molnár (2020) explore the relationship between Google search queries related to COVID-19 and the major indices' performance. These studies measure the fear of COVID-19 as the abnormal Google searches for terms related to the pandemic and find the existence of a casual positive relationship between these searches and the market volatility.

Finally, there is a set of literature on the stock market reaction to fiscal and monetary stimulus. The findings are consistent with Chan-Lau & Zhao (2020), which argue that markets react negatively to government stimulus. Shafiullah et al. (2021) analysed multiple countries, including Portugal, and suggest that a larger decline in the stock market results in a larger stimulus package. It also points out that monetary policy is more responsive to a stock market decline than fiscal policy.

2.6. Natural disasters, artificial disasters and terrorism

As far as historical precedents concern, there is a set of studies on the economic impact of natural disasters, artificial disasters and terrorism on financial markets. The datasets used for natural disasters include earthquakes, droughts, pandemics, floods, storms, volcanoes and hurricanes. For instance, Wang & Kutan (2013) employ an event study methodology to examine the impact of a Japanese earthquake in 2011 on global stock markets. The results show no significant impact on each of the US and Japan stock markets. However, on the event day, the insurance sector experienced a negative shock brought by the event.

Baker, Bloom, & Terry (2020) analyse a cross-country panel data on stock markets using natural disaster, terrorist attacks and political shocks in regressions. The findings show a negative impact of political shocks and terrorism attacks on stock markets, and also a negative but marginal impact of natural disasters. Consistently with the previous results, Tavor & Teitler-Regev (2019) study finds that during natural disasters, the stock index decreases on the event day and on the two following days.

2.7. Economic Recessions and Market Crashes

To end this literature review, we will also look at previous studies on the causes of economic recessions and market crashes. Financial markets history contains several periods of devastating crisis, from which some led to wider economic recessions. Herd behaviour, regulatory failures and the use of leverage are the main causes leading to international financial crisis, banking crisis and speculative bubbles throughout history.

According to different studies on the 2008 Global Financial Crisis, multiple factors caused the economic recession, such as loose monetary policy, cheap credit, and the easy availability of funds (Allen & Carletti, 2010; Islam & Verick, 2011). In addition, other factors such as subprime mortgages, weak regulatory structures, and high banking leverage, have exacerbated the impact of the crisis (Crotty, 2009).

As for the Dot-com bubble of 1999-2000, the general cause for this crash was the overvaluation of internet stocks. Shiller (2000) uses this example as an evidence on market inefficiency as many investors speculated on technological companies. The Internet's promise resulted in the largest creation and destruction of stock market wealth in history. From late 1998 to March 2000, the NASDAQ Composite Stock Index, which essentially represents high-tech companies, more than tripled, while the price-earnings multiples of the stocks surged to over 100.

Regarding the Black Monday crash of 1987 – which represents the largest single-day decline in the US stock market history – the explanations include illiquidity (Amihud et al., 1990), decoupled markets for derivative securities and program trading (Kleidon & Whaley, 1992), and the impact of portfolio insurance (Leland, 1988). The S&P500 was trading at 23 times earnings before the crash, well above the average of 14.5 times earnings.

Market history appears to contradict the notion that stock markets are rational and efficient. For proponents of market efficiency, the conclusion is that in every financial crash the market did correct itself. According to Malkiel (2003), anomalies can arise, markets can become irrationally optimistic, and they frequently attract ignorant investors. However, eventually real value is recognized by the market. Markets can be very efficient even with the existence of errors, like the Internet stocks in the early 2000s.

III

Research Goals

The literature review has shown an extensive set of studies trying to explain the behaviour of financial assets during the COVID-19 period. Even if some of them focus on the equity market, most only provide empirical evidence on a general and international level, not going further to analyse the specific country level. As until the date of this study there is no evidence for the pandemic impact on the Portuguese stock market, the main question we aim to respond is: how the lockdown announcements and extensions in Portugal affected the PSI-20 constituents?

In order to answer the main question, we employ the event study methodology to investigate the performance of the PSI-20 and its constituents during 21 selected events. The existence of abnormal returns (AR) and other metrics such as cumulative abnormal returns (CAR), average abnormal returns (AAR) and cumulative average abnormal returns (CAAR) will provide evidence to discuss the stock market reaction and semi-strong form of the EMH during the COVID-19 period in Portugal. Therefore, we set three objectives to answer the main question:

1) Verify if the PSI-20 and each constituent follow a semi-strong form of the EMH.
2) Verify if there are signals for overreaction and underreaction over each event.
3) Verify the presence of patterns of response through each type of event.

To answer the previous objectives, we will test the following hypotheses using the event study methodology:

1) The abnormal returns for each constituent and PSI-20 differ from zero.
2) The cumulative abnormal return differs from zero.
3) The average abnormal return for each event type differs from zero.

IV

Methodology

The event study methodology is a very solid instrument used to analyse how a particular event affects a company's stock price, volume or volatility. In order to test this impact, researchers assess the existence of abnormal returns (AR), which measures the difference between real observed returns and the expected returns if the event would not have occurred, also called "no news" returns. According to Brown & Warner (1980), there are three fundamental methodological assumptions required to conduct an event study:

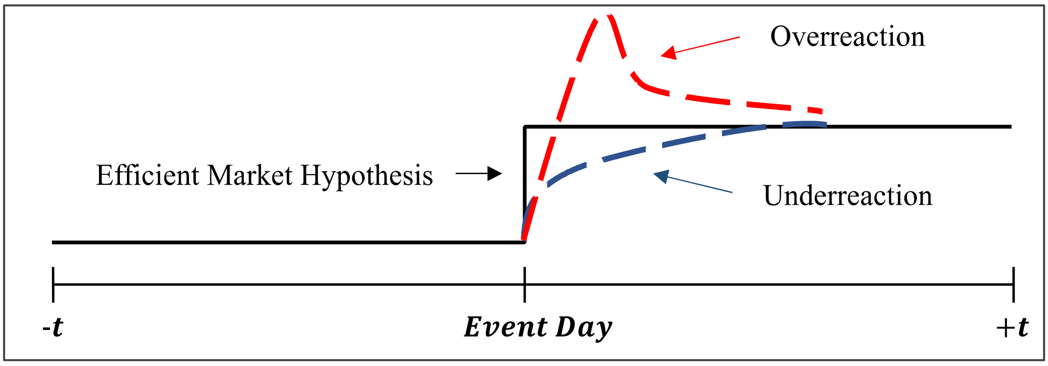
1. The stock returns in the event window express the economic impact of the event.
2. The event is not expected.
3. There are no confounding events in the event window.

The first assumption points out to the semi-strong form of the EMH. It implies that the market processes information in an efficient and unbiased form, meaning that all new information is quickly reflected in stock prices. Therefore, as Figure 1 displays, there should be evidence of the effect of the event on the security prices. In addition, the speed of the price adjustment reflects whether the market overreacted or under-reacted to the new information.

The second assumption is based on the idea that there is no evidence on the occurrence of the event, that is, the situation is unexpected. This assumption can be challenging, because most times an event is anticipated from an official announcement. As the date when the information is available to all investors is not accurate, it is difficult to establish with precision the event day, and as consequence the event window.

The last assumption requires that the event is isolated from other occurrences, in order to not confounding the impact of other events. The longer the event window, the highest the probability to violate this assumption. Therefore, the presence of event clustering is a challenging situation, as the test results origin cannot be proved.

Figure 1 – *Prices around the event day under the EMH*



4.1. Event Study Structure

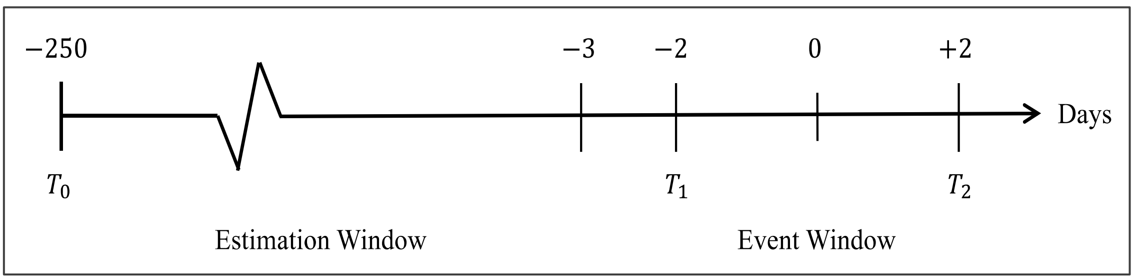
The event window and estimation window are two important concepts in this methodology. The event window is the time period adjacent to the event, while the estimation window is the period used for the forecast of returns. Because there is no defined rule for the length of these parameters, researchers have an open choice on the period selection. However, the assumptions taken in this section present a trade-off between improving the estimation accuracy and a potential parameter shift. Also, the identification of the event day is significant as it works as an “anchor” for the entire analysis. As referred in the previous section in assumption two, it is imperative to consider that on some occasions, the existence of rumours precedes the official announcement of an event. Thus, the event day is not always the date of the announcement, but the date when new information is leaked.

The terminology for the event window used is $[T_1, 0, T_2]$, and the event window length is $L = T_1 + T_2 + 1$. As described in assumption three, shorter event windows favour the non-existence of confounding events, however it should be long enough to capture the impact of the event. Event windows usually range between 1 and 11 days and are equally centred on the event day (Holler, 2014).

The terminology for the interval of the estimation window is $[T_0, T_1 - 1]$, where T_0 is the first observed day. Larger periods improve the estimation accuracy but also have the risk of covering structural breaks in the parameters estimated. Park (2004) shows that the sensitivity of results caused by changing the estimation window is low, as long as the length exceeds 100 days. MacKinlay (1997) uses 250 daily observations.

Figure 2 displays the window structure used. We use 252 daily observations for the periods across the events, beginning at day -250 until day +2. The estimation window comprises the first 247 days [-250, -3], and the event window the following 5 days [-2, +2]. The day of each event is defined as *day 0*. In the case when the announcement follows the market closing time, we consider the following day as *day 0*.

Figure 2 – *Event Study Window Structure*



4.2. Abnormal Returns Calculation

The abnormal returns correspond to the difference between the observed returns and the expected returns for each security on each trading day. The expected returns are to the normal values that were predicted if the event did not occur. This is a key indicator in event studies, as it identifies the presence of unexpected values that could be driven from the observed event. If this is the case, the abnormal return on the event day supports the semi-strong form of the EMH and is computed as follows:

$$AR_{i,t} = R_{i,t} - E(R_{i,t}) \quad (1)$$

where:

$AR_{i,t}$ = abnormal return for security i on day t ;

$R_{i,t}$ = observed return for security i on day t ;

$E(R_{i,t})$ = expected return for security i on day t.

Regarding return values, most event studies do not specify how they compute them. However, Brown & Warner (1985) show comparable results using simple and continuously compounded returns; and Thompson (1988) shows that the return form used does not appear to make significant differences. In this study, we adopt to use continuously compounded returns, as it improves the normality of the return distribution. Therefore, the observed returns $R_{i,t}$ take the natural logarithmic form:

$$R_{i,t} = \ln\left(\frac{P_t}{P_{t-1}}\right) \times 100 \quad (2)$$

where:

$R_{i,t}$ = continuously compounded return of company i on day t ;

$P_{i,t}$ = closing price per share of company i on day t ;

$P_{i,t-1}$ = closing price per share of company i on day $t-1$.

The price performance of a security can only be classified as "abnormal" when compared to the expected value if the event did not occur. However, contrary to observed returns, which are easy to collect on most financial platforms, the expected returns have to be estimated using specific models. The selection of these models has a major importance in the event study methodology, as an incorrectly estimated expected value can lead to biased returns.

4.3. Expected Return Models

There are a variety of models used to estimate the expected returns of securities. In this study, we use two models discussed in (Brown & Warner, 1980): market-adjusted model, and market model. In addition, we also adjust the market model using a GARCH expansion in order to deal with heteroskedasticity. In order to compute the AR values, we will estimate the returns for each model and then use the arithmetic mean of the three values as the expected return value. Therefore, we can mitigate the outliers that arise from a specific model calculation.

There is several evidence on the comparison between different expected return models in the event study methodology. Dyckman et al. (1984) show the ability of these three models to correctly detect the existence of abnormal returns is similar, with a small preference for the market model and GARCH model. However, the authors admit that the difference does not appear to be relevant. In addition, (Thompson, 1988) also concludes that the traditional market model ignoring extraneous individual company events would be appropriate in most cases. Although the models have been proposed for a long time and multiple adjustments have been made, recent reviews (Sorokina et al., 2013) argued that the market model remains the most commonly used model for event studies.

4.3.1. Market-Adjusted Return Model

The market-adjusted return model (MAM) considers the market movements that occur at the same time as each company's returns. In this model, a company is expected to generate similar returns as a market benchmark in the absence of new information. Therefore, the abnormal returns correspond to the difference between a company's observed returns and the general market returns at day t:

$$AR_{i,t} = R_{i,t} - R_{m,t} \tag{3}$$

where:

$R_{m,t}$ = expected market return day t.

Notice that *Equation 3* matches *Equation 1* as we consider the returns in the market as the expected returns: $E(R_{i,t}) = R_{m,t}$. The expected returns are considered to be constant across the sample securities, although not across time. Additionally, the market-adjusted return model benefits for its simplicity, as there is no need for an estimation process.

Regarding the market benchmark, we have compared three indices in order to select the best estimate to represent the market returns. The ACWI[6], which comprises around 3,000 securities across 23 developed countries and 26 emerging markets; the STOXX600 Europe[7], which covers about 90% of the free-float market capitalisation of the European stock market; and the Euronext100[8], which includes the largest and most liquid securities traded in Europe. In order to choose the best fit from the three indices, we have used the linear regression from next section's market model. Table 1 shows the R-squared values from each of the benchmarks using the PSI-20 as the independent variable. The STOXX600 and Euronext100 results are similar, with a high R^2 value, however we have selected the former as the test's power is higher.

Table 1 - R^2 *comparison for reference market selection*

Index	**R-Squared (R^2)**
STOXX600 Europe	67,85%
Euronext100 Index	66,38%
All Country World Index (ACWI)	51,72%

4.3.2. Market Model

The market model (MM) is a statistical model which adopts a stable linear relationship between the market return and each company's return. This way, it considers the systematic risk profile of each company in analysis on a constant relationship with the reference market. The parameters for this model are estimated during the estimation window using the ordinary least squares (OLS). For any company i, the market model is:

$$AR_{i,t} = R_{i,t} - \left(\alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t}\right) \tag{4}$$

$$E(\varepsilon_{it}) = 0 \quad ; \quad var(\varepsilon_{it}) = \sigma^2_{\varepsilon_i} \tag{5}$$

where:

$R_{i,t}$ = observed return on the share of company i on day t ;

$R_{m,t}$ = observed return on the reference market m on day t ;

α_i = intercept term of the regression of company i ;

β_i = systematic risk of company i ;

$\varepsilon_{i,t}$ = error term of company i on day d.

[6] All Country World Index: https://www.msci.com/acwi
[7] STOXX Europe 600: https://www.stoxx.com/index-details?symbol=SXXP
[8] Euronext 100 Index: https://live.euronext.com/en/product/indices/FR0003502079-XPAR

The gain of using the market model will depend upon the R^2 value for the regression. The variance of the abnormal return is reduced by removing the constituent related to the market return variation. Therefore, a higher R^2 translates into a higher reduction on the variance of abnormal returns, and into an improved model. Despite the high power of this model, regression models are based on some statistical assumptions. The model assumes that the residuals are normally distributed with a zero mean, have constant variance (homoscedasticity), are not serially correlated, and are not correlated with the explanatory variables. Therefore, there are some adjustments to perform in order to lower these assumptions.

4.3.3. Market Model with GARCH Adjustment

The market model with GARCH model adjustment (MMG) is an expansion version of the market model which accounts for changes in volatility. The GARCH (p, q)[9] process addresses the constant variance issue, by assuming that residuals can be conditional heteroskedastic. In this study we use the GARCH (1, 1) approach in Corhay & Rad (1996).

$$R_{i,t} = \widehat{\alpha_i} + \widehat{\beta_i} R_{m,t} + \varepsilon_{i,t} \tag{6}$$

This adjustment results into different parameter coefficients for the market model, which leads to a modification in the expected returns. In this case, $\widehat{\alpha_i}$ and $\widehat{\beta_i}$ parameters are the fitted values of the intercept and slope for the market model. The conditional variance $h_{i,t}$ (Bollerslev, 1986) in GARCH (1, 1) is computed as[10]:

$$h_{i,t} = \omega_i + \alpha_i \varepsilon_{i,t-1}^2 + \beta_i h_{i,t-1} \tag{7}$$

where the model parameters are estimated via maximum likelihood:

ω_i = variance intercept ;

α_i = adjustment to past shocks ;

β_i = adjustment to past volatility.

By adding the GARCH adjustment to the market model, we include conditional heteroskedasticity, recognising time-varying volatility. Therefore, this correction provides more accurate values, solving the assumption of constant variance on the error term.

[9] The *p* term models the variance of residuals, the *q* term models the variance of the process.

[10] Constrained by: $\omega_i > 0$, $\alpha_i > 0$, $\beta_i > 0$, and $\alpha_i + \beta_i < 1$

4.4. Statistical Hypotheses

In this section, we propose the aggregation of abnormal returns. The aggregation can be presented through two dimensions: time and securities. For this purpose, we will define and compute three additional concepts: the cumulative abnormal returns (CAR), the average abnormal returns (AAR) and the cumulative average abnormal returns (CAAR).

The cumulative abnormal return is the time-series aggregation of all the abnormal returns in the event window. As an event can be foreseen, there is a probable scenario of some disturbance across returns around the event day. In this case, some of the abnormal behaviour should be reflected before the event day. In addition, the adjustment speed to the new information is a question for market efficiency, as prices should adjust immediately to new information. The CAR null hypothesis tests if the cumulative abnormal return is zero:

$$CAR_i = \sum_{t=T_1}^{T_2} AR_{i,t} \tag{8}$$

The average abnormal return seeks to if test the cross-sectional aggregation of an event is abnormal. Typically, securities respond similarly to a specific event type, however, there is the possibility that some of them show different reactions. In order to detect if the response to the event is a company-specific reaction or an overall reaction, we average the abnormal returns across securities to compute the average abnormal return. Therefore, we will test the general market reaction on the Portuguese stock market. This hypothesis is also called cross-sectional aggregation and the null hypothesis considers that the average abnormal return is zero[11]:

$$AAR_t = \frac{1}{N}\sum_{t=1}^{N} AR_{i,t} \tag{9}$$

The cumulative average abnormal return considers both the aggregation of abnormal returns through securities and time. Similarly to the cumulative abnormal returns, we can summarize the average abnormal returns across time. Therefore, the cumulative average abnormal return is the aggregation of the average abnormal returns and the null hypothesis also considers the value to equal zero:

$$CAAR_{(T_1,T_2)} = \frac{1}{N_t}\sum_{t=T_1}^{T_2} AAR_t \tag{10}$$

[11] $N = 18\ number\ of\ constituents$

4.5. Test statistics

The hypothesis testing is set up so that the null hypothesis claims an event does not change the value of a company, in other words, the abnormal return equals zero. The non-rejection of the null hypothesis either implies a contradiction of the semi-strong form of the EMH, or that the new information is not sufficiently powerful to generate significant price movements in the stock market:

$$\begin{aligned} H_0 &: \mu = 0 \\ H_1 &: \mu \neq 0 \end{aligned} \tag{11}$$

where: $\mu = AR, CAR, AAR\ or\ CAAR.$

Most event studies use parametric[12] or non-parametric[13] tests to verify the significance of abnormal returns. Parametric tests make assumptions regarding the parameters of the population distribution from which the sample is derived. Usually, the assumption is that the population data is normally distributed, parametrized by the mean μ and standard deviation σ. The nonparametric tests are "distribution free", as it makes no assumptions about a parametric distribution. The motivation behind nonparametric tests comes from the concerns over the lack of normality in stock return distributions. Berry et al. (1990) highlights that nonparametric tests generate too few rejections of the null hypothesis, concluding that only perform well in the existence of extreme abnormal returns.

Researchers usually use nonparametric tests in conjunction with parametric tests. The presence of the nonparametric tests ensures that the conclusions drawn from the parametric analyses are more robust and reliable. An example occurs in (Schipper & Smith, 1983), in which the methodology combines the two methods in order to ensure that outliers do not bias the study results. In addition, different test statistics are needed to address challenges over the sample data. For instance, cross-sectional correlation occurs when the study focuses on events that happened for a set of securities at the same date. Likewise, the event-induced volatility is an issue when clustering occurs, as a model should account for changes in variance around the event date. Therefore, if the impact of these challanges is ignored, the test statistic becomes incorrect as the values are misspecified.

[12] (Agrawal & Kamakura, 1995; Martin Curran & Moran, 2007)
[13] (Campbell et al., 2010; Dombrow et al., 2000)

In our study, we use the set of tests from Table 2 to provide robust results on cross-sectional correlation and event-induced volatility. However, normality problems with parametric tests can appear because of the low number of observations in the data sample. According to the central limit theorem, the assumption of normality holds for a sample size larger than 30 observations. As the sample of companies used $N = 18$ is inferior, we use nonparametric tests to deal with non-normality.

Table 2 - *Parametric and Nonparametric Tests Used*

Null Hypothesis	Parametric Tests	Nonparametric Tests
AR = 0	t-test	-
CAR = 0	t-test	-
AAR = 0	t-test Patell Test BMP test	Generalized Sign test Modified Rank test
CAAR = 0	t-test Patell test BMP test	Modified Rank test

4.5.1. Parametric Tests

The parametric tests rely on the normality of returns as a key assumption. For this analysis, we have selected the traditional t-test, Patell test and BMP test. Although there is the existence of alternative tests, the three presented are generally accepted and widely used in the event study literature (Binder, 1998).

The standard t-test statistic is one of the most used tests in event studies. It is recognized for its simplicity, as the test statistic corresponds to the abnormal return divided by its estimated standard error. In the case of the AR t-test and standard error:

$$t_{AR_{i,t}} = \frac{AR_{i,t}}{S_{AR_i}} \tag{12}$$

$$S^2_{AR_i} = \frac{1}{M_i - 2} \sum_{t=T_0}^{T_1} \left(AR_{i,t}\right)^2 \tag{13}$$

where:

$AR_{i,t}$ = abnormal return from company i on date t ;

S_{AR_i} = standard error of the regression from the AR of company i in the estimation window

M_i = number of non-missing returns.

In the case of the CAR t-test, the difference occurs on the standard error[14]:

$$t_{CAR_{i,t}} = \frac{CAR_i}{S_{CAR_i}} \tag{14}$$

$$S^2_{CAR_i} = L_2 S^2_{AR_i} \tag{15}$$

This test statistic is also employed similarly for the AAR and CAAR. However, in this case we are assuming that the abnormal returns are cross-sectionally independent and identically distributed. The AAR t-test is computed as[15]:

$$t_{AAR_{t,}} = \sqrt{N}\frac{AAR_t}{S_{AAR_t}} \tag{16}$$

$$S^2_{AAR_t} = \frac{1}{N-1}\sum_{i=1}^{N}\left(AR_{i,t} - AAR_t\right)^2 \tag{17}$$

The CAAR t-test is computed as:

$$t_{CAAR_t} = \sqrt{N}\frac{CAAR}{S_{CAAR}} \tag{18}$$

$$S^2_{CAAR} = \frac{1}{N-1}\sum_{i=1}^{N}(CAR_i - CAAR)^2 \tag{19}$$

The limitation of the t-test statistic is that it ignores event cross-sectional correlation and changes in the event-induced variance (Brown & Warner, 1985). If the variance differs across securities, or the returns are correlated, the test statistic is probably to be incorrectly specified. Research suggests that if the variance is underestimated, it can cause a low power of the test, leading to a frequent rejection of the null hypothesis (*Type 1 error*). Because of these limitations, we perform additional statistical tests.

The second parametric test is the Patell test, which suggests the standardization of each abnormal return before computing the test statistic (Patell, 1976). This process serves two purposes. First, it accounts for the fact that the event-period residuals are an out-of-sample prediction. Second, standardizing the residuals prevents securities with large variances from dominating the test, smoothing the effect of large values and normalizing the returns. The standard of abnormal returns (SAR) is the standardization of abnormal returns by the estimation-period standard deviation:

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[14] $L_2 = T_2 - T_1$, which is the event window length.
[15] $N = 18$ is the number of components

$$SAR_{i,t}{}^{16} = \frac{AR_{i,t}}{S_{AR_{i,t}}} \quad (20)$$

As the event-window abnormal returns are an out-of-sample prediction, Patell adjusts the standard error by the forecast error, that is the difference between the predicted and observed values:

$$S^2_{AR_{i,t}} = S^2_{AR_i}\left(1 + \frac{1}{M_i} + \frac{\left(R_{m,t} - \bar{R}_m\right)^2}{\sum_{t=T_0}^{T_1}\left(R_{m,t} - \bar{R}_m\right)^2}\right) \quad (21)$$

where:

$\bar{R}_m$ = average of the market returns in the estimation window.

Therefore, in order to compute the Patell test statistic for the AAR we use the $z_{Patell,t}$ nomenclature and the calculation as follows:

$$z_{Patell,t} = \frac{ASAR_t}{S_{ASAR_t}} \quad (22)$$

where $ASAR_t$ is the sum of the SAR over the sample with expectation zero and variance:

$$ASAR_t = \sum_{i=1}^{N} SAR_{i,t} \quad (23)$$

$$S^2_{ASAR_t} = \sum_{i=1}^{N} \frac{M_i - 2}{M_i - 4} \quad (24)$$

As for the test statistic for the $CAAR$ we compute the z_{Patell} as:

$$z_{Patell} = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \frac{CSAR_i}{S_{CSAR_i}} \quad (25)$$

where $CSAR_i$ denotes cumulative standardized abnormal returns for each security with expectation zero and variance:

$$CSAR_t = \sum_{t=T_1+1}^{T_2} SAR_{i,t} \quad (26)$$

$$S^2_{CSAR_t} = L_2 \frac{M_i - 2}{M_i - 4} \quad (27)$$

[16] The $SAR_{i,t}$ follows a t-distribution with $M_i - 2$ degrees of freed

The Patell test presents the strength of how the AR are distributed across the event window, normalising the distribution of returns. However, the test still does not hold to cross-sectional correlation and event-induced volatility.

The third parametric test addresses the event-induced volatility issue. (Boehmer, 1991) proposed a standardized cross-sectional method that estimates the variance from the cross-section of the event day predicted errors, instead from the estimation period. Therefore, the BMP test is a hybrid between the Patell methodology, and the cross-sectional approach proposed in Charest (1978). First, the event-period returns are normalized and then a cross-sectional test is applied to the standardized residuals. This methodology does not reduce the t-test and Patell test power, and it accounts for event-induced volatility. For the BMP test, we will use the z_{BMP} nomenclature as the test statistic for the AAR:

$$z_{BMP,t} = \frac{ASAR_t}{\sqrt{N}S_{ASAR_t}} \tag{28}$$

with $ASAR_t$ defined in the Patell test and with a standard deviation of:

$$S^2_{ASAR_t} = \frac{1}{N-1}\sum_{i=1}^{N}\left(SAR_{i,t} - \frac{1}{N}\sum_{l=1}^{N} SAR_{l,t}\right)^2 \tag{29}$$

As for the $CAAR$, test statistic is computed as follows:

$$z_{BMP} = \sqrt{N}\frac{\overline{SCAR}}{S_{\overline{SCAR}}} \tag{30}$$

where $\overline{SCAR}$ denotes the standardized cumulative abnormal returns across the N companies, with standard deviation based on:

$$\overline{SCAR} = \frac{1}{N}\sum_{i=1}^{N} SCAR_i \tag{31}$$

$$S^2_{\overline{SCAR}} = \frac{1}{N-1}\sum_{i=1}^{N}(SCAR_i - \overline{SCAR})^2 \tag{32}$$

The BMP test is also robust in how the abnormal returns are distributed across the event window. In addition, the test accounts for event-induced volatility and for serial correlation. This statistic is also well specified when there are no changes in variance on the event day, nevertheless, is less powerful on that case. However, the limitation of the BMP test is that is still sensitive to cross-sectional correlation, as it assumes a similar variance across securities, as the two previous parametric tests.

4.5.2. Nonparametric Tests

In this section, we will specify the generalised sign test and the modified rank test as nonparametric tests, which account for cross-correlation of returns, serial correlation, and event-induced volatility.

The generalised sign test was proposed in Cowan (1992), as an improvement of the traditional sign test. The latter is a binomial test that builds a ratio for the frequency of positive cumulative abnormal returns in the event period. This procedure examines under the null hypothesis whether the proportion of positive abnormal returns in the event exceeds 50%.

$$t_{sign} = \sqrt{N}\left(\frac{\hat{p} - 0.5}{\sqrt{0.5(1 - 0.5)}}\right) \tag{33}$$

The generalisation of the sign test compares the proportion of positive abnormal returns during the event to the proportion over a period unaffected by the event. That is, the number of expected abnormal returns is based on the fraction of abnormal returns from the estimation window, which is not necessarily 50%. Therefore, the generalisation of the test accounts for an asymmetric return distribution under the null hypothesis. The test statistic is:

$$z_{gsign} = \frac{(w - N\hat{p})}{\sqrt{N\hat{p}(1 - \hat{p})}} \tag{34}$$

where:

$w =$ fraction with positive AR during the event window ;

$\hat{p}$ is estimated as:

$$\hat{p} = \frac{1}{N}\sum_{i=1}^{N}\frac{1}{L_1}\sum_{t=T_0}^{T_1}\varphi_{i,t} \tag{35}$$

$$\begin{cases} \varphi_{i,t} = 1, & if\ AR_{i,t} > 0 \\ \varphi_{i,t} = 0, & otherwise \end{cases} \tag{36}$$

An advantage of the sign test is that it measures the sign of the abnormal return and not the magnitude, therefore, it is robust against event-induced excess volatility. However, Corrado & Zivney (1992) evidence that the generalised sign test power is greater than the t-test power in detecting $\pm 0.5\%$ of abnormal performance but is less powerful in detecting $\pm 1\%$ of abnormal performance. That is, this nonparametric test is better specified for small levels of abnormal returns and loses power for higher abnormal return values.

The second non-parametric test that we will use is the rank test introduced in Corrado (1989). This test consists in transforming the abnormal returns into ranks for each daily return. Then, the test compares the ranks in the event window for each security, with the expected average ranks over the estimation window. In the procedure, ranks are standardised by dividing by one plus the number of non-missing returns in each company as follows[17]:

$$K_{i,t} = \frac{rank\left(AR_{i,t}\right)}{1 + M_i} \tag{37}$$

Then, the rank test statistic is the following with a standard deviation of[18]:

$$t_{rank,t} = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \frac{\left(K_{i,t} - 0.5\right)}{S_U} \tag{38}$$

$$S_U = \sqrt{\frac{1}{M_1} \sum_{t=T_0}^{T_2} \left(\frac{1}{\sqrt{N_t}} \sum_{i=1}^{N_t} \left(K_{i,t} - 0.5\right) \right)^2} \tag{39}$$

When both nonparametric tests are properly specified, the rank test offers more power for detecting abnormal returns in short event windows (Cowan, 1992). In addition, (Corrado & Zivney, 1992) prove the rank test shows a higher power than both the generalised sign test and t-test in detecting $\pm 0.5\%$ and $\pm 1\%$ of abnormal performance. However, the rank test is more sensitive to increases in the event window period, as the number of days in the event window increases, the rank's test power decreases. Therefore, the generalised sign test is better suitable for event windows ranging until eleven days, whether the rank test is preferable for small event window studies.

[17] M_i = number of non-missing returns for company i;
[18] N_t = number of non-missing returns in the cross-section of N-firms on day t;

V

Data

In this section we explain the data used for the test statistics, which includes the events, period of analysis and the securities studied. We also briefly explain the different type of events and its nature.

Regarding the securities, we have collected daily data from a sample of the 18 constituents of the PSI-20 index, and STOXX600 as the market benchmark, for the period from 1st April 2019 to 1st May 2021. This time period contains sufficient data to use in both the estimation and event windows for each event. The daily adjusted closing prices on the PSI-20 constituents and STOXX 600 are collected from the Yahoo Finance Database[19] secondary data source.

As for the lockdown events, we have considered the Portuguese Government publications from its official journal, *Diário da República Eletrónico*[20]. According to the Portuguese legislation[21], there are three stages to adopt in order to face catastrophes and adverse periods. From a lower to higher risk, the stages are the alert situation, the contingency situation, and the calamity situation. Additionally, the President of Portugal can declare an emergency stage, which corresponds to the higher risk condition. Each phase is linked to a temporary legislation that adjusts to the specific situation. Through the COVID-19 developments in Portugal, all stages were adopted in different moments, except for the alert situation.

Table 3 displays information describing each lockdown event examined in this study, with its announcement date and the period for each lockdown period. From the event sample, there are two calamity situations, two emergency situations, one contingency situation, and a total of 15 extensions for these conditions. Additionally, we have also considered the WHO declaration of COVID-19 as a pandemic as a relevant event to cover.

In order to go along with the methodology assumptions from Section 4, we have not considered *Event 15* and *Event 17* for the analysis, as there is the existence of confounding events. For *Event 15*, the announcement date was on 6th January 2021, the same day the EMA approved the Moderna vaccine. As for *Event 17*, the announcement was on 28th January 2021, one day preceding the approval of the AstraZeneca vaccine. Recalling the second assumption required to conduct event studies: “there should be no clustered events that could be responsible

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[19] https://finance.yahoo.com/
[20] https://dre.pt/
[21] https://dre.pt/legislacao-consolidada/-/lc/69738106/201906030021/69973183/diploma/indice

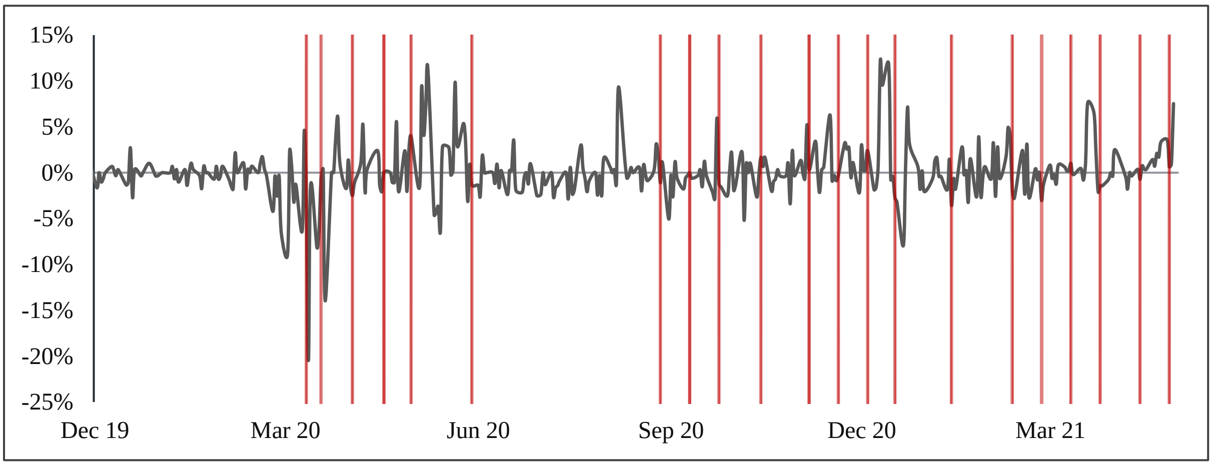
for the price changes". Therefore, as both events are in the presence of relevant clustering, the test statistics could be misleading, and as a result are ignored for this analysis.

Table 3 – *Event Description and Time Period*

Event Type	**Ann. Date**	**Period**	**Measures**
Event 1: COVID-19 as pandemic	11-Mar-20	-	-
Event 2: 1st Emergency situation	18-Mar-20	Until 2nd April	Close non-essential businesses Capacity restrictions
Event 3: Emergency situation extension	02-Apr-20	Until 17th Apr	Movement restrictions
Event 4: Emergency situation extension	17-Apr-20	Until 2nd May	No additional measures
Event 5: 1st Calamity situation	30-Apr-20	Until 17th May	Open small commercial and cultural establishments
(two phases)		18 May - 1 Jun 20	Open medium commercial and cultural establishments
Event 6: Calamity situation extension	29-May-20	Until 14th Jun	All measures removed
Event 7: 1st Contingency situation	27-Aug-20	Until 14th Sep	No measures added
Event 8: Contingency situation extension	10-Sep-20	Until 30th Sep	Gathering limits Time restrictions for commerce
Event 9: Contingency situation extension	24-Sep-20	Until 14th Oct	No additional measures
Event 10: 2nd Calamity situation	14-Oct-20	Until 31st Oct	Stricter gathering limits Higher surveillance and fines
Event 11: 2nd Emergency situation	06-Nov-20	Until 23rd Nov	Night-time curfews
Event 12: Emergency situation extension	20-Nov-20	Until 8th Dec	Face mask required Movement bans between regions
Event 13: Emergency situation extension	04-Dec-20	Until 23rd Dec	Restrictions on Holidays
Event 14: Emergency situation extension	17-Dec-20	Until 7th Jan	No additional measures
Event 15: *Emergency situation extension*	*6-Jan-21*	*Until 15th Jan*	*No additional measures*
Event 16: Emergency situation extension	13-Jan-21	Until 30th Jan	Night-time curfews Teleworking obligatory Close non-essential business
Event 17: *Emergency situation extension*	*28-Jan-21*	*Until 14th Feb*	*No additional measures*
Event 18: Emergency situation extension	11-Feb-21	Until 1st Mar	No additional measures
Event 19: Emergency situation extension	25-Feb-21	Until 16th Mar	No additional measures
Event 20: Emergency situation extension	11-Mar-21	Until 31st Mar	Reopen pre-schools and small commercial establishments
Event 21: Emergency situation extension	25-Mar-21	Until 15th Apr	Reopen some cultural and sport activities,
Event 22: Emergency situation extension	13-Apr-21	Until 30th Apr	Reopen schools, commercial and all cultural establishments
Event 23: Emergency situation end	27-Apr-21	-	Commercial and cultural activities without time restrictions

Figure 3 displays the PSI-20 returns during the event study period, as well as all the events tested. There is visual evidence for increased volatility around the event dates, compared with the period between December 2019 and March 2020. The volatility is more significant during the two first events, in which the index reached returns between -10% and 8%. In addition, we can observe that during the June 2020 – September 2020 period, the government did not adopt any lockdown measures, and the volatility in the Portuguese stock market decreased.

Figure 3 – *PSI-20 Returns and Events Data Frame*



As we will also analyse the sectorial impact of the pandemic and its lockdown periods, we look into the PSI-20 constituents' profile. According to the Global Industry Classification Standard (GICS), the index constituents are categorised in 9 of the 11 sectors. Table 4 discriminates each constituent by its weight in the index, industry, and total industry weight. Materials is the predominant sector in number with six constituents; followed by utilities with three constituents. The health care and real estate are the two sectors which are not represented in the PSI-20 index. As for industry weight, utilities represent nearly one third of the total market capitalisation of the index, followed by consumer staples with 20.09% industry weight. On the other hand, consumer discretionary and information technology weight in the PSI-20 is almost marginal, with a total influence of solely 1.20%. The weight data is collected from the Euronext PSI-20 Factsheet on June 30, 2021[22]. In addition, we present the ticker used to identify each constituent in the following section tables.

[22] https://live.euronext.com/en/product/indices/PTING0200002-XLIS/market-information

Table 4 – *PSI-20 Constituents Profile*

Company Name (Ticker)	Weight (%)	Industry (GICS)	Industry Weight (%)
Altri (ALTR)	3.03%	Materials	16.46%
Corticeira Amorim (COR)	3.97%	Materials	
Mota-Engil (EGL)	1.09%	Materials	
Ramada (RAM)	0.36%	Materials	
Semapa (SEM)	2.19%	Materials	
The Navigator Company (NVG)	5.82%	Materials	
EDP Renováveis (EDPR)	12.85%	Utilities	31.54%
Energias de Portugal (EDP)	10.63%	Utilities	
Redes Energéticas Nacionais (RENE)	8.06%	Utilities	
NOS (NOS)	5.72%	Communication Services	6.32%
Pharol (PHR)	0.60%	Communication Services	
Jerónimo Martins (JMT)	13.33%	Consumer Staples	20.09%
Sonae (SON)	6.76%	Consumer Staples	
Banco Comercial Português (BCP)	9.58%	Financials	9.58%
CTT Correios de Portugal (CTT)	4.75%	Industrials	4.75%
Galp Energia (GALP)	10.06%	Energy	10.06%
Ibersol (IBS)	0.71%	Consumer Discretionary	0.71%
Novabase (NBA)	0.49%	Information Technology	0.49%

VI

Empirical Results and Discussion

In this section, we examine and compare the results obtained on the tests performed according to section IV. The analysis will firstly assess the AR and CAR behaviour from the PSI-20 and each of its constituents, and then average and summarize the results to achieve the AAR and CAAR values.

Table 5 presents the descriptive statistics for each constituents of the index during the event window. In comparison with the descriptive statistics from the estimation period (see Appendix – Table 16), we can observe an increase on the standard deviation from an average 1.49% to 2.47%, on the kurtosis from 3.77 to 9.51, on the skewness -0.04 to 0.34 and on extreme values: the average minimum and maximum values on the estimation period are -5.65% and 5.66% versus -12.44% and 13.57% during the event window period. The excess kurtosis suggests the existence of extreme values, causing fat tails, while the positive skewness means that there is a higher number of observations with low values. Therefore, the descriptive statistics from both periods show the increase in risk over the two periods.

Table 5 – *Descriptive statistics of the PSI-20 constituents' data for the event window*

Ticker	Obs	Mean	St Error	Median	St Dev	Kurtosis	Skewness	Range	Min	Max
ALTR	291	0.19%	0.15%	0.12%	2.57%	6.09	-0.23	25.61%	-14.68%	10.93%
BCP	291	0.01%	0.17%	-0.17%	2.92%	5.07	0.85	27.44%	-10.11%	17.33%
COR	291	0.05%	0.12%	0.00%	1.96%	3.13	0.06	16.88%	-8.68%	8.20%
CTT	291	0.22%	0.14%	0.00%	2.37%	3.69	0.51	21.87%	-10.90%	10.97%
EDP	291	0.09%	0.13%	-0.04%	2.15%	10.05	-1.05	24.38%	-14.89%	9.48%
EDPR	291	0.19%	0.15%	0.29%	2.54%	3.34	-0.67	19.60%	-12.33%	7.27%
EGL	291	0.11%	0.21%	-0.14%	3.50%	16.35	1.56	44.44%	-16.43%	28.01%
GALP	291	0.02%	0.16%	-0.20%	2.80%	4.82	0.86	26.67%	-10.63%	16.04%
IBS	291	-0.05%	0.24%	-0.33%	4.04%	15.38	0.89	48.19%	-25.80%	22.39%
JMT	291	0.01%	0.11%	-0.16%	1.80%	10.16	0.07	21.32%	-11.56%	9.76%
NBA	291	0.11%	0.16%	0.00%	2.65%	20.34	1.02	36.79%	-15.10%	21.69%
NOS	291	0.03%	0.12%	-0.07%	2.10%	6.45	0.93	20.49%	-7.85%	12.64%
NVG	291	0.08%	0.12%	0.08%	2.13%	4.06	-0.02	20.24%	-10.96%	9.28%
PHR	291	0.14%	0.16%	-0.17%	2.67%	5.58	1.58	21.98%	-6.80%	15.18%
RAM	291	0.17%	0.19%	0.00%	3.22%	8.41	-0.30	32.62%	-20.48%	12.14%
RENE	291	0.02%	0.08%	0.00%	1.33%	17.91	-1.64	16.40%	-9.99%	6.41%
SEM	291	0.06%	0.16%	0.00%	2.68%	27.49	2.54	35.61%	-10.60%	25.01%
SON	291	0.10%	0.12%	-0.08%	2.02%	3.06	0.24	15.76%	-8.25%	7.51%
PSI-20	291	0.06%	0.09%	0.05%	1.51%	9.26	-0.68	17.80%	-10.27%	7.53%
Average	**291**	**0.08%**	**0.14%**	**-0.04%**	**2.47%**	**9.51**	**0.34**	**26.00%**	**-12.44%**	**13.57%**

6.1. Abnormal Returns

The abnormal return values were estimated using the average of the three models discussed in section 4.3. Then, we apply the t-test statistic in order to test the significance of the results at the 1% and 5% significance level. From the 21 events in the analysis, only the first two present significant results for abnormal returns on most constituents.

Table 6 displays the abnormal returns and correspondent t-test statistics for each constituent of the PSI-20, as for the index itself. By looking at AR (-2) and AR (-1), we detect the existence of abnormal returns prior to the WHO announcement of the COVID-19 as a pandemic, which shows the anticipation of investors of possible new information. During this period, 32% of the observations were significant for abnormal returns, from which 33% have a negative sign. As for the reaction after the announcement, 49% of the observations showed significant results and 54% with a negative sign. Regarding the PSI-20, the index only presents a positive AR on *day 0*, showing no significant results on the following days.

Table 6 – *AR Statistics for Event 1 – COVID-19 Declared as Pandemic*

Ticker	AR values					AR t-test				
	AR (-2)	AR (-1)	AR (0)	AR (+1)	AR (+2)	AR (-2)	AR (-1)	AR (0)	AR (+1)	AR (+2)
ALTR	2.36%	-3.08%	0.18%	-6.01%	4.60%	1.5657	-2.0396*	0.1162	-3.9813**	3.0479**
BCP	5.63%	0.78%	6.57%	-2.48%	-3.40%	3.2474**	0.4478	3.7906**	-1.4274	-1.9613
COR	1.84%	-3.09%	3.02%	1.11%	-5.01%	1.6311	-2.7324**	2.6754**	0.9837	-4.4344**
CTT	3.86%	1.96%	1.92%	-0.08%	0.97%	2.1856**	1.1123	1.0886	-0.0460	0.5519
EDP	-1.04%	2.02%	-4.24%	0.86%	-0.21%	-0.9930	1.9205	-4.0387**	0.8171	-0.1954
EDPR	-1.96%	-0.38%	-3.46%	2.04%	-1.44%	-1.8070	-0.3540	-3.1836**	1.8775	-1.3303
EGL	7.69%	2.60%	13.04%	0.58%	7.17%	4.5743**	1.5493	7.7572**	0.3477	4.2662**
GALP	0.73%	-0.19%	4.81%	-0.33%	2.68%	0.5866	-0.1548	3.8775**	-0.2633	2.1618**
IBS	-4.11%	-0.42%	-2.70%	-2.03%	-23.04%	-3.5813**	-0.3706	-2.3511*	-1.7675	-20.0894**
JMT	-1.66%	0.61%	3.83%	-0.07%	6.08%	-1.3658	0.4979	3.1487**	-0.0553	5.0055**
NBA	5.48%	-5.02%	0.97%	-1.41%	-11.77%	2.6542**	-2.4291*	0.4675	-0.6807	-5.6972**
NOS	0.92%	-0.57%	2.29%	0.59%	0.00%	0.7770	-0.4848	1.9407	0.5014	-0.0041
NVG	1.77%	-2.03%	2.58%	-3.01%	-0.58%	1.4718	-1.6898	2.1455**	-2.5071*	-0.4846
PHR	5.45%	6.22%	9.56%	-1.99%	-1.32%	2.9744**	3.3915**	5.2128**	-1.0870	-0.7212
RAM	5.39%	-2.63%	-13.23%	-2.13%	-5.06%	3.6046**	-1.7571	-8.8537**	-1.4248	-3.3873**
RENE	-1.35%	0.03%	-2.64%	-1.55%	-5.14%	-1.6773	0.0404	-3.2822**	-1.9241	-6.3932**
SEM	1.81%	-1.23%	0.37%	-3.51%	-6.33%	1.6365	-1.1092	0.3329	-3.1692**	-5.713**
SON	3.17%	0.56%	3.90%	-2.38%	-0.48%	2.7435**	0.4857	3.3727**	-2.0531*	-0.4159
PSI-20	0.43%	0.28%	1.41%	-0.50%	0.33%	0.8214	0.5234	2.6751**	-0.9417	0.6325

Total Observations = 95
% Significant Observations = 42%

In Table 7, we can observe the results for *Event 2 – 1st Emergency Situation*. The t-test statistic shows 58% of the observations significant before the announcement, and 51% significant after the announcement of the emergency situation. In this event window, all constituents had at least one statistically significant value at the 5% or 1% significance level.

During the event, there is evidence for some noise before the lockdown announcement, which can be a consequence of the proximity of the previous event. Regarding the reaction on the event day AR (0), there are 58% significant values, from which 82% negative results. Thus, it confirms the negative reaction of investors to the first lockdown measures. As for the days following the announcement, the negative significant values decreased to 47% on both AR (+1) and AR (+2). However, on AR (+1) the negative significant values decreased to 44%, while in AR (+2) to only 11%. This price behaviour suggests some overreaction after the declaration of the emergency situation, followed by a market correction. As for the PSI-20, the index presents negative abnormal returns on the event day (-3.89%) and previous day (-1.42%), followed by a market correction on *day 2* (2.19%), confirming the previous pattern.

Table 7 – *AR Statistics for Event 2 – 1st Emergency Situation*

Ticker	AR values					AR t-test				
	AR (-2)	AR (-1)	AR (0)	AR (+1)	AR (+2)	AR (-2)	AR (-1)	AR (0)	AR (+1)	AR (+2)
ALTR	-3.59%	-5.97%	0.22%	4.06%	3.02%	***-2.2739****	***-3.7792*****	0.1366	***2.5711*****	1.9134
BCP	0.91%	0.68%	-3.61%	0.58%	2.87%	0.4988	0.3719	***-1.9827****	0.3173	1.5730
COR	-4.63%	4.35%	1.57%	-1.20%	-1.65%	***-3.8252*****	***3.5914*****	1.2955	-0.9915	-1.3654
CTT	8.77%	-0.59%	-7.08%	-1.72%	3.74%	***4.9306*****	-0.3310	***-3.9803*****	-0.9648	***2.1014*****
EDP	4.20%	-5.15%	-10.47%	2.02%	2.74%	***3.9043*****	***-4.7855*****	***-9.7378*****	1.8775	***2.5492*****
EDPR	0.92%	-5.56%	-4.91%	1.22%	-1.10%	0.8186	***-4.9395*****	***-4.3635*****	1.0875	-0.9748
EGL	4.25%	2.20%	-3.33%	-7.39%	3.86%	***2.2052*****	1.1406	-1.7293	***-3.8327*****	***2.0049*****
GALP	4.20%	0.69%	-3.12%	-5.00%	5.59%	***3.2714*****	0.5359	***-2.4312****	***-3.8949*****	***4.3547*****
IBS	-4.55%	-11.80%	19.98%	-6.56%	1.04%	***-2.4315****	***-6.3044*****	***10.6763*****	***-3.5064*****	0.5536
JMT	6.09%	0.06%	-2.44%	-1.75%	1.39%	***4.8212*****	0.0491	-1.9315	-1.3829	1.0997
NBA	7.84%	4.34%	-1.13%	20.22%	-9.27%	***3.4734*****	1.9203	-0.5014	***8.9570*****	***-4.1043*****
NOS	-0.27%	3.17%	-1.56%	6.10%	1.39%	-0.2248	***2.6821*****	-1.3206	***5.1692*****	1.1738
NVG	3.17%	-1.17%	-3.38%	1.27%	0.70%	***2.5878*****	-0.9583	***-2.7616*****	1.0395	0.5729
PHR	-0.84%	-0.09%	5.15%	2.83%	3.19%	-0.4304	-0.0442	***2.6504*****	1.4585	1.6429
RAM	-8.37%	3.18%	-2.17%	-15.50%	4.22%	***-4.773*****	1.8108	-1.2366	***-8.8322*****	***2.4026*****
RENE	-0.42%	-0.82%	-0.91%	0.27%	2.40%	-0.4644	-0.9034	-1.0052	0.2959	***2.6434*****
SEM	-3.01%	-5.97%	-5.66%	3.18%	-0.37%	***-2.5004****	***-4.9516*****	***-4.6999*****	***2.6365*****	-0.3107
SON	-2,05%	-3,81%	-3,12%	5,57%	5,29%	-1,7724	-3,2964**	**-2,6955****	**4,8169****	**4,5737****
PSI-20	2.35%	-1.42%	-3.89%	0.40%	2.19%	***4.4657*****	***-2.6916*****	***-7.3835*****	0.7516	***4.1614*****

Total Observations = 95
% Significant Observations = 54%

Given the proximity in time of *Event 1* and *Event 2*, it is also relevant to analyse the joint results of both event windows. From the 202 statistically significant observations, 45% occurred during the two first events while the rest are distributed across the subsequent periods.

On a company-specific analysis, the securities with the most statistically significant values over both events are IBS and SON with 7 significant observations. In the consumer discretionary sector, IBS displays 86% negative abnormal returns, while SON on the consumer staples sector displays 43%. The following most affected companies during these events are ALTR, EGL, GALP, NBA RAM, and SEM with 5 abnormal observations each. From these six companies, four are from the materials sector, showing some sensitivity of the sector to the events. On the other hand, NOS, in the communication services sector, only counts with 2 significant abnormal returns, both with a positive sign. On average, the abnormal return per company is 4.79 during this period.

Table 8 displays the abnormal returns of all the 21 events. The security which showed the most statistically significant values over the study period is EDPR (16 observations), followed by GALP (15 observations) out of 105 total observations. In contrast, the constituents presenting the least significant values are CTT, JMT, RENE and NVG, all with 6 significant observations. Also, 44% of the total abnormal returns present a negative sign, with IBS having a negative 89% of its total significant observations, followed by NVG and RENE with 57%. In contrast, PHR and JMT only show 11% and 14% of negative abnormal returns.

From these results, we can observe a change in the distribution of abnormal returns across the constituents of the PSI-20 over the event periods. Following the first two events, IBS only shows 2 additional abnormal returns, RAM an additional 4 observations, while NOS presents 10 additional ones. Finally, we can verify that EDPR has the most significant observations, while IBS presents the greatest amount of negative abnormal returns, and that PHR and JMT are the least affected constituents with solely one negative value.

Table 8 – *Number of AR per constituent of the PSI-20*

	ALTR	BCP	COR	CTT	EDP	EDPR	EGL	GALP	IBS
Observations	105	105	105	105	105	105	105	105	105
Stat sig.	11	12	11	7	9	16	13	15	9
Stat sig. (%)	10.48%	11.43%	10.48%	6.67%	8.57%	15.24%	12.38%	14.29%	8.57%

	JMT	RAM	NBA	NOS	NVG	PHR	RENE	SEM	SON	PSI-20
Observations	105	105	105	105	105	105	105	105	105	105
Stat sig.	7	10	11	12	7	9	7	11	14	11
Stat sig. (%)	6.67%	9.52%	10.48%	11.43%	6.67%	8.57%	6.67%	10.48%	13.33%	10.48%

6.2. Cumulative Abnormal Returns

Regarding the cumulative abnormal returns, we can verify a similar pattern from the AR analysis, where only the first two events show statistically significant values for most of the constituents at the 1% and 5% significance level.

Table 9 shows that most securities show a significant CAR pattern over the 5-day event window in Event 1. EDPR, IBS, NBA, RAM, RENE and SEM display a negative cumulative value, while CTT, EGL, GALP, JMT and PHR show the contrary effect. As for the PSI-20, there is no evidence for cumulative abnormal returns. From the CAR (+2) test statistics, 58% of the observations present a statistically significant value, from which 55% have a negative value.

The results for Event 1, together with its AR values, evidence a reaction on the market over new information, suggesting the non-violation of the semi-strong form of the EMH. However, there is a sign for some under-reaction as in most cases the abnormal returns extend until *day 2* following the announcement. Finally, as the AR benchmark is the STOXX600, the results suggest a positive reaction to the announcement of the pandemic on the Portuguese stock market when comparing with other European markets.

Table 9 – *CAR Statistics for Event 1 – COVID-19 Declared as Pandemic*

Ticker	CAR values					CAR t-test				
	CAR (-2)	CAR (-1)	CAR (0)	CAR (+1)	CAR (+2)	CAR (-2)	CAR (-1)	CAR (0)	CAR (+1)	CAR (+2)
ALTR	2.36%	-0.72%	-0.54%	-6.55%	-1.95%	0.7002	-0.2119	-0.1600	-1.9405	-0.5774
BCP	5.63%	6.41%	12.98%	10.51%	7.11%	1.4523	1.6526	**3.3478****	**2.7095****	1.8323
COR	1.84%	-1.24%	1.78%	2.89%	-2.12%	0.7294	-0.4925	0.7040	1.1439	-0.8392
CTT	3.86%	5.83%	7.75%	7.67%	8.64%	0.9774	1.4749	1.9617	1.9411	**2.1879****
EDP	-1.04%	0.97%	-3.27%	-2.41%	-2.61%	-0.4441	0.4148	-1.3914	-1.026	-1.1134
EDPR	-1.96%	-2.35%	-5.81%	-3.77%	-5.21%	-0.8081	-0.9664	-2.3902*	-1.5506	**-2.1455***
EGL	7.69%	10.29%	23.33%	23.92%	31.09%	**2.0457****	**2.7386****	**6.2077****	**6.3632****	**8.2711****
GALP	0.73%	0.54%	5.35%	5.02%	7.71%	0.2623	0.1931	1.9272	1.8094	**2.7762****
IBS	-4.11%	-4.53%	-7.23%	-9.25%	-32.29%	-1.6016	-1.7674	**-2.8188****	**-3.6092****	**-12.5935****
JMT	-1.66%	-1.05%	2.77%	2.71%	8.79%	-0.6108	-0.3881	1.0201	0.9953	**3.2339****
NBA	5.48%	0.47%	1.43%	0.02%	-11.74%	1.1870	0.1007	0.3098	0.0053	**-2.5425***
NOS	0.92%	0.34%	2.63%	3.22%	3.22%	0.3475	0.1307	0.9986	1.2228	1.2210
NVG	1.77%	-0.26%	2.31%	-0.70%	-1.28%	0.6582	-0.0975	0.8620	-0.2592	-0.4759
PHR	5.45%	11.67%	21.23%	19.24%	17.92%	1.3302	**2.8469****	**5.1782****	**4.692****	**4.3695****
RAM	5.39%	2.76%	-10.47%	-12.60%	-17.66%	1.6120	0.8262	**-3.1332****	**-3.7704****	**-5.2853****
RENE	-1.35%	-1.32%	-3.95%	-5.50%	-10.64%	-0.7501	-0.7320	**-2.1999***	**-3.0604****	**-5.9195****
SEM	1.81%	0.58%	0.95%	-2.56%	-8.89%	0.7318	0.2358	0.3847	-1.0327	**-3.5876****
SON	3.17%	3.74%	7.64%	5.26%	4.78%	1.2269	1.4441	**2.9525****	**2.0343****	1.8483
PSI-20	0.43%	0.71%	2.12%	1.63%	1.96%	0.3674	0.6014	1.7978	1.3766	1.6595

Total Observations = 95
% Significant Observations = 31%

In line with the AR test statistics, Event 2 also displays significant results for the CAR values. Table 10 shows that 34% of the total observations present significant test results. Focusing on CAR (+2), only 7 constituents show significant results, from which 57% have a negative sign.

In comparison with Event 1, Event 2 presents similar significant test values on the 5-day event window, but fewer values on CAR (+2). This difference is justified by the market correction on *day 2* after the emergency situation announcement. That is, on Event 2 there is evidence for an overreaction on the event day followed by a market correction, while on Event 1 there is evidence for an under-reaction which extends the abnormal returns through the event period. Also, the second event shows more statistically significant values on the days preceding the event day, as it corresponds to the following days of Event 1 given the proximity of both.

Focusing on the company-specific level, NBA, NOS and PHR display a positive statistic for CAR (+2), while EDP, EDPR, RAM and SEM show a negative value. Comparing with Event 1, only EDPR and RAM maintain a negative cumulative response, while PHR is the only constituent which presents a positive cumulative response in both events.

Table 10 – *CAR Statistics for Event 2 – 1st Emergency Situation*

Ticker	CAR values					CAR t-test				
	CAR (-2)	CAR (-1)	CAR (0)	CAR (+1)	CAR (+2)	CAR (-2)	CAR (-1)	CAR (0)	CAR (+1)	CAR (+2)
ALTR	-3.59%	-9.57%	-9.35%	-5.29%	-2.26%	-1.0169	**-2.7070****	**-2.6459****	-1.4961	-0.6404
BCP	0.91%	1.59%	-2.03%	-1.45%	1.42%	0.2231	0.3894	-0.4973	-0.3555	0.3480
COR	-4.63%	-0.28%	1.29%	0.08%	-1.57%	-1.7107	-0.1046	0.4748	0.0313	-0.5793
CTT	8.77%	8.18%	1.10%	-0.61%	3.12%	***2.2050****	***2.0570****	0.2770	-0.1545	0.7853
EDP	4.20%	-0.95%	-11.42%	-9.40%	-6.66%	1.7460	-0.3941	***-4.7490****	***-3.9093****	***-2.7693****
EDPR	0.92%	-4.64%	-9.55%	-8.33%	-9.43%	0.3661	-1.8429	***-3.7944****	***-3.3080****	***-3.7439****
EGL	4.25%	6.45%	3.12%	-4.27%	-0.41%	0.9862	1.4963	0.7229	-0.9912	-0.0945
GALP	4.20%	4.89%	1.77%	-3.24%	2.36%	1.4630	1.7027	0.6154	-1.1264	0.8211
IBS	-4.55%	-16.35%	3.63%	-2.93%	-1.89%	-1.0874	***-3.9068****	0.8678	-0.7003	-0.4527
JMT	6.09%	6.15%	3.71%	1.97%	3.36%	***2.1561****	***2.1781****	1.3143	0.6958	1.1876
NBA	7.84%	12.18%	11.05%	31.27%	22.00%	1.5534	***2.4121****	***2.1879****	***6.1936****	***4.3581****
NOS	-0.27%	2.90%	1.34%	7.44%	8.83%	-0.1005	1.0989	0.5083	***2.8200****	***3.3450****
NVG	3.17%	2.00%	-1.39%	-0.11%	0.59%	1.1573	0.7287	-0.5063	-0.0414	0.2148
PHR	-0.84%	-0.92%	4.23%	7.06%	10.25%	-0.1925	-0.2122	0.9731	1.6253	***2.3601****
RAM	-8.37%	-5.20%	-7.37%	-22.86%	-18.65%	***-2.1345****	-1.3247	-1.8777	***-5.8276****	***-4.7531****
RENE	-0.42%	-1.24%	-2.15%	-1.88%	0.51%	-0.2077	-0.6117	-1.0612	-0.9289	0.2532
SEM	-3.01%	-8.98%	-14.64%	-11.47%	-11.84%	-1.1182	***-3.3327****	***-5.4345****	***-4.2554****	***-4.3944****
SON	-2.05%	-5.86%	-8.97%	-3.41%	1.88%	-0.7926	***-2.2668****	***-3.4723****	-1.3181	0.7273
PSI-20	2.35%	0.93%	-2.96%	-2.56%	-0.37%	***1.9971****	0.7934	***-2.5086****	***-2.1725****	-0.3114

Total Observations = 95
% Significant Observations = 34%

6.3. Average Abnormal Returns

The average abnormal returns help to eliminate the idiosyncratic values from each security, providing a test result that returns approximately the market reaction to each event. Therefore, the AAR results should be similar to the PSI-20 abnormal returns, although not equal as the index is a capitalisation-weighted index. For instance, larger returns from the highest market-capitalised constituents in the index can diverge the test results from the PSI-20 abnormal returns. In this section, we analyse the results according to the different types of events: COVID-19 pandemic announcement, emergency situations, calamity situations, contingency situations, and lockdown extensions.

The first event AAR test statistics differ from the AR statistics in Section 6.1. From Table 11, we can verify that AAR (0) does not show statistical evidence while AAR (+1) parametric tests do. A contrasting pattern from the PSI-20 AR test statistic. However, this difference is explained by the positive returns from JMT (3.83%), GALP (4.81%) and BCP (6.57%), which together combine one third of the total market capitalisation of the index. On the other hand, the lowest abnormal return is from RAM (-13.23%) which only sums 0.34% weight of the index capitalisation. Therefore, the PSI-20 AR presents a higher value than the AAR because of the positive returns from its highest capitalised constituents. Consequently, with the AAR statistics we test the Portuguese stock market as an equally weighted index, providing a uniform perspective over the performance of each constituent of the PSI-20.

On the other hand, the AAR (+1) statistics reveal significant results at the 5% significance level. Here, EDPR (+2.04%) and EDP (+0.86%) push the PSI-20 AR upwards (0.50%), while the average abnormal return stands below (-1.21%). Therefore, the average constituent returns show a negative significant response on the day following the first event. As for AAR (+2) the values do not reject the null hypothesis, as occurs in the PSI-20 AR. However, the average abnormal values present a negative sign (-2.35%), influenced by the low-capitalised constituents IBS (-23.04%) and NBA (-11.77%), while the index shows a small positive value (0.33%).

Table 11 – *AAR Statistics for Event 1 – COVID-19 as a Pandemic Announcement*

	AAR	t-test	Patell	BMP	G_Sign	M_Rank	PSI-20 AR
Event 1 – COVID-19 Declared as Pandemic							
AAR (0)	1.49%	1.0966	0.7611	0.2642	0.5571	0.5989	**2.6751****
AAR (+1)	-1.21%	**-2.5879***	**-3.4378****	**-2.2401***	-1.8004	-1.2590	-0.9417
AAR (+2)	-2.35%	-1.4339	**-8.8975****	-1.5513	-1.8004	-1.5100	0.6325

Regarding the emergency situation events, the test statistics suggest a significant negative AAR on the event day. As displayed in Table 12, in Event 2, the Patell parametric test and the nonparametric tests detect an AAR (0) at the 5% significance level. In addition, all the tests except for the t-test show a positive AAR (+2), evidencing the market correction. In this event, all the results match the PSI-20 AR regarding the significance of values.

As for Event 11, the results reapply on both the event day and following days, but with a lower power. In the second emergency situation, only the t-test and Patell tests present significant average abnormal returns. We can observe a negative value for AAR (0), followed by positive values in AAR (+1) and AAR (+2). Nevertheless, the values are not as statistical powerful as in the 1st emergency situation, and only present significant results at the 10% significance level.

The difference between the results from Event 2 and Event 11 can be explained by the different market conditions and investors' sentiment. The 1st emergency situation was called on March 18, 2020 while the 2nd emergency situation was called on November 6, 2020. During the first lockdown measures, the market volatility was higher, as the disease was unfamiliar, which led to an unpredictable situation. However, during the second emergency situation, even with similar lockdown measures, investors had more information on the general situation and outcomes, showing a least accentuated reaction.

Table 12 – *AAR Statistics for Emergency Situations*

	AAR	t-test	Patell	BMP	G_Sign	M_Rank	PSI-20 AR
Event 2 – 1st Emergency Situation							
AAR (0)	-1.31%	-0.8710	**-5.5584****	-1.3812	**-2.3106***	**-2.2738***	**-7.3835****
AAR (+1)	0.55%	-0.3321	1.8724	0.4700	0.9894	0.7199	0.7516
AAR (+2)	1.61%	0.6679	**4.6300****	**2.1844****	**2.4037****	**2.1578****	**4.1614****
Event 11 – 2nd Emergency Situation							
AAR (0)	-0.98%	**-2.0355***	**-2.1846***	-1.9653	-1.3137	-1.2759	-1.7846
AAR (+1)	2.03%	**2.3376****	**3.8668****	1.5976	1.5155	1.1229	1.3364
AAR (+2)	0.16%	**3.3376****	0.6734	0.4240	-0.3706	-0.0249	0.3394

As for calamity and contingency situations, the test results suggest significant average abnormal returns only when stricter measures are adopted. Table 13 displays a positive significant AAR (0) on the 1st calamity situation at 1% significance level. However, the 1st contingency and 2nd calamity situation both reject the null hypothesis for significant AAR during the event windows.

Table 13 – *AAR Statistics for Calamity and Contingency Situations*

	AAR	t-test	Patell	BMP	G_Sign	M_Rank	PSI-20 AR
Event 5 – 1st Calamity Situation							
AAR (0)	1.21%	**2.5999****	**2.4907****	**2.3273****	1.4689	1.3494	1.8984
AAR (+1)	0.86%	**3.0310****	**1.7948**	**2.5693****	1.4689	1.4815	1.2791
AAR (+2)	-0.76%	-1.2537	**-2.1239***	-1.5333	-1.8312	-1.5743	-1.5466
Event 7 – 1st Contingency Situation							
AAR (0)	1.47%	0.9112	**2.6247****	0.8518	-0.8325	0.0331	0.2260
AAR (+1)	-0.82%	-1.0747	-1.7408	-1.1967	-1.3041	-0.4932	-0.2282
AAR (+2)	-0.76%	-1.7526	-1.4396	-1.6751	-1.3041	-0.7974	-0.5386
Event 10 – 2nd Calamity Situation							
AAR (0)	0.25%	0.8322	0.3661	0.5419	0.5900	0.4380	0.6362
AAR (+1)	-0.19%	-0.5985	-0.6178	-0.8029	-1.2964	-0.4533	-0.7910
AAR (+2)	-0.85%	-1.9247	-1.3183	**-2.3387***	-1.7680	-0.874	-0.3595

The difference of results between the three events is associated with the measures linked to each announcement. For instance, Event 5 occurred when the severity of the situation in Portugal was decreasing, and the government presented a plan to reopen commercial and cultural activities. That is, the positive AAR in the 1st calamity situation is a response to an improvement in the Portuguese situation. On the other hand, Event 7 and Event 10 happened when the situation was aggravating. However, no significant measures were adopted. The 1st contingency situation took place in order to alert the general population about the beginning of a COVID-19 second wave, with no specific measures. As for Event 10, the new restrictions included limitations on gatherings, and an increase on surveillance and fines. Therefore, by analysing the three situations we can conclude that the market reacts strongly to the announcement of strict restrictions, and not to the type of situation *per se*.

As for lockdown extensions, there is no pattern found on the significance of results. From the 15 extension announcements, 3 presented no significant results, 5 positive abnormal returns, and 7 negative abnormal returns. Table 14 displays the first extension calls after each announcement type, where is visible that the market reaction is not majorly affected by the extension announcements. For instance, in Event 6 all previous imposed limitations were removed, and in Event 16 new restrictions included the close of non-essential business, obligation of teleworking and nigh-time curfews. As we can observe, Event 6 presents a positive market reaction, while Event 16 shows a contrary reaction. As for the remaining extension events, the significance can be explained by the occurrence of confounding events, with a higher valued information by the market.

Table 14 – *AAR Statistics for Extension Announcements*

	AAR	t-test	Patell	BMP	G_Sign	M_Rank	PSI-20 AR
Event 3 – 1st Emergency Extensions							
AAR (0)	-0.54%	-0.8755	-0.6992	-0.4596	0.0370	-0.2321	-0.3984
AAR (+1)	-0.17%	-0.3429	-0.0792	-0.0559	0.0370	0.1130	0.5982
AAR (+2)	-0.48%	-0.5790	-1.7410	-0.7904	-1.3773	-1.0758	**-2.9415****
Event 4 – 1st Emergency 2nd Extension							
AAR (0)	-1.15%	**-2.6436****	**-2.6521****	**-2.3291***	**-2.7836****	-1.4970	-1.8997
AAR (+1)	-1.03%	**-2.673****	**-1.9954***	**-2.0535***	-1.8407	-1.3116	-1.1264
AAR (+2)	-1.84%	**-7.0647****	**-4.5237****	**-7.2588****	**-4.1979****	**-3.1434****	**-2.4506***
Event 6 – 1st Calamity Extensions							
AAR (0)	2.42%	**3.5110****	**6.0487****	**3.7925****	**2.9547****	**1.9402**	**3.2989****
AAR (+1)	0.50%	0.5217	1.5377	0.7999	0.5966	0.5715	0.8803
AAR (+2)	-0.42%	-1.0810	-0.5804	-0.6502	-1.2898	-0.7971	-0.7249
Event 8 – 1st Contingency Extension							
AAR (0)	-0.34%	-0.8677	-0.8806	-0.9074	1.0713	-0.0486	-0.1264
AAR (+1)	-0.77%	-1.8289	-1.4497	-1.6070	-0.8151	-0.9117	-0.5686
AAR (+2)	-0.49%	**-2.3337***	-1.1936	**-2.5045***	**-2.2300***	-1.0128	-0.9549
Event 12 – 2nd Emergency Extension							
AAR (0)	0.94%	**3.3556****	**2.3856****	**3.7053****	**2.0382****	1.7082	1.1197
AAR (+1)	0.85%	1.8710	1.7381	1.8645	1.0948	0.9684	1.0080
AAR (+2)	2.57%	**3.0405****	**5.6675****	**2.8477****	**2.9816****	**2.2119****	**2.4774****
Event 16 – 2nd Emergency 5th Extension							
AAR (0)	-1.19%	**-3.1756****	**-2.0132***	**-2.7741****	-1.7053	-1.3370	-0.9373
AAR (+1)	-0.08%	-0.2999	-0.0851	-0.1332	-1.7053	-0.2109	-0.1952
AAR (+2)	-0.50%	-1.4461	-0.9468	-1.2543	-1.2334	-0.5997	-0.7277

In summary, the test results suggest a positive abnormal impact of the COVID-19 pandemic announcement, when compared to the larger securities in other European markets, a negative effect for strict restriction announcements, and a positive reaction on the withdrawal of such restrictions. That is, the market response goes in line with the EMH as it behaves according to new information. What concerns investors is not the type of announcement, but the conditions linked to each event. In addition, and according to the abnormal returns section, the first events show a more powerful impact in the Portuguese stock market when compared to the subsequent events with similar restrictions.

6.4. Cumulative Average Abnormal Returns

The CAAR test statistics are the final hypothesis tested in this study. The values indicate the statistically significance over the evolution of abnormal returns for the PSI-20 constituents. A rejection of the null hypothesis suggests investors under-react to positive or negative shocks, i.e., a positive (negative) abnormal return follows a positive (negative) abnormal return from the previous day.

In this subsection, we have only used as nonparametric test the modified rank test. From the 21 events displayed in Table 15, there are 4 events (19.05%) in which all the tests reject the null hypothesis for the CAAR values, two with positive values and two with negative returns. These events are all extension announcements: Event 4, Event 9, Event 12 and Event 13 at the 5% significance level. In addition, Event 5, Event 14 and Event 23 rejects the null hypothesis in all parametric tests at the 1% significance level. These events correspond to the 1st Calamity situation and two additional extensions.

Table 15 – *CAAR Test Statistics for the Event Study*

	CAAR	t-test	Patell	BMP	M_Rank	PSI-20 CAR
Event 1	-0.29%	-0.0870	**-3.5604****	-1.1608	0.4870	1.6595
Event 2	0.09%	0.0428	-0.743	-0.5791	0.2254	-0.3114
Event 3	0.02%	0.0138	0.8028	0.8886	0.8783	-0.1545
Event 4	-2.86%	**-2.7367****	**-3.7892****	**-4.6003****	**-2.1074***	-1.6973
Event 5	2.88%	**3.1139****	**2.9065****	**2.6105****	1.5545	1.5191
Event 6	2.34%	1.2769	**3.0169****	**2.0010****	-0.6805	1.8997
Event 7	-1.18%	-1.3523	-1.4134	-2.2615*	-1.4185	-1.1035
Event 8	-0.86%	-0.9753	-0.6143	-0.6213	-0.3756	-0.2837
Event 9	-3.76%	**-5.1343****	**-3.433****	**-4.7712****	**-2.4408***	-1.9214
Event 10	-0.13%	-0.1310	0.1682	0.3178	0.1125	1.2179
Event 11	-0.13%	-0.0820	0.1576	-0.1108	-0.6698	-0.7687
Event 12	4.47%	**3.8362****	**4.4427****	**3.3588****	**1.9759****	**2.2938****
Event 13	2.98%	**4.5640****	**3.0571****	**4.6849****	**2.3099****	1.9276
Event 14	-3.49%	**-3.2017****	**-3.0243****	**-3.309****	-1.7098	-0.7116
Event 16	-1.81%	-1.7506	-1.4953	-1.1554	-0.8506	-1.7462
Event 18	0.09%	0.0801	-0.0108	-0.1713	0.4947	-1.2497
Event 19	1.03%	1.0611	0.7577	1.4939	0.7569	0.3621
Event 20	0.68%	0.6290	0.9600	1.1579	0.4603	0.8744
Event 21	-0.23%	-0.2968	-0.0830	-0.0735	0.169	-0.0211
Event 22	-1.06%	**-3.9000****	-1.5127	**-3.2746****	-0.8185	-0.5844
Event 23	1.58%	**2.5272****	**2.3718****	**2.4136****	1.5924	0.9329

As we have seen in the previous subsection, the significance of the test results is not clear to be linked to the extensions announcement. Therefore, the statistical significance of the cumulative effects, on average, does not prove any direct link between the extension periods and the abnormal returns. In sum, although there is evidence for rejecting the null hypothesis over the CAAR values, the results do not suggest any clear pattern. For instance, in Event 23 extension, the positive analyses from Bank of America and CaixaBank/BPI to CTT, NOS and REN affected the securities in 7.28%, 5.85% and 4.96%. This event has no particular linkage to the extension announcement, however, it has a significant impact over the AAR and CAAR test statistics.

6.5. Results Summary

In an overall perspective, the events which included rigorous lockdown measures produced significant abnormal returns in the Portuguese stock market. On average, the first lockdown procedures induced a negative market reaction, whether the first lockdown withdrawals caused a positive reaction. As time went through, investors reacted less to new announcements, as the information release had precedents over the first wave of COVID-19.

Chronologically, the first emergency situation in March 2020 was the first lockdown measure, which occurred one week after the WHO pandemic announcement. The abnormal returns appeared on the day of the announcement, when the Portuguese government officially implemented restrictions such as self-isolation, closure of commercial establishments, and the suspension of selected flights. Followed by two lockdown extensions with ambiguous results, the declaration of a contingency situation showed a positive reaction in the PSI-20 comparing with the STOXX600 benchmark. This new situation stated the withdrawal of the lockdown measures in two phases, revealing the improved outlook on the number of COVID-19 cases. After this announcement in late-April, it followed a new contingency situation in August, a second calamity situation in October and a second emergency situation in November. From these three events, only the emergency situation showed significant market movements, consistent with the first emergency situation, as the restrictions were similar. However, the results present a lower statistical power, since the market was previously familiarised with the restrictions.

As for lockdown extensions, most announcements rather maintained or reduced the existing restrictions, causing a residual impact in the financial markets. In addition, as the pandemic situation was gradually improving, and no meaningful measures were adopted, there were no significant abnormal returns linked to the extension announcements. However, in Event 16 extension, the Portuguese government adopted similar restrictions as in the first emergency situation, leading to a negative market reaction. As for the remaining extension announcements, we have found statistical significance in six of the twelve final extensions. Some of the abnormal returns are assigned to the clustered events in specific companies, and not to the extension announcements. As the PSI-20 only counts with 18 constituents, a large price movement in a few large market capitalised companies has a significant impact on the index.

To conclude, our results suggest the existence of a strong impact of the announcements which contained lockdown and social distancing restrictions in the Portuguese stock market. As for the extensions, the announcements do not suggest a clear market response. The test results are in line with the EMH as there is a general reaction to new information release, while the impact of extensions does not provide a meaningful new information to investors.

As for the company-specific level, the majority of abnormal returns occur in the two first events. During this period, the companies most affected by the lockdown restrictions are from cyclical sectors as basic materials and consumer discretionary. For instance, IBS was the most impacted constituent with 86% of negative abnormal returns. As most lockdown measures forbid the activity of commercial establishments, the company had its brands, such as Burger King and PizzaHut closed for a large period of time. The negative abnormal returns were a prediction from the market that the company would reduce its revenue for an undefined period. On the other hand, the least affected companies during this phase were NOS and PHR, from the communication services sector, and JMT from the consumer discretionary sector. In all cases, the abnormal returns for these constituents all presented a positive sign. As for NOS and PHR, the communication services sector increased as a consequence of the *stay-at-home* policies and social distancing. Teleworking was mandatory in some periods, and consumers required a larger amount of internet usage for work and leisure. In the case of JMT, the consumer staples sector is less sensitive to business cycles. Therefore, as a specialised retail in food distribution and essential needs, the company suffered a lower impact on the decrease of its revenue.

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VII

Conclusions and Recommendations

7.1. Conclusion

In this research we have implemented the event study methodology to evaluate the impact of lockdown measures on the Portuguese stock market during the COVID-19 pandemic. Using three models to compute the expected returns and the STOXX600 as the reference market, we analyse the abnormal returns on each constituent of the PSI-20, the index itself and the average impact. In addition, we have performed parametric and nonparametric tests to consider the non-normality of returns and increase the robustness of results.

We have found on a multi-event analysis that the majority of constituents in the PSI-20 have been negatively affected by lockdown restriction and positively affected by the correspondent withdrawals, as reflected by the abnormal returns. Each emergency situation call, as well as the extension call in *Event 16*, which included strict lockdown measures, shows statistical significance at the 5% level in most of the tests. Nevertheless, we also verify that the nonparametric tests only reject the null hypothesis in the presence of extreme abnormal returns. In addition, there is evidence on the 1^{st} emergency situation for a market overreaction, as there is a significant positive abnormal return of *day 2* following the event day. That is, there was a correction in the market after two days of amplified losses.

On a company-specific analysis, we have verified a high impact in the cyclical sectors, such as materials and consumer discretionary. After the pandemic announcement and following a first set of lockdown measures, the companies with the highest number of significant results were Ibersol and Sonae with 7 significant values, followed by Semapa, Altri, Ramada, NovaBase, Galp and Mota-Engil with 6 significant observations. From these eight constituents, 50% are included in the materials sector. In addition, by looking at the top-10 negative abnormal returns, there are five constituents from materials, three from utilities and one from the consumer discretionary and information technology sector. On the other hand, the companies least affected by the lockdown measures are from the communication services (Pharol and NOS) and consumer staples sectors (Jerónimo Martins). These companies show a low number of significant observations, all with 0% of negative abnormal returns.

Our findings validate the EMH theory, with the rejection of the null hypothesis in the cases of strict lockdown measures or its removals. The non-rejection in the remaining cases proves that the information was not meaningful enough to investors in order to motivate large price changes.

7.2. Limitation Disclosures

The event study methodology is undeniably a powerful tool to measure the impact of selected events on a company's value. The existent literature shows that it provides functional and reliable results, being one of the most used by financial scholars to contribute on the market efficiency discussion. However, this methodology and its adjustments rely on certain assumptions which produce limitations that have to be addressed.

In the first place, and a more theoretical issue, is that we are considering that markets are efficient and stock prices fully and immediately reflect all the information in the market. If that is not the case, the event study loses its functionality. Therefore, we must consider the efficiency of financial markets.

Secondly, there is a set of problems specifically related to the event study methodology, such as variations in estimation periods, expected returns models, the existence of confounding events and thin trading. As for the variations in the estimation period, some events can be anticipated by investors, which difficult the event day selection. In addition, the estimation window length demands a trade-off between improving the estimation accuracy and potential parameter shifts. Therefore, both event day selection and estimation window length variations can lead to different values. As for the selection on return models, it is a key factor for the verification of the significance of abnormal returns. If the expected values are incorrectly estimated, other factors can lead to biased results. The existence of confounding events is another issue that might bias the study test results. As coexisting events can provide different market reactions than the event in the study, it is always relevant to check for confounding events that could cause any price movements. Finally, thin trading is a problem when the selected stocks trade on different days, making it impossible the analysis with unavailable data.

In this study and along with the described limitations, as the number of COVID-19 cases and deceases is a public information updated on a daily basis, the events could be expected by investors. However, even with the anticipation of the event, the exact measures were unknown, and their impact is visible, especially for the first events. Regarding the expected models' estimation issue, we have approached it using three return models. Then, we reduced the existence of outliers by computing the average of the different returns, providing more reliable values. As for the confounding events, we have removed *Event 15* and *Event 17*, as the most evident situations with contrasting significant events. Finally, there is no issue with thin trading as the selected stocks all belong to the same index, and therefore always trade on the same dates.

Third, there are some econometric problems in the event study methodology, as the regression models are based on a series of statistical assumptions. The model's assumptions include the normality of the error's distribution, homoscedasticity and no autocorrelation of errors, event-induced variance no multi-collinearity. As for the normality of distribution, there is evidence that returns data distribution is apart from normal, especially during crisis. For this reason, we have used nonparametric tests in order to reduce the effects of the normality assumption. Regarding the homoscedasticity and no autocorrelation of errors, our solution was to adjust the market model with the GARCH extension in order to model the changes in variance in the time series. However, the model is still sensitive for autocorrelation of residuals. As for event-induced variance, the model has to account for changes in variance around the event date. That is, the increase in variance during the event window is likely to bias the tests into a higher rejection of the null hypothesis. For this reason, we use the BMP test, which estimates the variance from the cross-section of the event day predicted errors, instead of the estimation period. Finally, regarding multi-collinearity, the linear regression assumes that there is no linear relationship between the independent variables. Nonetheless, as the independent variables are constituents from the same stock index, the assumption of no multi-collinearity is difficult to sustain.

To summarise, many conditions must be controlled in order to provide unbiased results. Even with the adjustments made, the results are exposed to econometric and theoretical assumptions that must be specified. Therefore, the reader should be aware of the assumptions used and adjustments made in order to obtain the best possible results.

7.3. Suggestions for Future Research

In this subsection we present three suggestions to improve the current event study, as well as to expand its application. First, we discuss some improvements to deal with the econometric limitations, secondly, we propose the extension of this research period, and finally the expansion of the framework used into other contexts and/ geographies.

Firstly, in order to improve the robustness of the event study methodology in future research, we suggest two aspects to be taken in consideration. First, a larger sample size increases the statistical power of the study and provides more accurate values. In our case we consider a sample size of 18 companies, which has a higher probability of misleading statistics caused by outliers. A solution would be to change the sample from the PSI-20 Index to the PSI All Share Index, which has 37 constituents. In addition to the increase of the statistical results, the incorporation of new constituents would increment the sectorial analysis, as it includes more companies to each sector, and examines new ones such as real estate. The other suggestion is to include additional expected return models in order to help mitigate the presence of outliers. Some complementary models include the Fama-French three factor and five factor models or the market model with the EGARCH extension.

Secondly, as the COVID-19 is an ongoing situation at the date of this research, we propose an expansion of the model to the 4^{th} and possible future waves of the disease in Portugal. Therefore, it would be a complete analysis on the complete period of the disease in the country.

The last suggestion is to reapply this event study model in a new context and/or geography. For instance, the application of this model into other developed countries would extend this study into a wider population, providing a comparison between different economies.

VIII

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IX
Appendix

Table 16 – *Descriptive statistics of the PSI-20 constituents' data for the estimation window*

Ticker	Obs.	Mean	St. Error	Median	St. Dev.	Kurtosis	Skewness	Range	Min.	Max.
ALTR	247	-0.14%	0.12%	-0.08%	1.88%	0.96	-0.05	12.18%	-6.15%	6.03%
BCP	247	-0.19%	0.13%	-0.13%	2.02%	0.72	-0.33	11.54%	-6.17%	5.36%
COR	247	-0.02%	0.07%	-0.11%	1.15%	0.36	0.31	7.04%	-3.17%	3.87%
CTT	247	-0.07%	0.13%	0.00%	1.98%	0.95	-0.13	13.60%	-6.91%	6.69%
EDP	247	0.14%	0.08%	0.18%	1.23%	2.66	-0.26	9.71%	-4.71%	5.00%
EDPR	247	0.16%	0.07%	0.05%	1.13%	0.65	0.21	6.89%	-3.40%	3.48%
EGL	247	-0.23%	0.13%	-0.23%	2.08%	2.50	-0.25	16.70%	-9.04%	7.66%
GALP	247	-0.08%	0.09%	0.00%	1.47%	3.16	-0.84	11.33%	-7.55%	3.78%
IBS	247	-0.01%	0.07%	0.00%	1.13%	3.01	-0.12	9.07%	-4.52%	4.55%
JMT	247	0.08%	0.09%	0.14%	1.38%	2.26	0.10	11.71%	-5.33%	6.38%
NBA	247	0.17%	0.13%	0.00%	2.09%	25.10	3.31	24.56%	-6.81%	17.75%
NOS	247	-0.18%	0.08%	-0.19%	1.32%	5.86	-0.94	11.78%	-7.40%	4.38%
NVG	247	-0.15%	0.10%	0.00%	1.53%	1.09	-0.16	10.52%	-5.01%	5.51%
PHR	247	-0.36%	0.13%	-0.39%	2.02%	2.66	0.71	14.19%	-5.70%	8.49%
RAM	247	-0.22%	0.09%	0.00%	1.48%	6.44	-1.43	12.78%	-8.92%	3.86%
RENE	247	0.02%	0.05%	0.00%	0.85%	7.77	0.61	8.72%	-3.32%	5.41%
SEM	247	-0.11%	0.08%	-0.15%	1.29%	0.64	0.28	8.01%	-3.75%	4.26%
SON	247	-0.11%	0.09%	-0.06%	1.40%	1.53	-0.53	8.92%	-5.55%	3.37%
PSI-20	247	-0.05%	0.06%	-0.01%	0.90%	3.26	-1.16	5.74%	-3.93%	1.80%
Average	247	-0.07%	0.09%	-0.05%	1.49%	3.77	-0.04	11.31%	-5.65%	5.66%

Table 17 – *AR and CAR for Event 3 – 1st Emergency Situation 1st Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-2)	AR(-2)	AR(-2)	AR(-2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	0.6867	0.8990	1.7651	0.0918	***3.0335***	0.3071	0.7092	1.4985	1.5396	**2.8962****
BCP	***-2.1991****	0.3979	***-3.4556*****	***-2.2390****	-0.5559	-0.9835	-0.8055	***-2.3509****	***-3.3522*****	***-3.6008*****
COR	-0.1636	***2.1684*****	0.9276	***-2.8968*****	-0.8524	-0.0732	0.8965	1.3114	0.0159	-0.3653
CTT	-0.6488	0.2498	1.0135	-1.2809	-1.2460	-0.2902	-0.1785	0.2748	-0.2980	-0.8553
EDP	1.2741	0.1104	-0.4611	0.5453	***-2.4976****	0.5698	0.6192	0.4129	0.6568	-0.4602
EDPR	***3.2135*****	-1.7337	-1.6582	1.4126	***-2.0109****	1.4371	0.6618	-0.0798	0.5520	-0.3474
EGL	0.5648	1.0041	-0.9687	0.8578	***4.0916*****	0.2526	0.7016	0.2684	0.6520	***2.4818*****
GALP	1.7414	0.8935	1.6123	-0.0882	***-5.5557*****	0.7788	1.1784	1.8994	1.8600	-0.6246
IBS	-1.7442	0.5856	-0.9405	0.4077	-0.0018	-0.7800	-0.5181	-0.9387	-0.7564	-0.7572
JMT	1.0699	-1.8810	0.4758	1.5868	***-2.3095****	0.4785	-0.3627	-0.1499	0.5597	-0.4732
NBA	***-2.2062****	1.2360	-1.2257	-0.8582	-0.7869	-0.9867	-0.4339	-0.982	-1.3658	-1.7177
NOS	-0.5413	***2.1532*****	-1.8290	***2.3511*****	-0.1578	-0.2421	0.7208	-0.0971	0.9543	0.8838
NVG	1.5576	1.2153	1.3333	-0.8384	0.2832	0.6966	1.2401	1.8364	1.4614	1.5881
PHR	-0.9763	0.2467	-1.818	-0.4805	-0.3051	-0.4366	-0.3263	-1.1393	-1.3542	-1.4907
RAM	0.1969	0.5141	-1.1806	-0.0378	-0.6614	0.0881	0.3180	-0.2100	-0.2269	-0.5227
RENE	0.6336	1.4487	1.4597	0.7182	-0.6200	0.2834	0.9312	1.5840	1.9052	1.6280
SEM	0.7064	***4.1548*****	1.7158	-1.4791	0.6907	0.3159	***2.174*****	***2.9413*****	***2.2798*****	***2.5887*****
SON	0.7941	1.2461	0.5970	***2.0533*****	***2.7787*****	0.3551	0.9124	1.1794	***2.0976*****	***3.3403*****
PSI 20	1.3575	1.0387	-0.3984	0.5982	-2.9415**	0.6071	1.0716	0.8935	1.1610	-0.1545

Table 18 – *AR and CAR for Event 4 – 1st Emergency Situation 2nd Extension*

Ticker	AR values					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	1.7898	0.8402	-0.0838	0.0447	-0.6907	0.8004	1.1762	1.1387	1.1587	0.8498
BCP	1.3503	-1.8303	-1.7471	0.0270	-0.7981	0.6039	-0.2147	-0.996	-0.9839	-1.3408
COR	0.4735	-0.6163	-0.1884	1.5475	-0.6701	0.2118	-0.0638	-0.1481	0.544	0.2443
CTT	1.0688	-0.2187	0.7958	-0.5063	-1.5181	0.4780	0.3801	0.736	0.5096	-0.1693
EDP	-1.3916	1.7774	1.0871	-1.683	-1.6610	-0.6224	0.1725	0.6587	-0.094	-0.8368
EDPR	***-2.7986***	***2.8428***	1.3251	-1.5282	-1.7852	-1.2516	0.0198	0.6124	-0.0711	-0.8695
EGL	-1.4945	-1.5504	-0.7782	-1.3689	-1.0742	-0.6684	-1.3617	-1.7098	***-2.3219****	***-2.8023***
GALP	-1.1020	-1.1178	***-3.0155***	0.7908	-0.5963	-0.4928	-0.9927	***-2.3413****	***-1.9876****	***-2.2543****
IBS	0.8739	0.0097	-0.6003	***-1.9721****	-1.8867	0.3908	0.3952	0.1267	-0.7553	-1.599
JMT	1.8299	***2.2889***	-1.0145	-0.2707	-0.584	0.8184	1.8420	1.3883	1.2672	1.006
NBA	1.9021	0.0111	-0.9766	-0.3567	-0.6081	0.8506	0.8556	0.4189	0.2593	-0.0126
NOS	***4.0783***	***2.3419***	***-2.8876***	-0.7621	-0.7098	1.8239	***2.8712***	1.5798	1.239	0.9216
NVG	0.6296	0.0946	-1.7294	-0.7904	***-2.2071****	0.2816	0.3239	-0.4496	-0.8031	-1.7901
PHR	1.6625	-0.2337	-0.1635	-0.9069	-0.7808	0.7435	0.639	0.5659	0.1603	-0.1889
RAM	0.9805	0.6249	-1.0581	-0.8075	-0.1336	0.4385	0.718	0.2447	-0.1164	-0.1762
RENE	-0.7077	***2.4694***	-0.4591	***-2.1911****	-1.1427	-0.3165	0.7879	0.5826	-0.3973	-0.9083
SEM	-0.7034	-1.0123	-0.0625	0.0224	***-2.117****	-0.3146	-0.7673	-0.7953	-0.7853	-1.732
SON	-1.2982	-1.6750	-0.3507	0.3916	-0.9641	-0.5806	-1.3296	-1.4865	-1.3114	-1.7425
PSI-20	0.4448	1.2367	-1.8997	-1.1264	***-2.4506****	0.1989	0.752	-0.0976	-0.6013	-1.6973

Table 19 – *AR and CAR for Event 5 – 1st Calamity Situation*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	-0.0433	1.7404	-0.1441	1.9020	***-2.3307****	-0.0194	0.7590	0.6945	1.5452	0.5028
BCP	0.3030	1.7590	1.7222	-0.2618	-0.9056	0.1355	0.9222	1.6924	1.5753	1.1703
COR	1.7168	0.9056	1.2393	0.3507	-1.8840	0.7678	1.1728	1.7270	1.8838	1.0412
CTT	-0.4974	-0.5266	0.8916	0.0217	0.2258	-0.2224	-0.4579	-0.0592	-0.0495	0.0514
EDP	-0.8079	-1.1541	1.8999	1.219	0.1709	-0.3613	-0.8775	-0.0278	0.5173	0.5937
EDPR	0.2565	-0.3411	1.6888	1.4054	-0.7304	0.1147	-0.0378	0.7174	1.3459	1.0192
EGL	***2.2572***	***1.9779***	-0.8963	-0.8624	-0.4494	1.0094	1.8940	1.4931	1.1075	0.9065
GALP	1.4847	***2.5843***	1.8635	-0.6445	0.9896	0.6640	1.8197	***2.6531***	***2.3649***	***2.8074***
IBS	-1.204	-0.0351	1.3686	0.6853	-0.2750	-0.5385	-0.5542	0.0579	0.3644	0.2414
JMT	-1.1645	-1.2656	0.3584	1.1872	-0.1594	-0.5208	-1.0868	-0.9265	-0.3956	-0.4669
NBA	0.7508	1.4568	-0.3406	0.5549	-0.3355	0.3358	0.9873	0.8349	1.0831	0.9331
NOS	-0.1401	0.1911	-0.2756	1.0816	-1.9486	-0.0627	0.0228	-0.1004	0.3833	-0.4881
NVG	1.7763	1.4874	0.0877	1.1504	***-2.0893****	0.7944	1.4596	1.4988	***2.0133***	1.0789
PHR	-0.3889	0.7221	0.7533	0.2544	-0.3587	-0.1739	0.1490	0.4859	0.5996	0.4392
RAM	-1.3944	0.7318	***2.5747***	0.5489	***3.5985***	-0.6236	-0.2963	0.8551	1.1006	***2.7099***
RENE	-0.4410	0.6631	-1.0666	0.2963	-1.1545	-0.1972	0.0993	-0.3776	-0.2451	-0.7614
SEM	0.4694	0.4720	0.1692	0.508	-1.2768	0.2099	0.4210	0.4967	0.7239	0.1529
SON	1.824	-0.1456	-0.0597	0.4163	-1.7155	0.8157	0.7506	0.7239	0.9101	0.1429
PSI-20	0.6009	1.1650	1.8984	1.2791	-1.5466	0.2687	0.7897	1.6387	***2.2108***	1.5191

Table 20 – *AR and CAR for Event 6 – 1st Calamity Situation 1st Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	-1.7645	-1.387	-0.2276	-0.2761	1.8971	-0.7891	-1.4094	-1.5112	-1.6346	-0.7863
BCP	-0.1378	-0.3835	0.9527	***3.5280****	1.0876	-0.0616	-0.2331	0.1929	1.7707	***2.2571****
COR	-0.4837	0.4875	0.0075	-0.6904	-0.8434	-0.2163	0.0017	0.0050	-0.3038	-0.6809
CTT	0.0019	-0.7577	***3.3243****	1.5459	-0.7658	0.0008	-0.3380	1.1487	1.8400	1.4975
EDP	-0.3327	1.5075	-0.3932	-0.3095	-0.2957	-0.1488	0.5254	0.3495	0.2111	0.0789
EDPR	***1.9983****	***2.0965****	1.3032	-0.2361	-1.0962	0.8937	1.8312	***2.4141****	***2.3085****	1.8182
EGL	***-2.0939****	-1.8258	1.6245	0.2589	-0.0914	-0.9364	-1.7529	-1.0264	-0.9107	-0.9516
GALP	-0.3356	-0.7292	***2.6942****	0.8726	-1.3230	-0.1501	-0.4762	0.7287	1.1189	0.5272
IBS	0.3875	0.2048	-0.0733	-0.8573	-0.7240	0.1733	0.2649	0.2321	-0.1513	-0.4751
JMT	***2.1245****	0.3721	-0.1038	-0.7801	0.1402	0.9501	1.1165	1.0701	0.7212	0.7839
NBA	0.1507	0.5809	0.5904	-1.0928	-0.6372	0.0674	0.3272	0.5912	0.1025	-0.1824
NOS	0.7798	-0.1995	***3.8167****	-0.0710	-0.4441	0.3487	0.2595	1.9664	1.9346	1.7360
NVG	-0.9152	-0.9513	1.1810	-0.6234	0.2976	-0.4093	-0.8347	-0.3065	-0.5853	-0.4522
PHR	***2.531****	0.5734	***4.9079****	***6.4653****	-0.5029	1.1319	1.3883	***3.5832****	***6.4746****	***6.2497****
RAM	-0.1174	-0.0325	-0.4863	-1.7606	-0.0198	-0.0525	-0.0671	-0.2845	-1.0719	-1.0807
RENE	-0.3463	0.3973	1.7066	-0.3139	-0.6103	-0.1549	0.0228	0.7860	0.6456	0.3727
SEM	-0.4961	-1.813	***2.2311****	-0.6837	1.5063	-0.2219	-1.0326	-0.0349	-0.3406	0.3330
SON	-0.1641	-0.2838	***2.6948****	-0.0292	-1.5999	-0.0734	-0.2003	1.0048	0.9918	0.2763
PSI-20	0.5073	0.2863	***3.2989****	0.8803	-0.7249	0.2269	0.3549	1.8302	***2.2239****	1.8997

Table 21 – *AR and CAR for Event 7 – 1st Contingency Situation*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	-0.2882	-0.7056	-0.2388	-0.5594	1.0888	-0.1289	-0.4445	-0.5513	-0.8014	-0.3145
BCP	0.1804	-0.9150	-0.2930	0.4618	-0.7371	0.0807	-0.3285	-0.4595	-0.2530	-0.5827
COR	-0.1224	-0.5871	-0.5254	0.4288	0.7955	-0.0547	-0.3173	-0.5522	-0.3605	-0.0047
CTT	-0.8162	-0.8352	-0.0185	-0.0728	-1.1508	-0.3650	-0.7385	-0.7468	-0.7794	-1.2940
EDP	-1.0401	-0.4551	-0.7030	0.0263	0.0408	-0.4652	-0.6687	-0.9830	-0.9713	-0.9530
EDPR	0.0265	0.3436	-0.5039	0.7026	0.1218	0.0118	0.1655	-0.0598	0.2544	0.3089
EGL	-0.6648	0.5607	***12.9337****	***-5.9409****	***-2.3119****	-0.2973	-0.0465	***5.7376****	***3.0807****	***2.0468****
GALP	-0.9447	-0.3058	-0.2571	0.5460	-0.6532	-0.4225	-0.5592	-0.6742	-0.4301	-0.7222
IBS	0.4625	-0.8530	-0.1182	-0.2485	0.1641	0.2068	-0.1746	-0.2275	-0.3386	-0.2653
JMT	0.2023	0.1178	0.1671	-0.8326	0.0837	0.0905	0.1432	0.2179	-0.1545	-0.1170
NBA	0.2886	-0.0846	0.3935	0.4624	-0.0527	0.1291	0.0913	0.2672	0.4740	0.4505
NOS	-0.8766	-0.8952	0.5949	-0.4745	-1.1822	-0.3920	-0.7923	-0.5263	-0.7385	-1.2672
NVG	-1.8724	-0.4826	0.5417	-0.4056	-0.3425	-0.8373	-1.0532	-0.8109	-0.9923	-1.1455
PHR	-0.3441	-0.4822	-0.2245	-0.8979	-0.1707	-0.1539	-0.3695	-0.4699	-0.8714	-0.9478
RAM	1.3018	0.4808	-0.1649	0.6181	-1.6485	0.5822	0.7972	0.7234	0.9999	0.2626
RENE	-0.1721	-1.2248	-0.3039	-0.2099	1.0033	-0.0770	-0.6247	-0.7606	-0.8545	-0.4058
SEM	-0.7669	-0.4462	0.2087	-0.3853	-0.1548	-0.3430	-0.5425	-0.4492	-0.6215	-0.6908
SON	-0.647	0.8378	0.1538	-0.3302	-0.6224	-0.2894	0.0853	0.1541	0.0064	-0.2720
PSI-20	-1.0874	-0.8392	0.2260	-0.2282	-0.5386	-0.4863	-0.8616	-0.7605	-0.8626	-1.1035

Table 22 – *AR and CAR for Event 8 – 1st Contingency Situation 1st Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(-2)	AR(-1)	AR(-2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	***2.6086*****	-1.9068	-1.2807	***-2.5682****	-0.5066	1.1666	0.3138	-0.2589	-1.4074	-1.6340
BCP	0.5476	-0.5676	0.2726	-1.2917	0.1232	0.2449	-0.0089	0.1130	-0.4647	-0.4096
COR	0.0566	***4.4615*****	***-3.3621*****	1.7651	0.8805	0.0253	***2.0206*****	0.5170	1.3064	1.7002
CTT	1.942	-0.6701	0.3926	-0.8528	-0.785	0.8685	0.5688	0.7444	0.3630	0.0119
EDP	-0.6722	1.1108	0.0078	-0.2616	-0.9058	-0.3006	0.1961	0.1996	0.0826	-0.3225
EDPR	-1.8801	1.1848	0.3812	0.3609	-0.3039	-0.8408	-0.3110	-0.1405	0.0209	-0.1150
EGL	-0.9121	-0.6036	-0.6614	-1.5737	-0.3431	-0.4079	-0.6779	-0.9736	-1.6774	-1.8309
GALP	-1.1493	0.6719	0.2465	-0.5631	-0.709	-0.5140	-0.2135	-0.1033	-0.3551	-0.6722
IBS	0.583	-0.4215	0.3585	0.0036	-0.1965	0.2607	0.0722	0.2325	0.2341	0.1463
JMT	0.4556	0.9215	-0.22	-0.0348	-0.7986	0.2037	0.6158	0.5174	0.5019	0.1447
NBA	0.3191	-0.5944	0.1553	0.2826	0.604	0.1427	-0.1231	-0.0537	0.0727	0.3428
NOS	0.3096	1.0682	-0.4635	0.2237	-0.3102	0.1385	0.6162	0.4089	0.5089	0.3702
NVG	1.2091	-0.972	0.1631	0.0101	-0.4168	0.5407	0.1060	0.1790	0.1835	-0.0029
PHR	1.2732	0.0729	-1.0839	-0.9104	0.0724	0.5694	0.6020	0.1173	-0.2899	-0.2575
RAM	0.16	-0.5264	0.2191	-0.2124	-0.1063	0.0716	-0.1638	-0.0659	-0.1608	-0.2084
RENE	0.3629	-1.0497	0.3786	-0.2808	-0.2934	0.1623	-0.3071	-0.1378	-0.2634	-0.3946
SEM	0.3938	0.1253	0.0397	-0.4191	-0.6002	0.1761	0.2321	0.2499	0.0625	-0.2060
SON	0.51	0.3885	1.0332	0.0111	-0.6352	0.2281	0.4018	0.8639	0.8689	0.5848
PSI-20	-0.0839	1.0995	-0.1264	-0.5686	-0.9549	-0.0375	0.4542	0.3976	0.1434	-0.2837

Table 23 – *AR and CAR for Event 9 – 1st Contingency Situation 2nd Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(-2)	AR(-1)	AR(-2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	-0.2747	-1.2798	-0.1534	-1.1779	-0.6291	-0.1228	-0.6952	-0.7638	-1.2906	-1.5719
BCP	-1.1017	-1.1361	-0.0723	***-2.2055****	1.0138	-0.4927	-1.0008	-1.0331	***-2.0194****	-1.5660
COR	-0.7535	***-2.3316****	0.392	-0.1014	-0.8154	-0.3370	-1.3797	-1.2044	-1.2497	-1.6144
CTT	-1.1756	0.0488	-0.1844	0.1208	1.3011	-0.5257	-0.5039	-0.5864	-0.5323	0.0495
EDP	-0.9927	0.5058	0.3948	0.0402	-1.0772	-0.4439	-0.2177	-0.0412	-0.0232	-0.5049
EDPR	-0.7905	-0.7984	0.7064	-1.1087	-0.2821	-0.3535	-0.7106	-0.3947	-0.8905	-1.0166
EGL	-1.3944	-1.2073	-0.1858	-0.6798	-0.3827	-0.6236	-1.1635	-1.2467	-1.5507	-1.7218
GALP	0.7375	***-2.1113****	-1.394	-1.1475	0.963	0.3298	-0.6144	-1.2378	-1.7510	-1.3203
IBS	-0.0125	-0.8947	-0.468	1.0844	-1.3748	-0.0056	-0.4057	-0.6150	-0.1301	-0.7449
JMT	-0.4001	0.0301	0.0659	-0.5073	0.6899	-0.1789	-0.1654	-0.1360	-0.3629	-0.0543
NBA	-0.3997	-1.2681	0.6071	0.4423	-0.8719	-0.1788	-0.7459	-0.4744	-0.2765	-0.6665
NOS	-1.008	-0.8631	-0.4418	-0.8353	1.7035	-0.4508	-0.8368	-1.0343	-1.4079	-0.6461
NVG	-1.0321	-1.8638	-0.7221	-1.2099	0.9977	-0.4616	-1.2951	-1.6180	***-2.1591****	-1.7129
PHR	1.0588	-0.0729	0.1735	-0.0760	-1.3376	0.4735	0.4409	0.5185	0.4846	-0.1136
RAM	-1.0722	***2.1102*****	-0.0964	-0.4945	-1.5372	-0.4795	0.4642	0.4211	0.2000	-0.4875
RENE	-0.3231	-0.3575	0.6915	-1.1146	-0.4556	-0.1445	-0.3044	0.0049	-0.4936	-0.6973
SEM	-1.4454	-1.5192	-1.0761	-1.1622	***2.5574*****	-0.6464	-1.3258	-1.8070	***-2.3268****	-1.1831
SON	-0.8975	-0.3008	0.8744	-0.2112	1.1552	-0.4014	-0.5359	-0.1449	-0.2393	0.2773
PSI-20	-1.4122	-1.7887	0.0160	-1.6955	0.5841	-0.6316	-1.4315	-1.4243	***-2.1826****	-1.9214

Table 24 – *AR and CAR for Event 10 – 2nd Calamity Situation*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	-1.2525	0.0309	0.0471	0.0467	-0.0245	-0.5601	-0.5463	-0.5253	-0.5044	-0.5153
BCP	-1.3751	-0.2348	-0.24	-0.1643	0.142	-0.6150	-0.7200	-0.8273	-0.9008	-0.8373
COR	1.3184	-0.1152	0.2358	-0.3597	-0.5123	0.5896	0.5381	0.6436	0.4827	0.2536
CTT	-0.6691	-0.6189	0.0333	0.3919	-0.4277	-0.2992	-0.5760	-0.5611	-0.3859	-0.5771
EDP	1.3584	***2.1794***	0.8298	-1.8945	0.2719	0.6075	1.5822	1.9533	1.1061	1.2276
EDPR	***4.1738***	***2.387***	1.7097	-0.7126	-0.0351	1.8666	***2.9341***	***3.6987***	***3.38***	***3.3643***
EGL	0.3539	-0.5654	-0.3872	-0.4046	-0.2985	0.1583	-0.0946	-0.2677	-0.4487	-0.5822
GALP	-1.2928	0.0925	0.6617	-0.331	-0.0099	-0.5782	-0.5368	-0.2409	-0.3889	-0.3933
IBS	0.1253	0.3379	0.6443	-0.3223	***-2.0781****	0.0560	0.2071	0.4953	0.3511	-0.5782
JMT	0.9085	1.0538	-0.8973	-0.2554	-0.0821	0.4063	0.8775	0.4762	0.3620	0.3253
NBA	0.7342	1.0736	-0.2958	-0.2416	-0.2703	0.3284	0.8085	0.6762	0.5681	0.4472
NOS	-0.1853	0.4619	-0.2475	0.854	0.1134	-0.0829	0.1237	0.0130	0.3949	0.4457
NVG	-0.0327	-0.6111	-0.1351	1.3403	-1.078	-0.0146	-0.2879	-0.3483	0.2510	-0.2311
PHR	-0.6856	0.2367	0.403	-0.5372	-0.5482	-0.3066	-0.2008	-0.0205	-0.2608	-0.5060
RAM	-1.1209	0.0975	0.7001	0.9181	0.2929	-0.5013	-0.4577	-0.1446	0.2660	0.3970
RENE	1.0967	1.1537	-0.1241	-0.1337	-0.8381	0.4905	1.0064	0.9509	0.8911	0.5163
SEM	-0.9863	-0.1039	-0.0285	0.7788	-0.6008	-0.4411	-0.4876	-0.5003	-0.1520	-0.4207
SON	-1.7563	0.4072	-1.4061	-0.4383	-0.5282	-0.7855	-0.6033	-1.2322	-1.4282	-1.6644
PSI-20	1.3100	1.9275	0.6362	-0.7910	-0.3595	0.5858	1.4479	1.7324	1.3786	1.2179

Table 25 – *AR and CAR for Event 11 – 2nd Emergency Situation*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	-0.4535	-1.9555	0.4150	1.8536	0.6347	-0.2028	-1.0773	-0.8917	-0.0628	0.2211
BCP	-1.3181	-0.2101	-0.7238	***6.9491***	1.8122	-0.5895	-0.6834	-1.0071	***2.1006***	***2.911***
COR	0.0472	-1.7866	1.4932	***2.164***	-1.5318	0.0211	-0.7779	-0.1101	0.8577	0.1727
CTT	-0.8516	***-2.6566***	-1.1507	0.2835	-1.0365	-0.3809	-1.5689	***-2.0835****	-1.9567	***-2.4202****
EDP	-0.3023	0.3690	-0.8706	-1.4919	-1.3867	-0.1352	0.0298	-0.3596	-1.0267	-1.6469
EDPR	-1.7467	1.7480	-1.5182	***-2.8438***	-1.4707	-0.7811	0.0006	-0.6784	-1.9502	***-2.6079***
EGL	-0.4241	-0.5133	-0.5907	1.3706	-0.4035	-0.1897	-0.4192	-0.6834	-0.0705	-0.2509
GALP	-1.7999	-1.1947	-0.7098	***6.2464***	***3.3280***	-0.8050	-1.3393	-1.6567	1.1368	***2.6251***
IBS	-0.5242	-0.0487	-0.4447	1.5112	0.8723	-0.2344	-0.2562	-0.4551	0.2207	0.6108
JMT	-0.1321	-0.1668	0.9000	-1.1108	-1.4878	-0.0591	-0.1336	0.2689	-0.2279	-0.8933
NBA	1.3698	0.5327	-1.1086	-1.4632	***-2.0379****	0.6126	0.8508	0.3550	-0.2993	-1.2107
NOS	0.8360	-0.4806	***-3.3458***	-0.7171	1.5151	0.3739	0.1589	-1.3374	-1.6581	-0.9805
NVG	-0.1287	0.4239	0.076	1.0544	0.3618	-0.0576	0.1320	0.1660	0.6375	0.7993
PHR	-0.4811	0.8380	0.9054	0.2461	-0.6016	-0.2151	0.1596	0.5645	0.6746	0.4055
RAM	-0.7767	1.6790	0.2311	0.1889	-0.0897	-0.3474	0.4035	0.5068	0.5913	0.5512
RENE	-1.9474	-0.8796	-0.6681	-1.7682	-0.7816	-0.8709	-1.2643	-1.5630	***-2.3538****	***-2.7034***
SEM	-1.1149	1.2668	-0.6034	0.8596	1.7676	-0.4986	0.0679	-0.2019	0.1825	0.9730
SON	-0.3675	***2.3025***	-1.6913	0.6417	***2.6613***	-0.1643	0.8654	0.1090	0.3960	1.5862
PSI-20	-1.6823	0.0722	-1.7846	1.3364	0.3394	-0.7523	-0.7200	-1.5182	-0.9205	-0.7687

Table 26 – *AR and CAR for Event 12 –2nd Emergency Situation 1st Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	0.4118	-0.8392	1.7842	0.4633	3.8039**	0.1841	-0.1912	0.6067	0.8139	2.5151**
BCP	***4.2305****	-0.9427	0.0929	0.9718	***2.3215****	1.8920	1.4704	1.5119	1.9465	***2.9847****
COR	1.0255	-1.004	0.6748	-0.4619	0.4093	0.4586	0.0096	0.3114	0.1048	0.2878
CTT	0.7769	-0.253	1.7403	-0.6756	-0.0465	0.3475	0.2343	1.0126	0.7105	0.6897
EDP	-0.1966	0.3169	0.6198	-0.3904	-1.1352	-0.0879	0.0538	0.3310	0.1564	-0.3513
EDPR	-0.0652	0.8863	0.8005	-0.0291	***-2.1081****	-0.0292	0.3672	0.7252	0.7122	-0.2306
EGL	0.7755	-1.2479	0.2694	1.0669	0.6085	0.3468	-0.2112	-0.0908	0.3864	0.6585
GALP	-0.3312	-0.4402	-0.0541	1.9617	***2.6457****	-0.1481	-0.3450	-0.3692	0.5081	1.6913
IBS	-0.4001	0.0306	-0.0768	-0.5598	0.7626	-0.1789	-0.1653	-0.1996	-0.4499	-0.1089
JMT	-0.0650	0.0592	-0.1416	0.4957	-0.7099	-0.0291	-0.0026	-0.0659	0.1558	-0.1617
NBA	0.2158	0.2183	-0.0289	-0.6078	0.6398	0.0965	0.1942	0.1812	-0.0906	0.1955
NOS	0.1829	-0.9494	0.1965	0.5257	***6.5725****	0.0818	-0.3428	-0.2549	-0.0198	***2.9195****
NVG	0.4646	-0.5913	0.7623	0.8712	***2.1767****	0.2078	-0.0566	0.2843	0.6739	1.6473
PHR	1.0307	-0.9769	0.5162	0.7695	0.6608	0.4609	0.0241	0.2549	0.5991	0.8946
RAM	-0.1871	-0.0584	-0.2101	1.268	0.7117	-0.0837	-0.1098	-0.2038	0.3633	0.6816
RENE	-1.4692	-0.0887	1.3333	-1.2622	1.0754	-0.6570	-0.6967	-0.1004	-0.6649	-0.1840
SEM	1.9436	-0.7757	1.4145	1.6505	***2.901****	0.8692	0.5223	1.1549	1.8930	***3.1904****
SON	-0.3115	-0.8404	0.065	1.3487	***2.2542****	-0.1393	-0.5152	-0.4861	0.1171	1.1252
PSI-20	1.0737	-0.5498	1.1197	1.0080	***2.4774****	0.4802	0.2343	0.7350	1.1858	***2.2938****

Table 27 – *AR and CAR for Event 13 – 2nd Emergency Situation 2nd Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	1.6854	1.0245	0.5822	0.2089	0.5428	0.7537	1.2119	1.4723	1.5657	1.8085
BCP	0.5250	-0.1352	0.9581	0.4596	0.9415	0.2348	0.1743	0.6028	0.8083	1.2294
COR	0.1370	-0.4237	0.2057	-0.1929	0.2505	0.0613	-0.1282	-0.0363	-0.1225	-0.0105
CTT	-0.6061	0.7023	0.6314	0.2611	-0.5146	-0.2710	0.0431	0.3254	0.4422	0.2120
EDP	1.6389	0.4523	0.0576	0.3346	0.4163	0.7329	0.9352	0.9610	1.1106	1.2968
EDPR	0.9123	0.7459	-0.3849	0.6950	1.5298	0.4080	0.7416	0.5694	0.8802	1.5644
EGL	0.3500	-0.1557	0.3622	-0.4679	-0.1317	0.1565	0.0869	0.2488	0.0396	-0.0193
GALP	-0.0025	-0.928	***2.1408****	-0.7024	0.2726	-0.0011	-0.4161	0.5413	0.2271	0.3491
IBS	0.2419	0.4214	0.0971	-0.0937	-0.2059	0.1082	0.2966	0.3400	0.2981	0.2060
JMT	-0.5867	0.2081	0.2525	0.1158	0.6929	-0.2624	-0.1693	-0.0564	-0.0046	0.3053
NBA	-0.6514	0.2257	-0.163	0.4234	0.0567	-0.2913	-0.1904	-0.2633	-0.0739	-0.0485
NOS	0.0623	1.4966	-0.4592	0.2503	0.4223	0.0278	0.6971	0.4918	0.6037	0.7926
NVG	0.8452	-0.1554	1.1212	-0.2492	0.7934	0.3780	0.3085	0.8099	0.6985	1.0533
PHR	-0.5803	0.9714	0.7406	0.0580	1.3658	-0.2595	0.1749	0.5061	0.5320	1.1428
RAM	0.1483	0.1305	0.7228	-0.5401	-0.6010	0.0663	0.1247	0.4479	0.2064	-0.0624
RENE	0.6528	0.0263	0.2374	-0.1625	0.4835	0.2919	0.3037	0.4099	0.3372	0.5534
SEM	0.3742	0.669	0.846	0.6408	1.7367	0.1673	0.4665	0.8449	1.1315	1.9081
SON	-0.2648	-1.2872	0.688	0.6633	1.3802	-0.1184	-0.6941	-0.3864	-0.0897	0.5275
PSI-20	1.1043	0.4288	1.0920	0.4072	1.2780	0.4939	0.6856	1.1740	1.3561	1.9276

Table 28 – *AR and CAR for Event 14 – 2nd Emergency Situation 3rd Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	-0.7341	-0.8709	0.2261	-0.8963	-0.1194	-0.3283	-0.7178	-0.6167	-1.0175	-1.0709
BCP	1.0434	-1.0714	0.3835	-0.9444	-1.1519	0.4666	-0.0125	0.1590	-0.2634	-0.7785
COR	0.7420	-0.3228	0.5044	-1.5244	-0.0157	0.3318	0.1875	0.4130	-0.2687	-0.2757
CTT	0.7710	-0.9746	-0.6668	-0.7852	-0.7538	0.3448	-0.0911	-0.3893	-0.7404	-1.0775
EDP	-0.7891	0.7274	0.4242	0.0778	0.6929	-0.3529	-0.0276	0.1621	0.1969	0.5067
EDPR	1.2498	0.5139	1.3561	-0.4493	1.0007	0.5589	0.7888	1.3953	1.1943	1.6418
EGL	0.5078	-0.1093	-0.4846	-0.259	0.4477	0.2271	0.1782	-0.0385	-0.1543	0.0459
GALP	-0.4857	-0.7670	-0.2501	0.2557	-1.4023	-0.2172	-0.5603	-0.6721	-0.5578	-1.1849
IBS	-0.8304	0.2060	0.0482	0.2769	-0.4552	-0.3714	-0.2793	-0.2577	-0.1339	-0.3374
JMT	-1.8333	-0.4697	0.4691	-0.7295	-0.4712	-0.8199	-1.0299	-0.8201	-1.1464	-1.3571
NBA	0.6862	-0.7837	0.4519	-0.0162	-0.8894	0.3069	-0.0436	0.1585	0.1512	-0.2465
NOS	***-2.4127****	-0.2794	-1.0594	-0.6203	0.9771	-1.0790	-1.2040	-1.6778	-1.9552	-1.5182
NVG	1.2908	-0.4400	-0.0076	-1.3049	-0.2153	0.5773	0.3805	0.3771	-0.2065	-0.3028
PHR	***-2.5407****	0.2309	-0.0590	-0.7668	-1.0134	-1.1362	-1.0329	-1.0593	-1.4022	-1.8555
RAM	-0.3184	-0.3412	-0.9828	-0.9737	***-1.9891****	-0.1424	-0.2950	-0.7345	-1.1699	***-2.0595****
RENE	-0.3313	0.0693	-0.1718	0.0544	0.3776	-0.1481	-0.1171	-0.1939	-0.1696	-0.0007
SEM	0.2794	-1.1637	-0.4948	-1.0094	-1.2631	0.1250	-0.3955	-0.6167	-1.0682	-1.6330
SON	-0.6649	0.7364	-0.8225	-1.7146	0.242	-0.2973	0.0320	-0.3359	-1.1027	-0.9945
PSI-20	-0.3564	-0.3545	0.4526	-1.2031	-0.1298	-0.1594	-0.3179	-0.1155	-0.6536	-0.7116

Table 29 – *AR and CAR for Event 15 – 2nd Emergency Situation 4th Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	0.1096	0.3234	1.0063	1.2012	-1.1236	0.0490	0.1936	0.6437	1.1809	0.6784
BCP	0.6091	***2.0026****	***3.2279****	0.7040	-1.5134	0.2724	1.1680	***2.6115****	***2.9264****	***2.2496****
COR	-0.2400	-0.7850	-0.1567	-0.6824	-0.7431	-0.1073	-0.4584	-0.5285	-0.8337	-1.1660
CTT	0.3011	0.5333	0.2634	-0.2728	-0.3349	0.1346	0.3731	0.4909	0.3689	0.2192
EDP	***2.1446****	-0.6572	1.3760	0.3752	0.2728	0.9591	0.6652	1.2805	1.4483	1.5703
EDPR	***2.6191****	-1.5879	0.8937	***3.4568****	-0.7961	1.1713	0.4612	0.8608	***2.4067****	***2.0507****
EGL	0.1979	0.6410	0.7764	0.9388	-1.4955	0.0885	0.3752	0.7224	1.1422	0.4734
GALP	-1.4685	***2.6717****	0.6679	0.1700	-0.3747	-0.6567	0.5381	0.8368	0.9128	0.7452
IBS	-0.5078	-0.1150	-0.3542	0.0164	-0.2031	-0.2271	-0.2785	-0.4369	-0.4296	-0.5204
JMT	1.1517	0.0350	0.2729	-0.5205	-0.2726	0.5151	0.5307	0.6528	0.4200	0.2981
NBA	0.3483	0.2776	-0.0535	-0.3637	-0.0741	0.1557	0.2799	0.2560	0.0933	0.0602
NOS	0.7367	1.0618	0.2354	0.9622	-0.5173	0.3295	0.8043	0.9096	1.3399	1.1086
NVG	-0.4503	-0.5147	1.2568	1.6342	-1.7600	-0.2014	-0.4316	0.1305	0.8613	0.0742
PHR	1.5025	0.0715	1.7339	0.9069	-1.4001	0.6719	0.7039	1.4793	1.8849	1.2588
RAM	-0.2873	0.4542	0.1793	-0.2567	-0.2945	-0.1285	0.0746	0.1548	0.0400	-0.0916
RENE	0.7547	-0.2333	-0.0911	0.075	-0.5884	0.3375	0.2332	0.1924	0.2259	-0.0372
SEM	-0.4790	0.1020	1.1717	0.7855	-1.4044	-0.2142	-0.1686	0.3554	0.7067	0.0786
SON	-0.2208	1.8800	0.6321	-0.7489	-0.9220	-0.0987	0.7420	1.0247	0.6898	0.2774
PSI-20	***1.9882****	0.6147	***2.4050****	***2.1405****	-1.5435	0.8891	1.1640	***2.2396****	***3.1989****	***2.5086****

Table 30 – *AR and CAR for Event 16 – 2nd Emergency Situation 5th Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	-1.5967	0.1886	-0.9995	-0.2949	-0.9836	-1.0169	-2.707**	-2.6459**	-1.4961	-0.6404
BCP	***-2.3465****	1.4251	-1.2596	-0.1694	-0.7959	0.2231	0.3894	-0.4973	-0.3555	0.3480
COR	-0.9109	1.1502	-0.2412	0.5823	-1.1546	-1.7107	-0.1046	0.4748	0.0313	-0.5793
CTT	-0.1695	0.9203	0.0917	0.2246	0.0861	***2.205*****	***2.057*****	0.2770	-0.1545	0.7853
EDP	-0.4937	-1.7957	-0.1930	-0.1446	-0.0148	1.7460	-0.3941	***-4.749*****	***-3.9093*****	***-2.7693*****
EDPR	***-2.5893****	-1.9499	0.0778	-0.4013	-0.6504	0.3661	-1.8429	***-3.7944*****	***-3.308*****	***-3.7439*****
EGL	-0.3563	1.5477	-0.9530	-0.1632	-0.2561	0.9862	1.4963	0.7229	-0.9912	-0.0945
GALP	-0.0455	1.4063	-1.1812	0.2809	-1.5599	1.4630	1.7027	0.6154	-1.1264	0.8211
IBS	-0.4871	-0.0686	-0.4279	-0.0645	0.1078	-1.0874	***-3.9068*****	0.8678	-0.7003	-0.4527
JMT	***2.8467*****	-1.2656	1.1665	-0.815	1.1838	***2.1561*****	***2.1781*****	1.3143	0.6958	1.1876
NBA	0.0828	0.9679	-0.2469	-0.4197	0.2898	1.5534	***2.4121*****	***2.1879*****	***6.1936*****	***4.3581*****
NOS	0.5839	0.7541	-1.3050	-0.1265	-0.1938	-0.1005	1.0989	0.5083	***2.82*****	***3.345*****
NVG	-0.2793	0.8422	-0.6779	-0.3693	-0.4720	1.1573	0.7287	-0.5063	-0.0414	0.2148
PHR	-1.6238	1.3185	0.3017	0.7625	-0.4980	-0.1925	-0.2122	0.9731	1.6253	***2.3601*****
RAM	-0.415	0.4580	-1.1629	-0.3844	-0.2855	***-2.1345****	-1.3247	-1.8777	***-5.8276*****	***-4.7531*****
RENE	0.4642	-0.5797	0.5227	-0.8229	0.4945	-0.2077	-0.6117	-1.0612	-0.9289	0.2532
SEM	-1.1090	1.3349	-1.6362	-0.2851	-0.4217	-1.1182	***-3.3327*****	***-5.4345*****	***-4.2554*****	***-4.3944*****
SON	-0.0238	0.9323	-0.4915	1.9186	1.6366	-0.7926	***-2.2668****	***-3.4723*****	-1.3181	0.7273
PSI-20	-1.7444	-0.3001	-0.9373	-0.1952	-0.7277	***1.9971*****	0.7934	***-2.5086****	***-2.1725****	-0.3114

Table 31 – *AR and CAR for Event 17 – 2nd Emergency Situation 6th Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	-0.4546	-0.7013	0.9797	-0.0474	0.1698	-0.2033	-0.5169	-0.0788	-0.1000	-0.0241
BCP	-0.5893	-0.1865	1.7131	-0.3255	-0.4491	-0.2636	-0.3469	0.4192	0.2736	0.0728
COR	-0.0590	-0.7547	1.251	1.8064	-0.6879	-0.0264	-0.3639	0.1955	1.0034	0.6957
CTT	-0.3417	-1.0010	1.6136	0.4341	-0.6003	-0.1528	-0.6004	0.1212	0.3153	0.0468
EDP	-1.4038	-0.7297	1.0667	0.6901	-0.0863	-0.6278	-0.9542	-0.4771	-0.1685	-0.2071
EDPR	***-2.7717*****	***-2.2355****	1.5604	-0.041	-0.3831	-1.2395	***-2.2393****	-1.5415	-1.5598	-1.7311
EGL	0.0264	0.2149	0.3402	0.0967	-0.3922	0.0118	0.1079	0.2600	0.3033	0.1279
GALP	-0.094	0.4318	-0.4073	-0.1146	-1.4691	-0.0420	0.1511	-0.0311	-0.0823	-0.7394
IBS	-0.047	0.3427	-0.1333	0.2971	0.2749	-0.0210	0.1322	0.0726	0.2055	0.3284
JMT	-1.1039	-0.3876	-0.6005	-0.2066	-1.3739	-0.4937	-0.6670	-0.9355	-1.0279	-1.6424
NBA	0.0382	-0.324	0.7367	-0.0062	-0.3512	0.0171	-0.1278	0.2017	0.1989	0.0418
NOS	-1.6451	0.0281	-0.3802	1.2283	-1.0467	-0.7357	-0.7231	-0.8932	-0.3439	-0.8120
NVG	-0.3658	-0.0951	1.2390	0.6724	-0.6964	-0.1636	-0.2061	0.3480	0.6487	0.3373
PHR	-1.3373	-0.7717	0.2812	-0.1752	-1.5473	-0.5981	-0.9432	-0.8174	-0.8958	-1.5878
RAM	1.0916	-0.5113	-0.1566	0.7136	-0.5233	0.4882	0.2595	0.1895	0.5086	0.2746
RENE	-0.3885	0.9796	-0.2347	0.8711	-0.9771	-0.1737	0.2644	0.1594	0.5490	0.1121
SEM	0.4337	0.9231	0.6595	0.0147	-0.711	0.1940	0.6068	0.9017	0.9083	0.5903
SON	-0.1965	-0.1228	-0.0457	-0.4727	-0.6497	-0.0879	-0.1428	-0.1632	-0.3746	-0.6652
PSI-20	***-2.4317****	-1.2781	1.6462	0.5323	-1.4189	-1.0875	-1.6591	-0.9229	-0.6849	-1.3194

Table 32 – *AR and CAR for Event 18 – 2nd Emergency Situation 7th Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	1.4328	0.4337	0.2687	-0.5563	1.0767	0.6408	0.8347	0.9549	0.7061	1.1876
BCP	1.0166	-1.3224	-0.6318	-1.0424	0.9132	0.4546	-0.1368	-0.4193	-0.8854	-0.4770
COR	-0.3605	-0.0178	-0.3775	0.0360	-0.4129	-0.1612	-0.1692	-0.3380	-0.3219	-0.5065
CTT	0.2587	-0.1779	-0.0709	-0.7492	0.1682	0.1157	0.0361	0.0044	-0.3306	-0.2554
EDP	-1.6707	0.2619	0.6105	-1.0886	-0.6610	-0.7471	-0.6300	-0.3570	-0.8438	-1.1394
EDPR	-1.7554	0.0429	-0.4672	***-4.1326***	-0.6030	-0.7850	-0.7658	-0.9748	***-2.8229***	***-3.0926***
EGL	-0.2149	0.1046	0.0261	-0.7860	0.3417	-0.0961	-0.0493	-0.0376	-0.3891	-0.2363
GALP	1.7712	0.0145	0.2259	0.1770	1.5673	0.7921	0.7986	0.8996	0.9788	1.6797
IBS	-0.1373	-0.0094	0.1344	-0.4929	1.0066	-0.0614	-0.0656	-0.0055	-0.2259	0.2242
JMT	0.5466	-0.9928	-0.6657	-0.7442	0.3312	0.2444	-0.1996	-0.4973	-0.8301	-0.6820
NBA	0.0219	0.2699	0.4787	-0.2887	0.0248	0.0098	0.1305	0.3446	0.2155	0.2266
NOS	0.1080	0.4736	-0.7899	-0.2298	0.2573	0.0483	0.2601	-0.0932	-0.1960	-0.0809
NVG	1.0508	0.9302	-0.4324	-0.0504	1.7620	0.4699	0.8859	0.6925	0.6700	1.4580
PHR	0.2212	-0.1573	-0.2011	-1.1245	***2.3413***	0.0989	0.0286	-0.0614	-0.5643	0.4828
RAM	1.5887	1.3714	-0.7251	-1.0392	0.1705	0.7105	1.3238	0.9995	0.5348	0.6110
RENE	-0.3005	0.5731	-1.4407	-0.5828	-0.4277	-0.1344	0.1219	-0.5224	-0.7830	-0.9743
SEM	0.7325	0.8706	0.8372	-0.8129	1.1232	0.3276	0.7169	1.0913	0.7278	1.2301
SON	0.5557	-0.4103	-0.9675	-1.0281	1.5085	0.2485	0.0650	-0.3677	-0.8274	-0.1528
PSI-20	-0.2051	-0.1531	-0.5569	***-2.7703***	0.8909	-0.0917	-0.1602	-0.4092	-1.6481	-1.2497

Table 33 – *AR and CAR for Event 19 – 2nd Emergency Situation 8th Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	-0.6296	1.0493	-0.2307	0.2082	-0.1210	-0.2815	0.1877	0.0846	0.1777	0.1236
BCP	-1.0019	0.0502	0.4862	-0.3471	0.1525	-0.4481	-0.4256	-0.2082	-0.3634	-0.2952
COR	1.4954	-0.7523	0.0338	-0.0541	0.1660	0.6688	0.3324	0.3475	0.3233	0.3975
CTT	-0.3033	0.8795	-0.1311	0.5967	1.3237	-0.1356	0.2577	0.1991	0.4659	1.0579
EDP	0.4683	-0.1488	1.4351	-0.0294	-0.0222	0.2094	0.1429	0.7847	0.7715	0.7615
EDPR	-0.8738	-1.0975	0.2301	-0.3212	0.6748	-0.3908	-0.8816	-0.7787	-0.9223	-0.6205
EGL	-0.0151	0.0538	0.8281	0.1022	0.0492	-0.0067	0.0173	0.3877	0.4334	0.4554
GALP	-0.5847	0.9572	1.2001	-0.8805	0.5896	-0.2615	0.1666	0.7033	0.3096	0.5732
IBS	0.1328	0.2147	1.5673	0.8470	0.5573	0.0594	0.1554	0.8564	1.2352	1.4844
JMT	0.6841	-0.4358	0.6579	-0.1445	0.3607	0.3059	0.1110	0.4053	0.3406	0.5019
NBA	-0.573	0.3730	0.9238	***-2.0397****	-0.9949	-0.2562	-0.0894	0.3237	-0.5885	-1.0334
NOS	-0.0086	-0.7343	1.5694	0.1522	-1.0806	-0.0039	-0.3323	0.3696	0.4377	-0.0456
NVG	-0.6945	1.2758	0.5138	0.3574	-0.1447	-0.3106	0.2600	0.4898	0.6496	0.5849
PHR	0.1973	-0.087	0.1162	-0.3765	-0.2810	0.0882	0.0493	0.1013	-0.0671	-0.1928
RAM	-0.1520	-0.1277	-0.8767	0.0234	-0.2172	-0.0680	-0.1251	-0.5171	-0.5067	-0.6038
RENE	-0.2988	-0.4780	0.4986	0.9543	-0.3535	-0.1336	-0.3474	-0.1244	0.3023	0.1443
SEM	0.6212	-0.5461	-0.0497	0.5106	-0.4945	0.2778	0.0336	0.0113	0.2397	0.0185
SON	-0.7815	-0.7233	***2.1901***	-0.3951	-0.1234	-0.3495	-0.6729	0.3065	0.1298	0.0746
PSI-20	-0.5991	-0.3005	1.6485	-0.3272	0.3881	-0.2679	-0.4023	0.3349	0.1886	0.3621

Table 34 – *AR and CAR for Event 20 – 2nd Emergency Situation 9th Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	0.5692	-0.9682	-0.0991	-0.1598	-0.6417	0.2546	-0.1784	-0.2228	-0.2942	-0.5812
BCP	-1.0328	-1.0448	-0.1106	0.4757	-0.6465	-0.4619	-0.9291	-0.9786	-0.7658	-1.0550
COR	-0.8201	-0.4843	0.3089	-1.2731	-0.4432	-0.3668	-0.5834	-0.4452	-1.0146	-1.2128
CTT	0.6115	-0.2612	***3.4186*****	1.4169	1.4572	0.2734	0.1566	1.6855	***2.3191*****	***2.9708*****
EDP	***2.2964*****	-0.2218	***2.2720*****	-1.1110	-0.7470	1.0270	0.9278	1.9438	1.4470	1.1129
EDPR	1.0233	0.7428	***2.0181*****	-0.5858	-0.6852	0.4577	0.7898	1.6924	1.4304	1.1239
EGL	-0.0808	-0.2493	-0.1148	0.3693	-0.0766	-0.0361	-0.1476	-0.1989	-0.0338	-0.0680
GALP	-0.7301	0.7848	0.4710	0.7455	-0.8019	-0.3265	0.0245	0.2351	0.5685	0.2099
IBS	-0.2347	-0.3620	-0.2826	-0.3395	0.0065	-0.1049	-0.2668	-0.3932	-0.5450	-0.5421
JMT	-0.0025	0.9186	-0.4347	0.0107	-0.4142	-0.0011	0.4097	0.2153	0.2201	0.0348
NBA	-0.3436	-0.6003	0.1059	-0.1499	0.6228	-0.1537	-0.4221	-0.3747	-0.4418	-0.1632
NOS	0.1185	1.1291	***2.7011*****	-1.1508	0.5929	0.0530	0.5579	1.7659	1.2512	1.5164
NVG	0.2350	-0.8434	0.4600	-0.3487	-1.0485	0.1051	-0.2721	-0.0664	-0.2223	-0.6912
PHR	-0.6356	-0.2551	0.1789	0.0321	-0.4495	-0.2842	-0.3983	-0.3183	-0.3039	-0.5050
RAM	-0.1261	-0.0516	0.2081	-0.0502	0.1025	-0.0564	-0.0795	0.0136	-0.0089	0.0369
RENE	0.4404	0.4291	0.8284	-0.7548	0.9132	0.1970	0.3889	0.7594	0.4218	0.8302
SEM	-0.4364	0.0332	-0.2352	0.3394	-0.0848	-0.1952	-0.1803	-0.2855	-0.1338	-0.1717
SON	-0.3668	-0.1852	1.0057	1.1075	1.0007	-0.1640	-0.2469	0.2029	0.6982	1.1457
PSI-20	0.4953	0.2706	***2.2565*****	-0.3106	-0.7566	0.2215	0.3425	1.3516	1.2127	0.8744

Table 35 – *AR and CAR for Event 21 – 2nd Emergency Situation 10th Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	-1.1900	0.0689	-0.1667	-0.1262	-0.5484	-0.5322	-0.5013	-0.5759	-0.6323	-0.8776
BCP	1.0309	0.7224	-1.1771	0.1024	-0.2234	0.4610	0.7841	0.2577	0.3035	0.2036
COR	0.0775	-1.4559	0.8067	-0.8174	-0.1812	0.0346	-0.6164	-0.2557	-0.6212	-0.7022
CTT	0.0916	0.6451	-0.2126	0.9551	1.0292	0.0410	0.3295	0.2344	0.6615	1.1218
EDP	1.2590	-1.6071	-0.7028	-0.3899	0.0526	0.5630	-0.1557	-0.4700	-0.6443	-0.6208
EDPR	1.0875	-1.0677	-1.7153	0.9903	0.4597	0.4863	0.0088	-0.7583	-0.3154	-0.1098
EGL	-0.396	0.3833	-0.7093	0.1812	-0.2322	-0.1771	-0.0057	-0.3229	-0.2419	-0.3458
GALP	-0.6664	0.8352	-1.5799	1.1472	-0.0356	-0.2980	0.0755	-0.6311	-0.1180	-0.1339
IBS	0.0465	-0.5496	-0.0907	-0.7359	0.3163	0.0208	-0.2250	-0.2655	-0.5946	-0.4531
JMT	1.4787	-0.5254	-0.5225	1.1020	1.5359	0.6613	0.4263	0.1927	0.6855	1.3723
NBA	***3.3392*****	-1.104	0.8444	-0.5074	1.5201	1.4933	0.9996	1.3772	1.1503	1.8301
NOS	0.8254	-0.4925	-0.8951	0.7638	0.6249	0.3691	0.1489	-0.2514	0.0902	0.3696
NVG	-0.5940	-0.552	-0.695	0.6884	0.0446	-0.2657	-0.5125	-0.8234	-0.5155	-0.4956
PHR	0.3771	0.5000	-0.8085	0.5839	0.5044	0.1686	0.3922	0.0306	0.2918	0.5174
RAM	0.7345	-0.8055	-0.5435	-0.8005	-0.3575	0.3285	-0.0317	-0.2748	-0.6328	-0.7927
RENE	***2.4650*****	***-3.6067*****	0.0679	-0.3239	0.4343	1.1024	-0.5106	-0.4803	-0.6251	-0.4309
SEM	-0.0555	-0.0069	0.0381	-0.4399	-0.0754	-0.0248	-0.0279	-0.0108	-0.2076	-0.2413
SON	0.0435	0.6571	-1.3413	-0.0399	-0.4609	0.0195	0.3133	-0.2865	-0.3044	-0.5105
PSI-20	1.1932	-0.8023	-1.8975	0.9194	0.5400	0.5336	0.1748	-0.6738	-0.2626	-0.0211

Table 36 – *AR and CAR for Event 22 – 2nd Emergency Situation 11th Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	-0.5253	-0.2618	-0.2006	-0.3738	-0.2181	-0.2349	-0.3520	-0.4417	-0.6089	-0.7064
BCP	-0.2649	0.8511	0.2181	0.0958	-1.9351	-0.1185	0.2622	0.3597	0.4026	-0.4628
COR	-0.7115	-0.275	0.1807	0.3781	-0.2943	-0.3182	-0.4412	-0.3603	-0.1913	-0.3229
CTT	0.5412	-0.7187	-0.3846	-0.2652	-0.8551	0.2421	-0.0794	-0.2513	-0.3699	-0.7524
EDP	-0.3491	-0.0076	-0.7736	-0.3292	-0.3071	-0.1561	-0.1595	-0.5055	-0.6527	-0.7900
EDPR	0.2120	0.2492	0.2704	0.9488	-0.5995	0.0948	0.2063	0.3272	0.7516	0.4835
EGL	-0.2241	0.0619	-0.4745	-0.0077	-0.4306	-0.1002	-0.0725	-0.2847	-0.2882	-0.4808
GALP	-0.6163	0.0201	-0.4477	1.9058	-1.0996	-0.2756	-0.2666	-0.4669	0.3855	-0.1063
IBS	-0.2316	-0.0223	-0.8655	1.0874	0.2006	-0.1036	-0.1136	-0.5006	-0.0144	0.0753
JMT	0.0550	0.1698	-0.1228	-0.2453	-0.0159	0.0246	0.1005	0.0456	-0.0641	-0.0712
NBA	-0.3388	0.4946	-0.506	***2.4902***	-0.626	-0.1515	0.0697	-0.1566	0.9570	0.6771
NOS	-0.6295	0.0175	-0.0638	0.0465	-0.2946	-0.2815	-0.2737	-0.3022	-0.2814	-0.4132
NVG	0.0435	-0.6038	-0.1242	-0.0752	-0.1594	0.0194	-0.2506	-0.3061	-0.3398	-0.4110
PHR	-0.1613	-0.1636	-0.3175	-0.6351	-1.1131	-0.0721	-0.1453	-0.2872	-0.5713	-1.0691
RAM	-0.2064	0.1941	-0.3454	0.1574	-0.0422	-0.0923	-0.0055	-0.1600	-0.0896	-0.1084
RENE	0.2089	0.5635	-0.0583	-0.5961	-1.7644	0.0934	0.3454	0.3194	0.0528	-0.7363
SEM	-0.1163	-0.1604	-0.2872	-0.4006	-0.0634	-0.0520	-0.1237	-0.2522	-0.4314	-0.4597
SON	-0.0166	0.3076	-0.2320	-0.5090	-0.7715	-0.0074	0.1301	0.0264	-0.2013	-0.5463
PSI-20	-0.3723	0.2459	-0.3428	0.6154	-1.4529	-0.1665	-0.0566	-0.2098	0.0654	-0.5844

Table 37 – *AR and CAR for Event 23 – 2nd Emergency Situation 12th Extension*

Ticker	AR t-test					CAR t-test				
	AR(-2)	AR(-1)	AR(0)	AR(+1)	AR(+2)	CAR(-2)	CAR(-1)	CAR(0)	CAR(+1)	CAR(+2)
ALTR	0.9519	0.6559	-0.4601	0.5052	0.4155	0.4257	0.7190	0.5133	0.7392	0.9250
BCP	-0.2152	0.9708	0.0813	0.7058	***2.2363***	-0.0963	0.3379	0.3743	0.6899	1.6900
COR	1.6897	-0.9587	0.6783	-0.1102	0.8020	0.7556	0.3269	0.6302	0.5809	0.9396
CTT	0.1036	1.5054	-1.2207	0.5388	***2.0720***	0.0463	0.7196	0.1737	0.4146	1.3412
EDP	-0.4561	-1.1172	-0.4280	-0.7348	-0.8151	-0.2040	-0.7036	-0.8950	-1.2236	-1.5881
EDPR	-0.1136	-0.5528	0.4295	-0.5991	-0.3354	-0.0508	-0.2980	-0.1059	-0.3738	-0.5238
EGL	0.1787	-0.1679	-0.2161	-0.1424	0.2277	0.0799	0.0049	-0.0918	-0.1555	-0.0536
GALP	-0.1634	0.6912	-0.2048	0.9991	0.3643	-0.0731	0.2360	0.1445	0.5913	0.7542
IBS	0.398	0.4051	0.095	0.1685	0.2246	0.1780	0.3592	0.4016	0.4770	0.5774
JMT	-1.1171	-0.1643	0.0903	-0.2103	***5.1904***	-0.4996	-0.5731	-0.5327	-0.6267	1.6945
NBA	0.3569	1.3868	0.6186	-0.4466	-0.3381	0.1596	0.7798	1.0565	0.8567	0.7055
NOS	0.0677	0.7532	0.0130	0.3419	0.1837	0.0303	0.3671	0.3730	0.5259	0.6080
NVG	1.1721	0.5680	-0.0882	0.1433	-0.1067	0.5242	0.7782	0.7388	0.8028	0.7551
PHR	0.0899	0.0085	-0.4037	-0.7661	0.6213	0.0402	0.0440	-0.1365	-0.4791	-0.2012
RAM	1.2320	1.2047	0.2118	0.3012	***2.8149***	0.5510	1.0897	1.1844	1.3192	***2.578***
RENE	0.1052	0.1021	-0.4339	0.5131	0.1867	0.0470	0.0927	-0.1013	0.1281	0.2116
SEM	0.3039	0.1863	-0.1906	-0.3167	0.2880	0.1359	0.2192	0.1340	-0.0077	0.1211
SON	-0.1395	0.1793	-0.0058	-0.0962	0.1299	-0.0624	0.0178	0.0152	-0.0279	0.0302
PSI-20	-0.0796	0.2442	-0.0863	0.1350	1.8726	-0.0356	0.0736	0.0350	0.0954	0.9329

Table 38 – *AAR Statistics for COVID-19 Declared as Pandemic*

	AAR	t-test	Patell	BMP	G_Sign	M_Rank
Event 1 – COVID-19 Declared as Pandemic						
AAR (-2)	2.00%	**2.6379****	**4.5685****	**1.9891****	**1.9716****	1.7155
AAR (-1)	-0.21%	-0.3558	-0.9554	-0.5862	-0.8574	-0.6344
AAR (0)	1.49%	1.0966	0.7611	0.2642	0.5571	0.5989
AAR (+1)	-1.21%	**-2.5879***	**-3.4378****	**-2.2401***	-1.8004	-1.259
AAR (+2)	-2.35%	-1.4339	**-8.8975****	-1.5513	-1.8004	-1.5100

Table 39 – *AAR Statistics for Emergency Situations*

	AAR	t-test	Patell	BMP	G_Sign	M_Rank
Event 2 - 1st Emergency Situation						
AAR (-2)	0.70%	0.6366	**2.1643****	0.7380	0.5180	0.4780
AAR (-1)	-1.24%	-1.2082	**-4.7698****	-1.6301	-0.8963	-0.5779
AAR (0)	-1.44%	-0.971	**-5.5584****	-1.3812	**-2.3106***	**-2.2738***
AAR (+1)	0.46%	-0.3321	1.8724	0.4700	0.9894	0.7199
AAR (+2)	1.61%	0.6679	**4.6300****	**2.1844****	**2.4037****	**2.1578****
Event 11 - 2nd Emergency Situation						
AAR (-2)	-1.00%	**-2.5386***	**-2.0284***	**-2.3514***	**-2.2568***	-1.4442
AAR (-1)	-0.07%	-0.1137	0.0254	0.0189	0.1009	0.1243
AAR (0)	-0.99%	**-2.0698***	**-2.1846***	-1.9653	-1.3137	-1.2759
AAR (+1)	1.78%	**2.3376****	**3.8668****	1.5976	1.5155	1.1229
AAR (+2)	0.16%	**3.3376****	0.6734	0.4240	-0.3706	-0.0249

Table 40 – *AAR Statistics for Contingency and Calamity Situations*

	AAR	t-test	Patell	BMP	G_Sign	M_Rank
Event 5 – 1st Calamity Situation						
AAR (-2)	0.37%	0.7450	1.4070	1.2412	0.5260	0.5287
AAR (-1)	1.20%	**2.5982****	**2.9307****	**2.7577****	1.9403	1.6907
AAR (0)	1.21%	**2.5999****	**2.4907****	**2.3273****	1.4689	1.3494
AAR (+1)	0.86%	**3.031****	1.7948	**2.5693****	1.4689	1.4815
AAR (+2)	-0.76%	-1.2537	**-2.1239***	-1.5333	-1.8312	-1.5743
Event 7 – 1st Contingency Situation						
AAR (-2)	-0.44%	-1.2630	-1.4535	**-2.0617***	-1.7756	-0.9494
AAR (-1)	-0.63%	**-2.2450***	-1.1513	**-1.9748***	-1.7756	-0.9650
AAR (0)	1.47%	0.9112	**2.6247****	0.8518	-0.8325	0.0331
AAR (+1)	-0.82%	-1.0747	-1.7408	-1.1967	-1.3041	-0.4932
AAR (+2)	-0.76%	-1.7526	-1.4396	-1.6751	-1.3041	-0.7974
Event 10 – 2nd Calamity Situation						
AAR (-2)	-0.01%	-0.0146	0.2965	0.2097	0.1184	-0.0499
AAR (-1)	0.67%	1.8407	1.6496	**1.9969****	1.5331	1.1909
AAR (0)	0.25%	0.8322	0.3661	0.5419	0.5900	0.4380
AAR (+1)	-0.19%	-0.5985	-0.6178	-0.8029	-1.2964	-0.4533
AAR (+2)	-0.85%	-1.9247	-1.3183	**-2.3387***	-1.7680	-0.8740

Table 41 – *AAR Statistics for Extension Situations*

	AAR	t-test	Patell	BMP	G_Sign	M_Rank
Event 3 – 1st Emergency Situation 1st Extension						
AAR (-2)	-0.09%	-0.1526	0.8071	0.5926	0.9799	0.7791
AAR (-1)	1.32%	**3.0083****	**3.5075****	**2.5706****	**3.337****	**2.3797****
AAR (0)	-0.54%	-0.8755	-0.6992	-0.4596	0.0370	-0.2321
AAR (+1)	-0.17%	-0.3429	-0.0792	-0.0559	0.0370	0.1130
AAR (+2)	-0.48%	-0.5790	-1.7410	-0.7904	-1.3773	-1.0758
Event 4 – 1st Emergency Situation 2nd Extension						
AAR (-2)	0.93%	1.4400	1.7556	1.0568	0.9879	0.8511
AAR (-1)	0.23%	0.4320	0.6983	0.4956	-0.4264	0.0558
AAR (0)	-1.15%	**-2.6436****	**-2.6521****	**-2.3291***	**-2.7836****	-1.497
AAR (+1)	-1.03%	**-2.673****	**-1.9954***	**-2.0535***	-1.8407	-1.3116
AAR (+2)	-1.84%	**-7.0647****	**-4.5237****	**-7.2588****	**-4.1979****	**-3.1434****
Event 6 – 1st Calamity Situation 1st Extension						
AAR (-2)	0.09%	0.1658	0.4238	0.3423	-0.3466	0.2482
AAR (-1)	-0.25%	-0.5884	-0.6837	-0.6939	-0.3466	-0.2218
AAR (0)	2.42%	**3.5110****	**6.0487****	**3.7925****	**2.9547****	1.9402
AAR (+1)	0.50%	0.5217	1.5377	0.7999	0.5966	0.5715
AAR (+2)	-0.42%	-1.0810	-0.5804	-0.6502	-1.2898	-0.7971
Event 8 – 1st Contingency Situation 1st Extension						
AAR (-2)	0.68%	1.4171	1.2698	1.1751	**2.0146****	1.0536
AAR (-1)	0.07%	0.1259	0.8804	0.6291	0.1281	0.0797
AAR (0)	-0.34%	-0.8677	-0.8806	-0.9074	1.0713	-0.0486
AAR (+1)	-0.77%	-1.8289	-1.4497	-1.6070	-0.8151	-0.9117
AAR (+2)	-0.49%	**-2.3337***	-1.1936	**-2.5045***	**-2.2300***	-1.0128
Event 9 – 1st Contingency Situation 2nd Extension						
AAR (-2)	-1.17%	**-3.2955****	**-2.5981****	**-3.8193****	**-2.7054****	**-2.0306***
AAR (-1)	-1.37%	**-2.4921***	**-3.0232****	**-2.8620****	**-2.2338***	-1.9278
AAR (0)	-0.15%	-0.5751	-0.3450	-0.5969	-0.3474	-0.0330
AAR (+1)	-0.84%	**-2.0796***	**-2.4234***	**-3.2259****	**-2.7054****	-1.5690
AAR (+2)	-0.23%	-0.3857	0.7133	0.5886	-0.3474	0.1028
Event 12 – 2nd Emergency Situation 1st Extension						
AAR (-2)	0.97%	1.6911	**1.9710****	1.6504	0.6231	0.8941
AAR (-1)	-0.87%	**-2.8268****	-1.8281	**-3.3543****	**-2.2071***	-1.3643
AAR (0)	0.94%	**3.3556****	**2.3856****	**3.7053****	**2.0382****	1.7082
AAR (+1)	0.85%	1.8710	1.7381	1.8645	1.0948	0.9684
AAR (+2)	2.57%	**3.0405****	**5.6675****	**2.8477****	**2.9816****	**2.2119****
Event 13 – 2nd Emergency Situation 2nd Extension						
AAR (-2)	0.48%	1.5047	1.1505	1.6709	**2.1017****	0.8923
AAR (-1)	0.51%	1.5608	0.9493	1.3960	1.6297	0.9181
AAR (0)	1.00%	**3.2798****	**2.1131****	**3.4839****	**3.0457****	1.6811
AAR (+1)	0.11%	0.4972	0.3734	0.9169	1.1577	0.4563
AAR (+2)	0.88%	**2.6980****	**2.2496****	**3.3382****	**2.1017****	1.2174
Event 14 – 2nd Emergency Situation 3rd Extension						
AAR (-2)	-0.55%	-0.9176	-1.0025	-0.8620	-0.2901	-0.2714
AAR (-1)	-0.62%	**-2.1471***	-1.1045	-1.8388	-1.2337	-0.7237
AAR (0)	-0.20%	-0.6358	-0.2385	-0.3976	0.1818	0.0240
AAR (+1)	-1.22%	**-4.3360****	**-2.7076****	**-4.6308****	**-2.1774***	-1.8018
AAR (+2)	-0.91%	-1.8480	-1.7094	**-2.1030***	-1.2337	-1.0504

	AAR	t-test	Patell	BMP	G_Sign	M_Rank
Event 15 – 2nd Emergency Situation 4th Extension						
AAR (-2)	0.66%	1.3754	1.6417	1.6639	**2.1017****	0.8923
AAR (-1)	0.84%	1.6531	1.4202	1.3302	1.6297	0.9181
AAR (0)	1.49%	**3.2066****	**3.2193****	**3.9175****	**3.0457****	1.6811
AAR (+1)	0.96%	**2.0458****	**2.0255****	**2.0383****	1.1577	0.4563
AAR (+2)	-1.61%	**-4.8343****	**-3.0931****	**-5.3087****	**2.1017****	1.2174
Event 16 – 2nd Emergency Situation 5th Extension						
AAR (-2)	-1.17%	**-2.1147***	**-2.0731***	-1.7283	-1.2334	-1.1554
AAR (-1)	1.14%	**2.0313****	1.7746	1.5682	**2.0694****	1.4012
AAR (0)	-1.19%	**-3.1756****	**-2.0132***	**-2.7741****	-1.7053	-1.3370
AAR (+1)	-0.08%	-0.2999	-0.0851	-0.1332	-1.7053	-0.2109
AAR (+2)	-0.50%	-1.4461	-0.9468	-1.2543	-1.2334	-0.5997
Event 17 – 2nd Emergency Situation 6th Extension						
AAR (-2)	-0.95%	**-2.0868***	**-2.0883***	**-2.3707***	-1.2318	-1.0811
AAR (-1)	-0.59%	-1.6695	-1.2881	-1.6799	-1.2318	-0.6605
AAR (0)	1.09%	**2.9131****	**2.2284****	**2.9550****	1.5992	1.4409
AAR (+1)	0.61%	**2.2146****	1.0487	1.8609	1.1274	0.9344
AAR (+2)	-1.29%	**-4.6544****	**-2.5549***	**-5.2992****	**-3.1192****	-1.8025
Event 18 – 2nd Emergency Situation 7th Extension						
AAR (-2)	0.64%	1.2658	1.1277	1.1489	1.1215	0.9066
AAR (-1)	0.28%	0.7976	0.5001	0.7827	1.1215	0.5556
AAR (0)	-0.40%	-1.5125	-0.9292	-1.6124	-0.7657	-0.5151
AAR (+1)	-1.80%	**-3.8769****	**-3.3314****	**-3.5746****	**-3.1248****	**-2.0585***
AAR (+2)	1.37%	**2.9655****	**2.6087****	**3.0545****	**2.5370****	1.6051
Event 19 – 2nd Emergency Situation 8th Extension						
AAR (-2)	-0.27%	-0.8749	-0.6068	-0.9468	-0.2901	-0.3230
AAR (-1)	0.02%	0.0497	-0.0209	-0.0308	-0.2901	0.0316
AAR (0)	1.36%	**2.8541****	**2.5115****	**3.2475****	**2.5410****	1.6573
AAR (+1)	-0.12%	-0.3078	-0.4106	-0.6104	-0.2901	0.0404
AAR (+2)	0.05%	0.1638	0.2211	0.3889	0.1818	0.2862
Event 20 – 2nd Emergency Situation 9th Extension						
AAR (-2)	-0.10%	-0.3017	0.2142	0.2753	-0.2226	0.0441
AAR (-1)	-0.23%	-0.7470	-0.3126	-0.4765	-1.1670	-0.1430
AAR (0)	1.28%	**2.4429****	**3.0194****	**2.6748****	1.6663	1.4581
AAR (+1)	-0.07%	-0.2202	-0.4209	-0.5547	-0.2226	-0.1695
AAR (+2)	-0.19%	-0.6062	-0.3535	-0.4944	-0.6948	-0.1606
Event 21 – 2nd Emergency Situation 10th Extension						
AAR (-2)	0.88%	**2.0002****	**2.2503****	**2.0531****	**2.1565****	1.2086
AAR (-1)	-0.59%	-1.5167	-1.8939	-1.7119	-0.6775	-0.7105
AAR (0)	-1.14%	**-3.3026****	**-2.2487***	**-3.2144****	**-2.0945***	-1.4228
AAR (+1)	0.21%	0.5893	0.683	0.9949	0.2671	0.4754
AAR (+2)	0.41%	1.5412	1.0236	1.6470	0.7395	0.8272
Event 22 – 2nd Emergency Situation 11th Extension						
AAR (-2)	-0.41%	**-2.7948****	-0.8055	**-2.5054***	-1.1284	-0.4684
AAR (-1)	0.07%	0.4166	0.0409	0.1075	0.7616	0.3363
AAR (0)	-0.58%	**-2.989****	-1.0807	**-3.4533****	**-2.5459***	-0.7261
AAR (+1)	0.53%	1.276	0.8503	0.9937	0.2891	0.4166
AAR (+2)	-1.06%	**-3.9000****	-2.3875*	**-4.0945****	**-3.0184****	-1.3886

	AAR	t-test	Patell	BMP	G_Sign	M_Rank
Event 23 – 2nd Emergency Situation 12th Extension						
AAR (-2)	0.54%	1.8348	0.9778	1.4769	1.7063	0.8425
AAR (-1)	0.67%	1.9510	1.3342	1.8225	**2.1788****	1.0721
AAR (0)	-0.13%	-0.6651	-0.386	-0.8782	0.2888	0.0016
AAR (+1)	0.07%	0.2879	0.1524	0.2962	0.2888	0.2781
AAR (+2)	1.58%	**2.5272****	**3.2252****	**2.2408****	**2.6513****	1.3664

Table 42 – *CAAR test statistics*

Event	CAAR	t-test	Patell	BMP	M_Rank
Event 1	-0.29%	-0.0870	**-3.5604****	-1.1608	0.4870
Event 2	0.09%	0.0428	-0.7430	-0.5791	0.2254
Event 3	0.02%	0.0138	0.8028	0.8886	0.8783
Event 4	-2.86%	**-2.7367****	**-3.7892****	**-4.6003****	**-2.1074***
Event 5	2.88%	**3.1139****	**2.9065****	**2.6105****	1.5545
Event 6	2.34%	1.2769	**3.0169****	**2.0010****	-0.6805
Event 7	-1.18%	-1.3523	-1.4134	**-2.2615***	-1.4185
Event 8	-0.86%	-0.9753	-0.6143	-0.6213	-0.3756
Event 9	-3.76%	**-5.1343****	**-3.4330****	**-4.7712****	**-2.4408***
Event 10	-0.13%	-0.1310	0.1682	0.3178	0.1125
Event 11	-0.13%	-0.0820	0.1576	-0.1108	-0.6698
Event 12	4.47%	**3.8362****	**4.4427****	**3.3588****	**1.9759****
Event 13	2.98%	**4.5640****	**3.0571****	**4.6849****	**2.3099****
Event 14	-3.49%	**-3.2017****	**-3.0243****	**-3.3090****	-1.7098
Event 15	2.35%	**2.365****	**2.3316****	**2.8858****	1.2273
Event 16	-1.81%	-1.7506	-1.4953	-1.1554	-0.8506
Event 17	-1.13%	-1.3336	-1.1870	-1.5405	-0.5227
Event 18	0.09%	0.0801	-0.0108	-0.1713	0.4947
Event 19	1.03%	1.0611	0.7577	1.4939	0.7569
Event 20	0.68%	0.6290	0.9600	1.1579	0.4603
Event 21	-0.23%	-0.2968	-0.0830	-0.0735	0.1690
Event 22	-1.06%	**-3.9000****	-1.5127	**-3.2746****	-0.8185
Event 23	1.58%	**2.5272****	**2.3718****	**2.4136****	1.5924